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# Exploring a recognition-induced recognition decrement

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Four experiments were performed to explore a recognition decrement that is associated with the recognition of a word from a short list. The stimulus material for demonstrating the phenomenon was a list of words of different syntactic types. A word from the list was recognized less well following a decision that a word of the same type had occurred in the list than following a decision that such a word had not occurred in the list. A recognition decrement did not occur for a word of a given type following a positive recognition decision to a word of a different type. A recognition decrement did not occur when the list consisted exclusively of nouns. It was concluded that the phenomenon may reflect a criterion shift but, probably, does not reflect a list strength effect, suppression, or familiarity attribution consequent to a perceived discrepancy between actual and expected fluency.

Memory processes are heavily involved in discourse comprehension. Shorter term memory keeps track of the information needed to maintain discourse coherence. Longer term memory provides the knowledge needed to make sense of the discourse in terms of the larger word (Almor, 1999; Graesser, Singer, & Trabasso, 1994; Just & Carpenter, 1992; Kintsch, 1988). The present study focused on a shorter term memory process associated with *anaphor* comprehension.

An entity is identified with an anaphoric expression each time it is mentioned following its introduction in a passage. An *antecedent* must then be located for the anaphoric expression in the preceding material. When this is accomplished, the anaphor is said to be *resolved* (Cacciari, Carreiras, & Cionini, 1997; Garnham, 1985, 2001; Garnham, Oakhill, & Cain, 1997; Garrod, Freudenthal, & Boyle, 1994; McDonald & MacWhinney, 1995).

## A Comprehension Phenomenon?

We infer that anaphor resolution involves memory processes because the capacity for remembering the contents of a passage changes with the resolution of an anaphor. The anaphor's antecedent is recognized more quickly and/or more accurately at this point (Cloitre & Bever, 1989; Corbett & Chang, 1983; Dell, McKoon, & Ratcliff, 1983; Gernsbacher, 1989; O'Brien, 1987; O'Brien, Duffy, & Myers, 1986; O'Brien, Plewes, & Albrecht, 1990). Other words in the passage are recognized less quickly and/or less accurately (Gernsbacher, 1989; MacDonald & MacWhinney, 1990; Nordlie, Dopkins, & Johnson, 2001). The present study explored the process underlying the latter phenomenon.

The phenomenon was first demonstrated by Gernsbacher (1989) using a *probe recognition task.* On each trial, the participant (1) read a sentence as it was presented word by word on a computer screen and (2) made a recognition judgment to a test word that appeared at some point during the presentation of the sentence. Each of the critical sentences contained two clauses, with two characters being introduced in the first clause, identified either with proper nouns or with definite noun phrases, and with a repeated-noun anaphor occurring at the beginning of the second clause. The antecedent of the anaphor was the proper or common noun that had been used to identify one of the characters—for example, "Ann predicted that Pam would lose the track race, but Pam came in first very easily."

The crucial results occurred when the test word was the noun that was not the anaphor's antecedent—for example, "Ann predicted that Pam would lose the track race, but Pam [Probe: *Ann*] came in first very easily." Recognition times were longer when the test word was presented after as opposed to before the anaphor. Gernsbacher (1990) attributed these results to a process associated with anaphor comprehension, the function of which is to promote retrieval of a repeated-noun anaphor's antecedent by reducing the availability of competing words.

## A Memory Phenomenon

Gernsbacher's (1990) interpretation of her results was called into question, however, by results that Dopkins and Ngo (2002) subsequently observed. Dopkins and Ngo (2002) started with sentences like Gernsbacher's, each of which mentioned two characters, identified with either

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proper or common nouns. Dopkins and Ngo (2002) scrambled the order of the words in these sentences and used the resulting lists as stimulus material for a probe recognition task. On each trial of the task, the participant read a list, made a recognition judgment with respect to a test word, and indicated whether the list contained any repeated words. In the crucial condition, the test word was a noun from the list, and the last word in the list was another noun that was repeated from earlier in the list—for example, "Robert more Jim be honest urged to at tax time but Robert [Probe: *Jim*]." The test word was recognized less quickly and/or less accurately in this condition than when (1) an adverb was inserted in place of the repeated noun (e.g., "Robert more Jim be honest urged to at tax time but then [Probe: *Jim*]"), (2) a new noun was inserted in place of the repeated noun (e.g., "Robert more Jim be honest urged to at tax time but Bill [PROBE: *Jim*]"), or (3) the list ended immediately before the repeated noun would have occurred (e.g., "Robert more Jim be honest urged to at tax time but [Probe: *Jim*]").

Thus, the results of Dopkins and Ngo (2002) resembled the results of Gernsbacher (1989). For Gernsbacher, a noun in a sentence was recognized less well following the processing of a repeated-noun anaphor. For Dopkins and Ngo (2002), a noun in a list obtained from a scrambled sentence was recognized less well following the processing of a repeated noun. Notwithstanding the resemblance between the two sets of results, Dopkins and Ngo (2002) concluded that their results could not reflect an anaphor comprehension process such as Gernsbacher proposed. Crucially, the lists in the Dopkins and Ngo (2002) study were derived from scrambled sentences and, therefore, had minimal discourse properties. Thus, they should not have evoked anaphor comprehension processes. Instead, Dopkins and Ngo (2002) concluded (1) that the participants, perhaps under pressure from the requirement that word repetition be monitored, recognized the repeated noun as having occurred before in the list and (2) that as a consequence of the positive recognition decision, the test noun was recognized less well.

On the basis of further experimentation, Dopkins and Ngo (2005) suggested that the Dopkins and Ngo (2002) memory process was responsible for the Gernsbacher (1989) phenomenon. Dopkins and Ngo (2005) proposed, therefore, that the Gernsbacher (1989) phenomenon does not imply the existence of a specialized nonantecedent suppression process, as Gernsbacher (1989) proposed. Rather, the phenomenon implies that recognition memory plays a role in the identification of potential anaphors: While reading a passage, a person remains alert to the occurrence of words that are repeated from earlier in the passage. When a repeated word is recognized as such, it is classified as a potential anaphor, and the earlier occurrence of the word is retrieved. Further processing then determines whether or not the repeated word is, in fact, an anaphor. As a consequence of the positive recognition decision regarding the repeated word, other words in the passage are subject to a recognition decrement, implemented by a process such as Dopkins and Ngo (2002) proposed.

**Understanding the Memory Phenomenon**

We need to better understand the phenomenon that Dopkins and Ngo (2002) observed. In particular, we need to establish the boundary conditions of that phenomenon. Dopkins and Ngo (2002) studied recognition memory in a rather specialized situation. The memory set for a given trial in their study was a list obtained from a scrambled sentence. The test word was a proper or a common noun. The last word of the list—the word that was processed immediately before the recognition judgment—was also a proper or a common noun.

Given the specificity of the situation that Dopkins and Ngo (2002) studied, a number of questions arise as to the generality of the phenomenon that they observed. Does a recognition decrement occur only following the processing of a repeated noun? Does the recognition decrement that occurs following the processing of a repeated noun affect only a noun test word? More generally, does the recognition decrement that occurs following the processing of a repeated word of a certain type affect only a test word of the same type? Does a recognition decrement occur only when the memory set is syntactically heterogeneous, as with a scrambled sentence?

