# Direct Versus Indirect Tests of Memory for Source: Judgments of Modality

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We studied the relation between performance on direct versus indirect tests of memory for modality. Subjects read or heard words in a mixed list and then were tested by visual perceptual identification (the indirect test) and direct report of items as read, heard, or new. There was a dependent relation between perceptual identification performance and modality judgments, in accord with the hypothesis that subjects base their judgments of modality on relative perceptual fluency. In Experiment 2, we attempted to change the degree of dependence by providing subjects with an alternative basis for modality judgments. Subjects given a mnemonic to encode modality exhibited less dependence between perceptual identification performance and modality judgments than did subjects who encoded modality incidentally. The relation between direct and indirect tests of memory for source characteristics depends on the basis used for each.

People can remember a variety of physical attributes of events including modality (Bray & Batchelder, 1972; Hintzman, Block, & Inskeep, 1972; Lehman, 1982; Light & Berger, 1974), sex of speaker (Geiselman & Bellezza, 1977), and location (Schulman, 1973; Mandler, Seegmiller, & Day, 1977). Recent research has focused on whether or not memory for such attributes is automatic (e.g., Hasher & Zacks, 1979) and on differences among subject populations in ability to remember physical details and contextual information about events, such as the source of a communication (e.g., Hirst, 1982; Schacter, Harbluk, & McLachlan, 1984). For example, amnesics may be particularly impaired in their ability to remember the source of information.

In the experiments above, memory for physical attributes was assessed by direct report. In this article, we argue that indirect tests of memory can be usefully applied to study memory for physical details and memory for source. The distinction between direct versus indirect tests of memory refers to two kinds of procedures used to assess memory for an event (Johnson & Hasher, 1987; Richardson-Klavehn & Bjork, 1988). Recognition and recall are direct tests of memory because the instructions ask subjects to report an event in their personal history, such as the presentation of a list of words. For indirect tests of memory, people are not directly asked to report on their memory for a prior event, but the use of memory is inferred from effects on performance. For example, the prior presentation of a word makes it more likely that people will be able to later perceptually identify that word when it is briefly flashed (e.g., Jacoby & Dallas, 1981) or complete a fragment of that word (Tulving, Schacter, & Stark, 1982). Performance on indirect tests of memory can be independent of performance on direct tests of memory. For example, even when a person is unable to recall or recognize an item as previously presented, effects may be observed on indirect tests.

Although not described as such, indirect tests of memory for modality of presentation and other physical details of an event have also been used. Indirect evidence of memory for physical details is found when the match of details between study and test influences performance although a person is not directly asked to report on those details. For example, a test of perceptual identification performance indirectly tests memory for study modality because performance on that test is better when modality is constant between study and test (e.g., Jacoby & Dallas, 1981). Similarly, an item recognition test can be considered an indirect test of memory for the physical attributes of an event. A word is more likely to be recognized as previously presented if the study and the test presentation of the word are in the same modality (Kirsner, 1974; Kirsner & Smith, 1974) or in the same speaker's voice (Craik & Kirsner, 1974) even though subjects are instructed to call items old regardless of any change in modality or speaker's voice.

Memory theorists (e.g., Cohen & Squire, 1980; Tulving, 1983) have focused on dissociations between direct and indirect tests of memory for occurrence. Following this lead, one might search for dissociations between performance on direct and indirect tests of memory for physical details or source. For example, one might find effects of modality on perceptual identification performance (an indirect memory test) that are dissociated from memory for modality as measured by direct reports. On the other hand, some researchers (e.g., Jacoby & Witherspoon, 1982; Johnston, Dark, & Jacoby, 1985) have reported dependence between performance on the two types of tests. Given this variable relation, it is important to specify

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factors that determine the relation rather than simply to demonstrate that performance on direct and indirect tests can be dissociated.

We argue that the variable relation between performance on direct and indirect tests reflects the fact that there are multiple bases for responding on direct tests of memory (e.g., Jacoby & Dallas, 1981; Mandler, 1980). Independence occurs when people use a different basis for responding on the direct versus indirect tests. Dependence occurs when an effect on performance of the sort measured by an indirect test is used as a basis for subjects' decisions on a direct test of memory. In the first experiment we examined the latter possibility by investigating the relation between the effects of modality on perceptual identification performance and performance on a direct test of memory for modality.