If the phenomenon that Dopkins and Ngo (2002) observed reflects a memory process, as they have proposed, the phenomenon must generalize beyond the specialized situation in which it was initially observed. Thus, the answers to at least some of these questions must be *no*. Granting that the Dopkins and Ngo (2002) phenomenon reflects a memory process, the answers to these questions may help us to understand the nature of the process. The universe of possible processes is best delineated in terms of ideas from the domain of recall, where the study of memory deficits has a long history. Accounts of recall deficits have traditionally been of four sorts (Anderson & Bjork, 1994). *Associative bias* accounts tie recall deficits to failures of the links between the memory traces for retrieval cues and test words, usually as the result of interference (McGeoch, 1936, 1942; Melton & Irwin, 1940). *Cue bias* accounts tie recall deficits to the use of inappropriate retrieval cues (Estes, 1955; Martin, 1971). *Executive bias* accounts tie recall deficits to inappropriate memory strategies (Raaijmakers & Schiffrin, 1981). *Suppression* accounts tie recall deficits to the operation of control processes that render memory traces reversibly less accessible (Bjork, 1989; Postman, Stark, & Frazier, 1968).

To apply these ideas to the Dopkins and Ngo (2002) phenomenon, we must adapt them to the domain of recognition. In general, recognition models are of two sorts. In *global match* models, making a recognition judgment involves a single process that assesses the degree of overlap between the test item and all of the items in memory. In *dual-process* models, making a recognition judgment involves two different processes, one of which assesses the familiarity of the test item, the other of which attempts to recollect the fact of the item's previous occurrence in the context of interest.

Applying the associative bias conception to the Dopkins and Ngo (2002) phenomenon, we come up with the

possibility that the phenomenon reflects a process of interference. This idea is most easily developed in the global match framework. Some global match models predict what is known as the *list strength effect*, in which the capacity for recognizing a list item decreases as the memory strength of other list items increases (Ratcliff, Clark, & Shiffrin, 1990; Shiffrin, Ratcliff, & Clark, 1990). Although the list strength effect is often not observed in situations in which it is predicted, it has not been explored in the particular situation of the present phenomenon. One possibility, then, is that the phenomenon reflects a variant of the list strength effect: The repeated word is strengthened in memory as a by-product of its repetition. As a result, the capacity for recognizing the test word decreases. The capacity for recognizing the test word does not decrease following the processing of the control material. Recognition performance is, consequently, poorer in the former case.

The cue bias conception cannot be directly applied to the Dopkins and Ngo (2002) phenomenon, inasmuch as recognition is not generally thought to be cue driven. A related account can be fashioned, however, from the general idea that the phenomenon reflects inappropriate influences in the informational context of the memory test. This account is most easily developed in the dual-process framework. The account is based on the *discrepancy attribution hypothesis*, which seeks to explain how familiarity is assessed in the dual-process framework (Whittlesea & Williams, 1998, 2000, 2001a, 2001b). The hypothesis holds that a discrepancy between actual and expected fluency in the processing of an item is accommodated with an appropriate adjustment in the item's presumed level of familiarity. Applying this idea in the present context, we come up with the following account: The second time the repeated word appears in the list, it is processed relatively fluently, as a by-product of its repetition. Fluency in the processing of the repeated word leads to the expectation of fluency in the processing of the test word. A discrepancy then occurs between actual and expected fluency in the processing of the test word. No such discrepancy occurs following the processing of the control material. As a result, the test word is ascribed a lower degree of familiarity following the processing of the repeated word than following the processing of the control material. Recognition performance is, consequently, poorer in the former case.

Applying the executive bias conception to the Dopkins and Ngo (2002) phenomenon, we come up with the possibility that the phenomenon reflects a change in response bias. This idea can be developed in either the global match or the dual-process framework. In order to instantiate a global match or a dual-process model, one must assume a value of overlap or familiarity that is sufficient for a positive recognition decision. The idea, then, is that an increment occurs to this value following the processing of the repeated word, but not following the processing of the control material. As a result, the criterion value of overlap or familiarity is more difficult to achieve following the processing of the repeated word than following the processing of the control material. Recognition performance is, consequently, poorer in the former case.

Applying the suppression conception to the Dopkins and Ngo (2002) phenomenon, we come up with the possibility that the phenomenon reflects the operation of a control process that renders the test word reversibly less accessible. This idea is most easily developed in the dual-process framework. Of course, we must assume a suppression mechanism as an added feature of the framework. The idea, then, is that this mechanism reduces the accessibility of the test word to recollection following the processing of the repeated word, but not following the processing of the control material. Recognition performance is, consequently, poorer in the former case.

In the present study, we sought to delineate the boundary conditions of the Dopkins and Ngo (2002) phenomenon. In doing this, we sought to show that the phenomenon generalizes beyond the specialized situation in which it was initially observed. In addition, we sought to gather evidence regarding the foregoing accounts of the phenomenon. As it turned out, the results of Experiments 2A and 2B argued against the list strength account of the phenomenon, and the results of Experiments 3A and 3B argued against the discrepancy attribution and suppression accounts of the phenomenon.

## EXPERIMENT 1

In Experiment 1, we sought to show that the Dopkins and Ngo (2002) procedure gives rise to a recognition decrement following the processing of a repeated word that is other than a noun. Specifically, we sought to show that the procedure gives rise to a recognition decrement following the processing of a repeated verb. In this way, we sought to show that the Dopkins and Ngo (2002) phenomenon generalizes beyond the specialized situation in which it was initially observed.

Each of the lists used in the experiment was created by scrambling the words in a sentence. Included in the list were two nouns and two verbs. In the *repeated* condition, one of the two verbs in the list was repeated as the last word in the list. In the *new* condition, a third verb was introduced at that point. On each trial, the participant read a list, word by word, made a recognition judgment to a test word, and indicated whether the list contained any repeated words. The test word was the verb that was not repeated in the repeated condition. The question of interest was whether a recognition decrement would occur—whether recognition performance would be worse in the repeated than in the new condition.

A word should be said about the requirement that the participants indicate after reading each list whether it contained any repeated words. The purpose of this requirement was to ensure that the participants recognized the repeated verb that ended the list in the repeated condition. One might be concerned that this requirement played a role in producing any recognition decrement that was observed. Results to be reported later should allay this concern.

## Method

### Participants

The participants were 50 students at the George Washington University. They received extra credit in a psychology course in exchange for their efforts.

### Design

Last word type was manipulated within participants and within items.

### Materials

The 48 experimental lists were based on sentences from an earlier study of the Gernsbacher phenomenon (Nordlie et al., 2001). Each of these sentences described an event involving two characters. In one half of the sentences, the characters were identified with proper nouns; in the other half of the sentences, the characters were identified with common nouns that described occupations (e.g., *cook* or *butler*). All of the sentences contained a prominent verb. The words in each of the 48 sentences were randomly reordered. In addition, a second verb was added to each list. The meaning of the added verb was roughly consistent with the meaning of the other words in the list. In the repeated condition, one of the two verbs in the list was repeated as the last word in the list. In the new condition, a third verb was introduced at that point. The test word was the verb that was not repeated in the repeated condition. The Appendix presents a sample list, which was derived from the sentence, *Then the chef and waiter tripped, after the hard soufflé fell flat.*

Across participants, the experimental lists were rotated through the two last word type conditions in such a way as to produce two materials sets. The experimental lists were randomly intermixed with 28 filler lists. The test words for 25 of these lists required a negative response. In order to make the task more difficult, the negative test words either were drawn from earlier lists or were related in meaning to the other words in the current list. The test words for 11, 11, and 6 of the lists were verbs, nouns, and adjectives, respectively. As in all of the experiments for the study, the word types and response polarities of the test words for the filler lists were chosen so as to (1) balance as much as possible the number of positive and negative trials and (2) divert attention from the word type that was to be tested on experimental trials. Fifteen of the filler lists contained a repeated word.

### Procedure

The participants were randomly assigned to materials sets. The lists were presented on a computer monitor, according to the procedure of Dopkins and Ngo (2002). The participant started the presentation of each list by pressing the space bar of the computer. The list was presented word by word, with each successive word appearing alone in the middle of the screen for an amount of time that was calculated according to a formula used by Dopkins and Ngo (2002) and derived from Gernsbacher (1989): presentation time = (450 msec) + [(16.667 msec) × (number of letters)]. After the last word of the list disappeared, a row of asterisks appeared at the top of the screen, an interval of 2,000 msec elapsed, the asterisks disappeared, and the test word appeared, where the asterisks had been, in uppercase letters. The word remained on the screen until the participant responded. At this point, a prompt appeared, asking whether the list had contained any repeated words. The participant was instructed to respond positively to the test word only if it had appeared in the current list. He/she was instructed to respond positively to the repeated-word question only if a content word (i.e., noun, verb, adjective, or adverb) had been repeated in the current list. Note that the participant did not have to indicate which word had been repeated, only whether a word had been repeated. The participant was instructed to respond as quickly as possible to the test word, without sacrificing accuracy, but to strive only for accuracy in responding to the repeated-word question.

## Results

Responses to the repeated-word question were correct 77% of the time.

Only response times for correct responses were examined. Response times greater than 7,500 msec were truncated at that value. The data were broken down in terms of the accuracy of the response to the repeated-word question. Primary attention was focused on the data for trials on which the repeated-word response was correct. Given that the goal of the experiment was to observe the effects of recognizing the repeated word, and given that the repeated word would not always be recognized, it was reasoned that analyses should be limited as much as possible to data from trials on which it was. Although the response to the repeated-word question would not be an infallible indicator of whether or not the repeated word was recognized, it was the best indicator that was available.

Systematic analyses were not attempted on the data for trials on which the repeated-word response was incorrect. Because performance on the repeated-word question was good, these data were compromised by large amounts of missing data. As a consequence, the data points for the different conditions did not reflect the same participants or even the same numbers of participants. The main objective was to compare the rough pattern of these data with the pattern of the data for correct repeated-word trials. It was reasoned that, if the results for correct repeated-word trials reflected the effects of recognizing the repeated word, the pattern of data for these trials should not be preserved in the data for incorrect repeated-word trials.

### Repeated-Word Response Correct

Although response time was greater in the repeated condition ($M$ = 1,101 msec, $SD$ = 392 msec) than in the new condition ($M$ = 1,041 msec, $SD$ = 270 msec), the difference was not reliable [$F_1(1,48) = 1.41$, $MS_e = 64{,}318$, $p = .24$; $F_2(1,46) = 1.58$, $MS_e = 26{,}790$, $p = .215$]. Error rate was reliably greater in the repeated condition ($M$ = .22, $SD$ = .17) than in the new condition ($M$ = .15, $SD$ = .17) [$F_1(1,48) = 5.54$, $MS_e = 0.02$; $F_2(1,46) = 8.61$, $MS_e = 0.015$].

### Repeated-Word Response Incorrect

Response time was greater in the new condition ($M$ = 1,092 msec) than in the repeated condition ($M$ = 1,056 msec). Error rate was greater in the new condition ($M$ = .23) than in the repeated condition ($M$ = .17). Thus, the pattern differed from the pattern observed on correct repeated-word trials.

## Discussion

A recognition decrement was observed for a verb test word following the processing of a repeated verb in a list that was obtained from a scrambled sentence. The recognition decrement evidently reflected the effects of recognizing the repeated verb. The recognition decrement was present in the error rate but not in the response time data.

The participants evidently set their speed–accuracy tradeoff in such a way that the decrement was unable to appear in the response time data. These results show that the Dopkins and Ngo (2002) procedure gives rise to a recognition decrement following the processing of a repeated verb, as well as a repeated noun. They show that the Dopkins and Ngo (2002) phenomenon generalizes beyond the specialized situation in which it was initially observed.

## EXPERIMENTS 2A–2C

In Experiments 2A–2C, we asked whether the recognition decrement that occurs in the Dopkins and Ngo (2002) procedure with a certain type of repeated word extends to a test word of a different type. Specifically, in Experiment 2A, we asked whether the decrement occurring with the processing of a repeated noun extends to a verb test word; in Experiment 2B, we asked whether the decrement occurring with the processing of a repeated proper noun extends to a common noun test word; in Experiment 2C, we asked whether the decrement occurring with the processing of a repeated common noun occupation name extends to a test word that is a common noun object name.

It was reasoned that the experiments would further clarify the generality of the Dopkins and Ngo (2002) phenomenon and might speak to one possible account of the phenomenon: If the recognition decrement occurring with the processing of a certain type of repeated word extends only to a test word of the same type, this suggests a limit to the generality of the phenomenon. In addition, it argues against accounting for the phenomenon in terms of the list strength effect. Under a list strength account, processing a repeated word increases the strength of that word in memory. The increased strength of the repeated word, in turn, impedes recognition judgments to the test word. In the global match framework, which underlies the list strength account, a test item is matched against all of the items in memory. Thus, increasing the strength of a certain type of word should impede recognition judgments to a test word of any type. Therefore, if the recognition decrement for a certain type of repeated word extends only to a test word of the same type, this argues against the list strength account (Ratcliff et al., 1990; Shiffrin et al., 1990).

The basic procedure of the three experiments was the same as that in Experiment 1. Each of the experimental lists was a scrambled sentence (see the Appendix). Included in each of the lists for Experiment 2A were two proper or common nouns and a verb. In the *repeated* condition, one of the two nouns was repeated as the last word in the list. In the *new* condition, a third noun, of the same type as the other two (proper or common), was introduced at that point. In the *noun* condition, the test word was the noun that was not repeated in the repeated condition. In the *verb* condition, the test word was the verb.

Included in each of the lists for Experiment 2B were two proper nouns, a verb, and a common noun that identified an object. In the repeated condition, one of the two proper nouns was repeated as the last word in the list. In the new condition, a third proper noun was introduced at that point. In the proper noun condition, the test word was the proper noun that was not repeated in the repeated condition. In the common noun condition, the test word was the common noun.

Included in each of the lists for Experiment 2C were two common nouns that identified occupations, a verb, and a common noun that identified an object. In the re-

**Table 1**
**Results of Experiments 2A and 2B: Response Times (RTs, in Milliseconds) and Error Rates (ERs)**

| | Last Word Type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Repeated | | | | New | | | |
| | RT | | ER | | RT | | ER | |
| Test Word Type | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Experiment 2A | | | | | | | | |
| Repeated-Word Response Correct | | | | | | | | |
| Noun | 1,228 | 477 | .17 | .16 | 1,120 | 311 | .14 | .16 |
| Verb | 1,146 | 307 | .17 | .16 | 1,176 | 377 | .16 | .18 |
| Repeated-Word Response Incorrect | | | | | | | | |
| Noun | 1,181 | | .22 | | 1,177 | | .20 | |
| Verb | 1,191 | | .20 | | 1,114 | | .20 | |
| Experiment 2B | | | | | | | | |
| Repeated-Word Response Correct | | | | | | | | |
| Proper noun | 1,111 | 303 | .24 | .19 | 1,068 | 304 | .16 | .18 |
| Common noun | 1,103 | 283 | .25 | .19 | 1,101 | 406 | .24 | .19 |
| Repeated-Word Response Incorrect | | | | | | | | |
| Proper noun | 1,150 | | .27 | | 1,115 | | .25 | |
| Common noun | 1,104 | | .29 | | 1,103 | | .29 | |

Note—Standard deviations are not given for trials on which the repeated word response was incorrect, because each data point represents different numbers of participants.

peated condition, one of the two occupation names was repeated as the last word in the list. In the new condition, a third occupation name was introduced at that point. The test word was the object name.

On the basis of Dopkins and Ngo (2002), it was expected that recognition decrements would occur in the noun condition of Experiment 2A and the proper noun condition of Experiment 2B; that is, it was expected that recognition performance in each case would be worse in the repeated than in the new condition. The question of interest was whether recognition decrements would occur in the verb condition of Experiment 2A, in the common noun condition of Experiment 2B, and in Experiment 2C.

## Method

### Participants

The participants were 84 (Experiment 2A), 60 (Experiment 2B), and 70 (Experiment 2C) students from the same population as that used in Experiment 1.

### Design

Last word type and test word type were manipulated within participants and within items.

### Materials

Thirty-six, 40, and 48 experimental lists were used in Experiments 2A, 2B, and 2C. The Appendix presents sample lists. In Experiments 2A and 2B, the experimental lists were rotated through the two last word type conditions and the two test word type conditions in such a way as to produce four materials sets. In Experiment 2C, the experimental lists were rotated through the two last word type conditions in such a way as to produce two materials sets. The experimental lists were randomly intermixed with 42, 42, and 30 filler lists in Experiments 2A, 2B, and 2C. The test words for 31, 29, and 25 of the filler lists required a negative response in Experiments 2A, 2B, and 2C. The test words for the negative lists were selected as in Experiment 1. In Experiment 2A, the test words for 15, 8, 15, 2, and 2 of the lists were verbs, proper nouns, common nouns, adjectives, and adverbs, respectively. Twenty-two of the filler lists contained a repeated word. In Experiment 2B, the test words for 3, 20, and 19 of the lists were verbs, proper nouns, and common nouns, respectively. Twenty-six of the filler lists contained a repeated word. In Experiment 2C, the test words for 10, 4, 4, and 12 of the filler lists were verbs, proper nouns, occupation nouns, and object nouns, respectively. Sixteen of the filler lists contained a repeated word.

### Procedure

The procedure was the same as that in Experiment 1.

## Results

The recognition data for the three experiments are summarized in Table 1.

### Experiment 2A (Noun/Noun, Verb)

The data for proper and common noun items were collapsed in the interest of stability. Responses to the repeated-word question were correct 81% of the time.

**Repeated-word response correct**. Response time did not vary as a function of last word type [$F_1(1,80) = 1.93$, $MS_e = 64{,}740$, $p = .169$; $F_2(1,32) < 1$] or test word type [$F_1(1,80) < 1$; $F_2(1,32) < 1$]. The effects of last word type and test word type interacted, however, in the response time data [$F_1(1,80) = 7.48$, $MS_e = 53{,}964$; $F_2(1,32) = 3.25$, $MS_e = 29{,}043$ (one-tailed)]. In the noun condition, response time was greater in the repeated than in the new condition [$F_1(1,80) = 6.97$, $MS_e = 70{,}115$; $F_2(1,32) = 2.88$, $MS_e = 21{,}154$ (one-tailed)]. In the verb condition, response time did not differ in the repeated and new conditions [$F_1(1,80) < 1$; $F_2(1,32) = 1.53$, $MS_e = 23{,}053$, $p = .225$]. Error rate did not vary as a function of last word type [$F_1(1,80) = 1.47$, $MS_e = 0.025$, $p = .28$; $F_2(1,32) < 1$] or test word type [$F_1(1,80) < 1$; $F_2(1,32) < 1$]. The effects of last word type and test word type did not interact in the error rate data [$F_1(1,80) = 1.01$, $MS_e = 0.016$, $p = .318$; $F_2(1,32) < 1$].

**Repeated-word response incorrect**. As for the correct repeated-word trials, response time and error rate in the noun condition were greater in the repeated than in the new condition. The differences were smaller, however, than for

**Table 2**
**Results of Experiment 4: Response Time (RTs, in Milliseconds) and Error Rates (ERs)**

| | | Last Word Type | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Repeated | | | | New | | | |
| | | RT | | ER | | RT | | ER | |
| Test Word Type | Number of Nouns | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Repeated-Word Response Correct | | | | | | | | | |
| Noun | 3 | 1,344 | 345 | .20 | .19 | 1,238 | 331 | .13 | .15 |
| | 7 | 1,152 | 239 | .20 | .19 | 1,078 | 238 | .17 | .15 |
| Verb | 3 | 1,350 | 385 | .18 | .20 | 1,294 | 504 | .13 | .19 |
| | 7 | 1,194 | 337 | .18 | .21 | 1,185 | 297 | .17 | .22 |
| Repeated-Word Response Incorrect | | | | | | | | | |
| Noun | 3 | 1,262 | | .22 | | 1,406 | | .24 | |
| | 7 | 1,142 | | .19 | | 1,087 | | .27 | |
| Verb | 3 | 1,286 | | .17 | | 1,382 | | .35 | |
| | 7 | 1,319 | | .18 | | 1,107 | | .32 | |

Note—Standard deviations are not given for trials on which the repeated word response was incorrect, because each data point represents different numbers of participants.

the correct repeated-word trials. Thus, the data for incorrect repeated-word trials did not completely preserve the pattern observed on correct repeated-word trials.

### Experiment 2B (Proper Noun/Proper Noun, Common Noun)

Responses to the repeated-word question were correct 75% of the time.

**Repeated-word response correct**. Response time did not vary as a function of last word type [$F_1(1,56) < 1$; $F_2(1,36) = 1.49$, $MS_e = 13{,}903$, $p = .23$] or test word type [$F_1(1,56) < 1$; $F_2(1,36) < 1$]. The effects of last word type and test word type did not interact in the response time data [$F_1(1,56) < 1$; $F_2(1,36) < 1$]. The error rate was greater in the repeated than in the new condition [$F_1(1,56) = 6.76$, $MS_e = 0.037$; $F_2(1,36) = 5.25$, $MS_e = 0.015$]. The error rate was marginally greater in the common noun than in the proper noun condition [$F_1(1,56) = 2.82$, $MS_e = 0.03$, $p = .10$; $F_2(1,36) = 2.98$, $MS_e = 0.024$, $p = .09$]. The effects of last word type and test word type interacted in the error rate data [$F_1(1,56) = 2.88$, $MS_e = 0.023$ (one-tailed); $F_2(1,36) = 5.53$, $MS_e = 0.011$]. In the proper noun condition, the error rate was greater in the repeated than in the new condition [$F_1(1,56) = 8.33$, $MS_e = 0.034$; $F_2(1,36) = 10.66$, $MS_e = 0.013$]. In the common noun condition, the error rate did not differ in the repeated and new conditions $F_1(1,56) < 1$; $F_2(1,36) < 1$].

**Repeated-word response incorrect**. As for the correct repeated-word trials, response time and error rate in the proper noun condition were greater in the repeated than in the new condition. The differences were smaller, however, than those for correct repeated-word trials. Again, the data for the incorrect repeated-word trials did not completely preserve the pattern observed on correct repeated-word trials.

### Experiment 2C (Occupation Noun/Object Noun)

Responses to the repeated-word question were correct 78% of the time.

**Repeated-word response correct**. Although response time was greater in the repeated condition ($M =$ 1,079 msec, $SD =$ 355 msec) than in the new condition ($M =$ 1,077 msec, $SD =$ 388 msec), the difference was not reliable [$F_1(1,68) < 1$; $F_2(1,46) = 1.18$, $MS_e = 8{,}918$, $p = .28$]. Error rate was greater in the repeated ($M = .23$, $SD = .15$) than in the new condition ($M = .18$, $SD = .13$) [$F_1(1,68) = 7.76$, $MS_e = 0.011$; $F_2(1,46) = 5.25$, $MS_e = 0.006$].

**Repeated-word response incorrect**. Response time was greater in the repeated condition ($M =$ 1,162 msec) than in the new condition ($M =$ 1,062 msec). Error rate did not differ in the repeated ($M = .28$) and new ($M = .28$) conditions. The repeated − new difference in the response time data was greater than for correct repeated-word trials. In the error rate data, however, which produced the significant difference on the correct repeated-word trials, the repeated − new difference was completely absent. Thus, it could be argued that the data for incorrect repeated-word trials did not preserve the pattern observed for correct repeated-word trials.

## Discussion

These results suggest that, for the most part, the recognition decrement associated with the processing of a certain type of repeated word extends only to a test word of the same type. Generalization does occur, but only to a limited degree. These results suggest a limit to the generality of the Dopkins and Ngo (2002) phenomenon. In addition, they argue against explaining the phenomenon in terms of the list strength effect. A list strength account has trouble accommodating the failure of the recognition decrement to extend from a repeated noun to a verb test word and from a repeated proper noun to a common noun test word. In contrast, the other possible accounts that were suggested earlier for the phenomenon can probably accommodate these results.

Consider, first, the discrepancy attribution account. According to this account, processing the repeated word causes a discrepancy between actual and expected fluency in the processing of the test word. This discrepancy, in turn, causes a decrease in the perceived familiarity of the test word. To accommodate the present results in terms of this account, we would stipulate that processing a certain type of repeated word affects only the perception of fluency for words of the same type. It would follow that processing a certain type of repeated word does not affect a recognition judgment to a test word of a different type.

Consider, next, the criterion shift account. According to this account, processing the repeated word causes an increment in the criterion that is used to assess overlap or familiarity for the test word. To accommodate the present results in terms of this account, we would stipulate that processing a certain type of repeated word affects only the criterion for words of the same type. It would follow that processing a certain type of repeated word does not affect a recognition judgment to a test word of a different type.

Consider, finally, the suppression account. According to this account, processing the repeated word reduces the accessibility of the test word to recollection. To accommodate the present results in terms of this account, we would stipulate that processing a certain type of repeated word reduces only the accessibility of a test word of the same type. We could do this as follows. The test word becomes less accessible because it interferes with the recollection of the repeated word. Only words of the same type as the repeated word interfere with its recollection. Because words of different types do not interfere with the recollection of the repeated word, these words do not become less accessible. It follows that processing a certain type of repeated word does not affect a recognition judgment to a test word of a different type. This account is consistent with suppression accounts that have been offered in the recall domain (Anderson, Bjork, & Bjork, 1994; Anderson & McCulloch, 1999; Anderson & Neely, 1996; Anderson & Spellman, 1995; see also Ciranni & Shimamura, 1999; Radvansky, 1999; Shaw, Bjork, & Handal, 1995).

Finally, it should be noted that the results of Experiment 2A (noun/noun, verb) and Experiment 2B (proper noun/proper noun, common noun) argue against the view

that the phenomenon under study reflects distraction from the repetition-monitoring requirement. If distraction of this kind were responsible for the phenomenon, words of all types should have been recognized less well following the processing of the repeated noun in Experiments 2A and 2B.

## EXPERIMENTS 3A AND 3B

Each of the lists of Dopkins and Ngo (2002) and Experiments 1–2C of the present study consisted of the words from a sentence, arranged in a scrambled order. As a consequence of their sentential origin, each of the lists was syntactically heterogeneous. In contrast, much memory research has been carried out with syntactically homogeneous lists. In experiments 3A and 3B, we asked whether a recognition decrement occurs when the Dopkins and Ngo (2002) procedure is carried out with a homogeneous list of nouns.

It was reasoned that the experiments would further clarify the generality of the Dopkins and Ngo (2002) phenomenon and might speak to several of the accounts that were suggested earlier for the phenomenon. If a recognition decrement does not occur with a homogeneous list of nouns, this argues against accounting for the phenomenon in terms of discrepancy between actual and expected fluency and in terms of suppression.

Consider, first, the implications for the discrepancy attribution account: If processing a certain type of repeated word in a heterogeneous list causes a decrease in the perceived familiarity of a test word of that type, the same thing should happen when the words are part of a homogeneous list. Therefore, if a recognition decrement does not occur with a homogeneous list of nouns, this argues against the discrepancy attribution account.

Consider, next, the implications for the suppression account: If processing a certain type of repeated word in a heterogeneous list reduces the accessibility of a test word of the same type, the same thing should happen when the words are part of a homogeneous list. Therefore, if a recognition decrement does not occur with a homogeneous list of nouns, this argues against the suppression account.

The experiments followed the general procedure of Experiments 1–2C, except that the list for each trial consisted exclusively of common nouns, rather than of words from a sentence. On the crucial experimental trials, the list was 7 words long in Experiment 3A and 13 words long in Experiment 3B. (Lists of this length were used because the lists in the experimental conditions in Experiments 1–2C contained, on average, 7 content words and 13 words of all sorts.) In the repeated condition in both experiments, one of the common nouns from the list was repeated as the last word in the list. In the new condition, the last word in the list was a new common noun that had not previously appeared in the list. The question of interest was whether a recognition decrement would be observed—whether recognition performance would be worse in the repeated than in the new condition.

### Method

#### Participants

The participants were 48 (Experiment 3A) and 52 (Experiment 3B) students from the same population as that used in Experiment 1.

#### Design

Last word type was manipulated within participants and within items.

#### Materials

There were 28 experimental lists. To balance the list position of the word that was repeated in the repeated condition, four different kinds of lists were used. In describing the four kinds of lists, a distinction is made between the last word of the list and the rest of the list, with the latter being termed the *list proper*. In Type 1 lists, the last word in the list had already appeared as one of the words in the first third of the list proper. In Type 2 lists, the last word in the list had already appeared as one of the words in the second third of the list proper. In Type 3 lists, the last word in the list had already appeared as one of the words in the third third of the list proper. In Type 4 lists, the last word in the list had not previously appeared in the list. The test word always came from the first third of the list proper. A sample list is shown in the Appendix.

Across participants, the experimental lists were rotated through the four list types in such a way as to create four materials sets. The experimental lists were randomly intermixed with 38 filler lists. The filler lists ranged in length from 4 to 10 words (Experiment 3A) and from 8 to 14 words (Experiment 3B). For 19 of the filler lists, the test word had appeared in the list, so that a positive response was appropriate. For these lists, the test word came with equal probability from the different positions of the list. For 19 of the filler lists, the test word had not appeared in the list, so that a negative response was appropriate. Twelve of the filler lists contained repeated words.

#### Procedure

The procedure was the same as that in Experiment 1.

### Results

#### Experiment 3A (Short Lists)

Responses to the repeated-word question were correct 86% of the time. In the data for trials on which the repeated-word response was correct, response time for the recognition judgments did not differ in the repeated ($M$ = 1,057 msec, $SD$ = 258 msec) and new ($M$ = 1,081 msec, $SD$ = 293 msec) conditions [$F_1(1,44) < 1$; $F_2(1,24) = 3.63$, $MS_e = 16{,}007$, $p = .07$]. Error rate for the recognition judgments also did not differ in the repeated ($M$ = .14, $SD$ = .14) and new ($M$ = .19, $SD$ = .21) conditions [$F_1(1,44) = 2.27$, $MS_e = 0.031$, $p = .14$; $F_2(1,24) = 3.13$, $MS_e = 0.010$, $p = .09$]. Because the data for correct repeated-word trials produced no effects, the data for incorrect repeated-word trials were not examined.

#### Experiment 3B (Long Lists)

Responses to the repeated-word question were correct 68% of the time. In the data for trials on which the repeated-word response was correct, response time for the recognition judgments did not differ in the repeated ($M$ = 1,055 msec, $SD$ = 264 msec) and new ($M$ = 1,071 msec, $SD$ = 353 msec) conditions [$F_1(1,48) < 1$; $F_2(1,24) = 1.20$, $MS_e = 37{,}365$, $p = .285$]. Error rate for the recognition judgments also did not differ in the repeated ($M$ =

.26, $SD = .18$) and new ($M = .24$, $SD = .20$) conditions [$F_1(1,48) < 1$; $F_2(1,24) = 1.15$, $MS_e = 0.014$, $p = .295$]. Again, because the data for correct repeated-word trials produced no effects, the data for incorrect repeated-word trials were not examined.

### Discussion

A recognition decrement was not observed. The test word was recognized no less well in the repeated than in the new condition. Although there was a trend in Experiment 3A (short lists) toward better performance in the repeated than in the new condition, this trend was not present in Experiment 3B (long lists). Because these results were somewhat unexpected, they were replicated using 7- and 13-element lists of proper nouns. Again, neither response time [$F(1,51) < 1$] nor error rate [$F(1,51) < 1$] differed in the repeated and new conditions (because the lists for this experiment were composed through a random sampling procedure, separate participant and item analyses were not necessary).

These results argue against explaining the Dopkins and Ngo (2002) phenomenon in terms of a perceived discrepancy between actual and expected fluency. They also argue against explaining the phenomenon in terms of a suppression process. If either of these accounts were correct, recognition decrements should have occurred with a homogeneous list. In contrast, the criterion shift account can probably accommodate these results. We will address the criterion shift account more specifically in the General Discussion section.

These results also suggest another limit to the generality of the Dopkins and Ngo (2002) phenomenon. Whereas the phenomenon occurred in Experiments 1–2C with a heterogeneous list, it did not occur in Experiments 3A and 3B with a homogeneous list. One possible conclusion is that list heterogeneity is crucial to the occurrence of the phenomenon. Before accepting this conclusion, we must consider two rival interpretations that might be offered for the pattern of generalization so far observed. First, it is possible that the Dopkins and Ngo (2002) phenomenon occurs only when the list contains a relatively small number of words of the same type as the repeated word. We must consider this possibility because the number of nouns in the lists for Experiments 3A and 3B was greater than the number of nouns in the lists for Experiments 2A–2C and greater than the number of verbs in the lists for Experiment 1. Second, it is possible that the phenomenon occurs only when the list retains some vestige of the character of discourse. We must consider this possibility because the lists for Experiments 3A and 3B completely lacked the character of discourse, whereas the lists of Experiments 1–2C may have retained some of that character. Experiment 4 tested these two rival interpretations of the present results.

Finally, it should be noted that the results of the Experiments 3A and 3B argue against the view that the phenomenon under study reflects distraction from the repetition-monitoring requirement. If distraction of this kind were responsible for the phenomenon, a recognition decrement should have been observed in Experiments 3A and 3B.

## EXPERIMENT 4

Experiment 4 tested the hypotheses (1) that the Dopkins and Ngo (2002) phenomenon occurs only when the list contains a relatively small number of words of the same type as the repeated word and (2) that the Dopkins and Ngo phenomenon occurs only when the list retains at least some of the character of discourse.

The materials and procedures for the experiment were the same as those in Experiment 2A (noun/noun, verb–heterogeneous), except that, for half of the lists, four more nouns, of the same type (proper or common noun) as the rest of the nouns in the list, were inserted in randomly chosen locations in place of words in the original versions that were neither nouns nor verbs. Thus, each list in the seven-noun condition contained seven nouns (with seven distinct nouns appearing in the new condition and six distinct nouns appearing in the repeated condition, because one noun occurred in the list proper and again as the last word in the list). This was in contrast to the items in the three-noun condition, which contained three nouns, as in Experiment 2A (with three distinct nouns appearing in the new condition and two distinct nouns appearing in the repeated condition). Note, however, that even in the seven-noun condition, each list contained some words other than nouns and verbs. Both noun and verb test words were used, as in Experiment 2A.

The results for the noun test word were of primary interest. The lists for the three-noun condition were essentially the same as the lists for Experiment 2A (noun/noun, verb–heterogeneous), in which a recognition decrement was observed. Thus, a recognition decrement was expected in the three-noun condition. The point of the experiment was to find out whether a recognition decrement would occur in the seven-noun condition.

The lists for the seven-noun condition had the same number of nouns as the lists for Experiment 3A (noun/noun–homogeneous–short lists), in which no recognition decrement was observed. Thus, if the reason for the absence of a decrement in Experiment 3A is that the Dopkins and Ngo (2002) phenomenon occurs only when the list contains a relatively small number of words of the same type as the repeated word, a decrement should not occur in the seven-noun condition. In addition, augmented as they were with extra nouns, the lists for the seven-noun condition retained almost nothing of the character of discourse. Thus, if the reason for the absence of a recognition decrement in Experiment 3A is that the phenomenon occurs only when the list retains at least some of the character of discourse, a decrement should not occur in the seven-noun condition.

The results for the verb test word were of interest primarily in that they allowed for a replication of the crucial results of Experiment 2A (noun/noun, verb–heterogeneous)—that is, the absence of a recognition decrement following the

processing of a repeated noun. It was expected that a recognition decrement would be similarly absent in the three- and seven-noun conditions.

## Method

### Participants

The participants were 66 students from the same population as that used in Experiment 1.

### Design

Last word type and test word type were manipulated within participants and within items. Number of nouns was manipulated within participants and between items.

### Materials

The 48 experimental lists were based on a set of lists of the same sort as those used in Experiment 2A, modified as described earlier. Across participants, the 24 lists in the three- and seven-noun conditions were independently rotated through the last word type and test word type conditions. The noun condition appeared twice as often as the verb condition in the test word type rotation. As a result, six lists were needed to cycle through the last word type and test word type conditions, with the test word for four of the lists being a noun and the test word for two of the lists being a verb and with the noun and verb lists being divided equally between the repeated and the new conditions. In this way, six materials sets were created. The distances were equated between the ends of the lists and the points at which the noun and verb test words initially appeared in the lists. Table 1 presents sample lists.

The experimental lists were randomly intermixed with 51 filler lists. The test words for 37 of these lists required a negative response. The negative test words were chosen as in Experiment 1. The test words for 16, 12, 16, 4, and 3 of the lists were verbs, proper nouns, common nouns, adjectives, and adverbs, respectively. Twenty-four of the filler lists contained a repeated word.

### Procedure

The procedure was the same as that in Experiment 1.

## Results

Responses to the repeated-word question were correct 77% of the time. Table 2 summarizes the recognition data. As in Experiment 2A (noun/noun, verb–heterogeneous), the data for proper and common noun items were collapsed. To simplify the interpretation, the results for the noun and the verb conditions were analyzed separately.

### Repeated-Word Response Correct

In the noun condition, response time was greater in the repeated than in the new condition [$F_1(1,60) = 14.93$, $MS_e = 35{,}557$; $F_2(1,24) = 12.28$, $MS_e = 19{,}857$]. Response time was also greater in the three- than in the seven-noun condition [$F_1(1,60) = 61.75$, $MS_e = 33{,}040$; $F_2(1,24) = 5.70$, $MS_e = 113{,}927$]. The effects of last word type and number of nouns did not interact in the response time data [$F_1(1,60) < 1$; $F_2(1,24) < 1$]. Error rate was greater in the repeated than in the new condition [$F_1(1,60) = 4.82$, $MS_e = 0.031$; $F_2(1,24) = 9.37$, $MS_e = 0.006$]. Error rate did not vary as a function of number of nouns [$F_1(1,60) < 1$; $F_2(1,24) < 1$]. The effects of last word type and number of nouns did not interact in the error rate data [$F_1(1,60) = 1.49$, $MS_e = 0.019$, $p = .23$; $F_2(1,24) < 1$]. Because they were particularly important to the interpretation of the results of the experiment, tests were conducted of the effect of last word type within the seven-noun condition. Response time was greater in the repeated than in the new condition [$F_1(1,60) = 9.82$, $MS_e = 18{,}126$; $F_2(1,12) = 26.26$, $MS_e = 6{,}185$]. Error rate did not differ in the repeated and the new conditions [$F_1(1,60) < 1$; $F_2(1,12) < 1$].

In the verb condition, response time did not vary as a function of last word type [$F_1(1,60) < 1$; $F_2(1,24) = 1.40$, $MS_e = 26{,}871$, $p = .25$]. Response time was marginally greater in the three- than in the seven-noun condition [$F_1(1,60) = 13.69$, $MS_e = 84{,}999$; $F_2(1,24) = 3.92$, $MS_e = 105{,}718$, $p = .06$]. The effects of last word type and number of nouns did not interact in the response time data [$F_1(1,60) < 1$; $F_2(1,24) < 1$]. Error rate did not vary as a function of last word type [$F_1(1,60) < 1$; $F_2(1,24) = 1.31$, $MS_e = 0.009$, $p = .26$]. Error rate also did not vary as a function of number of nouns [$F_1(1,60) < 1$; $F_2(1,24) < 1$]. The effects of last word type and number of nouns did not interact in the error rate data [$F_1(1,60) < 1$; $F_2(1,24) < 1$].

### Repeated-Word Response Incorrect

The results for the noun condition were of primary interest. In the three-noun condition, response time and error rate were greater in the new than in the repeated condition. In the seven-noun condition, response time was greater in the repeated condition, but error rate was greater in the new condition. Thus, the data for incorrect repeated-word trials did not preserve the pattern observed on correct repeated-word trials.

## Discussion

A recognition decrement was observed for the noun test word regardless of whether the list contained three or seven nouns. Whereas most of the previous experiments have demonstrated recognition decrements in terms of error rate data, the present experiment demonstrated a recognition decrement in terms of the response time and error rate data. On the basis of these results, we can discount the possibility that the Dopkins and Ngo (2002) phenomenon occurs only when the list contains a relatively small number of words of the same type as the repeated word. We must consider this possibility because the number of same-type words was relatively large in Experiments 3A and 3B (homogeneous), in which recognition decrements did not occur, and relatively small in Experiments 1–2C (heterogeneous), in which recognition decrements occurred. We can discount the possibility because the number of same-type words was identical in Experiment 3A, in which a recognition decrement did not occur, and the seven-noun condition in the present experiment, in which a recognition decrement occurred.

We can also discount the possibility that the Dopkins and Ngo (2002) phenomenon occurs only when the list retains at least some of the character of discourse. We must consider this possibility because the lists in Experiments 3A and 3B (homogeneous) completely lacked the character of discourse, whereas the lists in Experiments 1–2C (heterogeneous) may have retained some of that character. We can discount the possibility because the

lists in the seven-noun condition, in which a decrement occurred, retained almost nothing in the way of discourse character. These results therefore support the conclusion that list heterogeneity is crucial to the occurrence of the Dopkins and Ngo (2002) phenomenon.

A recognition decrement was not observed for the verb test word following the processing of the repeated noun. These results replicate the results of Experiment 2A (noun/noun, verb–heterogeneous).

Finally, a word should be said about the fact that both noun and verb test words were recognized less well in the three- than in the seven-noun condition. This result is probably spurious, because the three- and seven-noun conditions were not matched in terms of distance between the end of the list and the point at which the test word initially appeared in the list.

## GENERAL DISCUSSION

Four experiments were performed to explore a decrement in recognition memory performance that is associated with the recognition of a word from a short list. The results of the experiments are summarized in Table 3. In Experiment 1, a verb test word was subject to a recognition decrement following the processing of a repeated verb in a list obtained from a scrambled sentence. In Experiment 2A, a noun, but not a verb, test word was subject to a recognition decrement following the processing of a repeated noun in a list of the same sort. In Experiment 2B, a proper, but not a common, noun test word was subject to a recognition decrement following the processing of a repeated proper noun in a list of the same sort. In Experiment 2C, an object noun test word was subject to a recognition decrement following the processing of a repeated occupation noun in a list of the same sort. In Experiments 3A (short lists) and 3B (long lists) and in the experiment that was conducted to follow up on those experiments, a noun test word was not subject to a recognition decrement following the processing of a repeated noun in a homogeneous list. In Experiment 4, a noun, but not a verb, test word was subject to a recognition decrement following the processing of a repeated noun in a list obtained from a scrambled sentence, enough of the original words of which had been replaced by nouns that the list contained as many nouns as did the lists in Experiment 3A.

These results are important, first, in that they testify to the reliability of the phenomenon that Dopkins and Ngo (2002) observed. Such a phenomenon has not been reported previously. The nearest precedent is *output interference*, in which members of a memory set are remembered less well the later they are tested in a sequence of trials (Roediger & Schmidt, 1980; Smith, 1971; Tulving & Arbuckle, 1963). Although output interference is generally a recall phenomenon, it has also been observed in recognition tasks (Ratcliff et al., 1990; Ratcliff & Murdock, 1976; Smith, 1971). In a related result, Neely, Schmidt, and Roediger (1983) found that exemplars from a semantic category were recognized more slowly following six, as opposed to two, prior retrievals from that category. The present phenomenon differs from output interference in at least two respects. First, whereas recognition performance decreases as the consequence of multiple memory retrievals in output interference, recognition performance decreases as the consequence of a single retrieval in the present case. Second, whereas output interference occurs with a homogeneous list of words, the present phenomenon occurs with a heterogeneous list.

The results also clarify the boundary conditions of the Dopkins and Ngo (2002) phenomenon. On one hand, we find that the phenomenon occurs more broadly than was implied by Dopkins and Ngo (2002). Whereas Dopkins and Ngo (2002) observed a recognition decrement following the processing of a repeated noun, a recognition decrement occurred here following the processing of a repeated verb, as well as a repeated noun.

On the other hand, we find that the phenomenon is more limited in scope than might have been expected on the basis of the Dopkins and Ngo (2002) results. A recog-

**Table 3**
**Summary of Results**

| | Repeated Word | Test Word | List Type | Number of Words of the Type Repeated | Effect Present? |
|---|---|---|---|---|---|
| Experiment 1 | verb | verb | heterogeneous | 3 | yes |
| Experiment 2A | noun | noun | heterogeneous | 3 | yes |
| | noun | verb | heterogeneous | 3 | no |
| Experiment 2B | proper noun | proper noun | heterogeneous | 3 | yes |
| | proper noun | common noun | heterogeneous | 3 | no |
| Experiment 2C | occupation noun | object noun | heterogeneous | 3 | yes |
| Experiment 3A | common noun | common noun | homogeneous | 7 | no |
| Experiment 3B | common noun | common noun | homogeneous | 13 | no |
| Follow-up | proper noun | proper noun | homogeneous | 7 | no |
| | proper noun | proper noun | homogeneous | 13 | no |
| Experiment 4 | noun | noun | heterogeneous | 3 | yes |
| | noun | verb | heterogeneous | 3 | no |
| | noun | noun | heterogeneous | 7 | yes |
| | noun | verb | heterogeneous | 7 | no |

nition decrement occurred here with a syntactically heterogeneous list, but not with a syntactically homogeneous list. It is unclear whether other sorts of heterogeneity are capable of evoking a recognition decrement. Future work will explore this issue.

In addition to providing the necessary condition for the present phenomenon, syntactic differentiation limits the scope of the phenomenon in another way. Following the recognition of a word of a particular type, only words of similar type are subject to a recognition decrement. For example, following the recognition of a noun, recognition of a noun is impeded, but recognition of a verb is unimpeded. By implication, a noun is recognized less well because it is seen as being similar to the recognized word; a verb is unaffected because it is seen as being dissimilar from the recognized word.

The present results are important in that they shed light on the process underlying the Dopkins and Ngo (2002) phenomenon. They argue, first, against uninteresting interpretations that view the phenomenon as a by-product of the repetition-monitoring requirement. The key result here is that a recognition decrement occurs only for words of the same type as the repeated word. This should not be the case if the recognition decrement reflects the repetition-monitoring requirement. The results argue, further, that the phenomenon reflects a process associated with memory, rather than with comprehension. We must consider the possibility that the phenomenon reflects a comprehension process, because Gernsbacher (1989) observed a similar phenomenon in a probe recognition task, using intact sentences as stimulus material. Gernsbacher (1989) proposed that her phenomenon reflected an anaphor comprehension process, as was described earlier. It is unlikely, however, that the present phenomenon reflects such a process. (1) In Experiments 1, 2A, 2B, 2C, and 4, a recognition decrement occurred with a list derived from a scrambled sentence. When a repeated word was encountered in one of the lists for these experiments, it is unlikely to have evoked the kind of processing that an anaphor would have evoked. (2) In Experiment 1, a verb test word was subject to a recognition decrement following the processing of a repeated verb. Such an outcome is unlikely if the phenomenon reflects an anaphor comprehension process, given that anaphors are usually nouns. Thus, the present phenomenon probably reflects a memory process, as Dopkins and Ngo (2002) proposed.

Granting that the Dopkins and Ngo (2002) phenomenon reflects a memory process, the present results may help us to understand the nature of that process. The results of Experiment 2A (noun/noun, verb–heterogeneous) and Experiment 2B (proper noun/proper noun, common noun–heterogeneous) suggest that the phenomenon does not reflect a process of interference, such as that responsible for the list strength effect. According to a list strength account, processing the repeated word increases the strength of that word in memory. The increased memory strength of the repeated word, in turn, impedes the recognition judgment to the test word. A list strength account has trouble accommodating the failure of the recognition decrement to extend from nouns to verbs and from proper to common nouns. If the phenomenon reflected the proposed process, increasing the memory strength of a certain type of repeated word should impede a recognition judgment to a test word of any type.

The results of Experiments 3A and 3B (noun/noun–homogeneous) suggest that the phenomenon does not reflect familiarity attribution consequent to a perceived discrepancy between actual and expected fluency. According to a discrepancy attribution account, processing the repeated word causes a discrepancy between actual and expected fluency in the processing of the test word. This discrepancy, in turn, causes a decrease in the perceived familiarity of the test word. A discrepancy attribution account has trouble accommodating the fact that a recognition decrement occurs for a heterogeneous, but not a homogeneous, list. If the phenomenon reflected the proposed process, processing a certain type of repeated word should cause a decrease in the perceived familiarity of a test word of the same type, regardless of whether the words occurred in a homogeneous or a heterogeneous list.

The results of Experiments 3A and 3B (noun/noun–homogeneous) also suggest that the phenomenon does not reflect a process of suppression. According to a suppression account, processing the repeated word reduces the accessibility of the test word to recollection. A suppression account has trouble accommodating the fact that a recognition decrement occurred with a heterogeneous, but not a homogeneous, list. If the phenomenon reflected the proposed process, processing a repeated word a certain type should reduce the accessibility of a test word of the same type, regardless of whether the words occurred in a homogeneous or a heterogeneous list.

A criterion shift account might accommodate the present results better than do list strength, discrepancy attribution, or suppression accounts. A criterion shift account might run as follows. After a positive recognition judgment to a word of Type X from a heterogeneous list, the recognition criterion is raised for Type X items. This makes sense if we assume that the items we encounter from the list are randomly sampled from that list without replacement and without regard to type. Given that one Type X item has been sampled from the list, fewer Type X items are available for sampling. The probability of a Type X item's being sampled is consequently lower after than before the sampling of a Type X item. After a positive recognition judgment to a word of Type X from a homogeneous list, the recognition criterion is not changed for Type X items. This also makes sense under the proposed assumptions. Inasmuch as the list contains only Type X words, the probability of a Type X item's being sampled is no lower after than before the sampling of a Type X item.

Among the present results, a criterion shift account has difficulty only with the results of Experiment 4 (noun/noun, verb–heterogeneous–3-, 7-noun lists). Under such an account, one might expect the three-noun list to produce a larger recognition decrement than does the seven-noun list. This follows because the probability of sampling another noun is reduced more following the sampling of a noun from a three- than from a seven-noun list. One can

envision a criterion shift account, however, in which the recognition criterion does not track sampling probability completely faithfully.

With regard to the criterion shift account, we must also note the work that has been done exploring the capacity of participants for shifting their recognition criterion from one judgment to the next. The general conclusion emerging from this work is that participants are reluctant to shift their criterion in this way (Morrel, Gaitan, & Wixted, 2002; Stretch & Wixted, 1998; Wixted & Stretch, 2000). We must note, however, that the work in question has generally used homogeneous lists, so that the items associated with the different criterion settings have generally been distinguished with external markers. The authors of the work have noted that participants may more readily shift their criterion from one judgment to the next when the items associated with different criterion settings are of different intrinsic types, as was the case here (Stretch & Wixted, 1998).

In sum, we encounter problems accounting for the present recognition decrement in terms of a list strength, discrepancy attribution, or suppression process but find that an explanation in terms of a criterion shift shows promise. The relative merits of these four sorts of account will be explored in future work.

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## APPENDIX
## Sample Stimulus Materials

### Experiment 1

flat
chef
the
fell
hard
waiter
then
tripped
soufflé
after
and
fell (*repeated condition*) / shoved (*new condition*)

Test word: tripped

### Experiment 2A

flat
the
shoved
hard
waiter
then
soufflé
chef
after
and
fell
waiter (*repeated condition*) / hostess (*new condition*)

Test words: chef (*noun condition*)
shoved (*verb condition*)

### Experiment 2B

flat
the
shoved
hard
Lisa
then
soufflé
Becky
after
and
fell
Lisa (*repeated condition*) / Brandy (*new condition*)

Test words: Becky ( *proper noun condition*)
soufflé (*common noun condition*)

### Experiment 2C

flat
the
shoved
hard
waiter
then
soufflé
chef
after
and
fell
waiter (*repeated condition*) / hostess (*new condition*)

Test word: soufflé

### Experiment 3A

relay
mind
hole
blessing
talk
letter
blessing (*repeated condition*) / dare (*new condition*)

Test word: mind

### Experiment 4

Three-noun condition (same as for Experiment 2A)

Seven-noun condition
flat
busboy
shoved
investor
waiter
critic
soufflé
chef
baker
and
fell
waiter (*repeated condition*) / hostess (*new condition*)

Test words: chef (*noun condition*)
shoved (*verb condition*)

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