We (e.g., Jacoby & Dallas, 1981) have proposed that easy or fluent perception of a test item can give rise to the feeling of item familiarity. By this account, the feeling of familiarity involves the attribution of fluency on a present task (reading a test item) to the past (having read that item on the study list) (Jacoby, Kelley, & Dywan, 1989). If a test word is relatively fluently perceived on a recognition test, the subject judges it old. Subjects' use of perceptual fluency as a basis for recognition judgments may occur without their awareness; they simply experience relative perceptual fluency as a feeling of familiarity.

The effects of past experience on perception may also serve as a basis for modality judgments. When items are read at test, those that were read at study will be more fluently perceived (and hence feel more familiar) than those that were heard at study. Subjects may interpret feelings of familiarity as evidence that an item read on the test was also read at study. Therefore, we predicted a dependent relation between modality judgments and performance on the indirect test of perceptual identification.

Subjects studied a mixed list of items, half heard and half read. Their memory for modality was then tested indirectly by a visual perceptual identification test, followed by direct report of memory for modality. Probability of visual perceptual identification should be highest for old read items, followed by old heard items, and lowest for new items. Because perceptual identification probability indexes perceptual fluency (and so familiarity), items that are perceptually identified at test should be experienced as more familiar. Therefore, subjects would judge identified items as ones that were in the same modality at study and test. Further, the relatively low perceptual fluency of new items should produce a bias toward judging false alarms as heard during study rather than read. Finally, we also treated item recognition memory as an indirect test of modality. To the extent that recognition judgments rely on familiarity, performance should be better when modality was held constant rather than changed between study and test.

In a second experiment, we examined the possibility that people have multiple bases for responding on direct tests of modality. Many theories of item recognition memory propose two bases for judging an item as old: familiarity and conscious recollection or retrieval of the item (Atkinson & Juola, 1974; Jacoby & Dallas, 1981; Mandler, 1980). Similarly, reports of attributes may be based on relative familiarity of items or on retrieval of specific item information. Specific item information might be in the form of an abstract propostion (Hintzman et al., 1972) or be inferred from the effects of an attribute on the meaning of an item (Geiselman & Bellezza, 1977; Fisher & Cuervo, 1983). The relation between performance on direct and indirect tests of memory for an attribute will depend on the basis used for judgments on the direct test. The use of familiarity on the direct test should produce dependence in performance on the two types of tests because familiarity reflects relative perceptual fluency as measured by an indirect test of memory—perceptual identification. In contrast, the use of conscious recollection or the retrieval of a proposition as a basis for performance on a direct test of modality should weaken the relation between performance on the two tests.

Jacoby and Witherspoon (1982) and Johnston et al. (1985) applied a similar analysis to the variable relation between direct and indirect tests of memory for item occurrence. For example, Johnston et al. (1985) found a correlation between perceptual identifiability and the probability of judging pseudowords as old on a recognition memory test and argued that the dependence stemmed from the use of perceptual fluency as a basis for recognition. However, the correlation was lower when words were presented for the two types of tests. Because words can be meaningfully elaborated upon, subjects could base their later recognition memory judgments on retrieval of specific item information and on familiarity of the items, thus decreasing the degree to which the direct test relies on the same basis as the indirect test.

In the second experiment, we attempted to vary the degree of dependence between perceptual identification performance and direct report of modality by manipulating the basis used for judgments on the direct test. Subjects in one condition were instructed in the use of a mnemonic to encode modality. The mnemonic should provide an alternative to familiarity for judging modality and so weaken the relation between perceptual identification performance and modality judgments.

# Experiment 1

# Method

Subjects. Subjects were 16 volunteers from an introductory psychology course at McMaster University who served in the experiment for course credit.

Design and materials. Subjects were tested individually in a within-subjects design that varied whether items at test were new, previously read, or previously heard. The materials consisted of 5- and 6-letter low-frequency nouns (1-5 per million) selected from Thorndike and Lorge (1944). The words selected were ones that could be pronounced readily and had only one correct spelling.

The test words were divided equally among three sets that were differentiated by details of the presentation of the words during the first phase of the experiment. A list of 120 words was presented at study, half on a computer screen to be read aloud by the subject, while the other half were pronounced by the experimenter to be heard (but not repeated) by the subject. From this list, 30 read items and 30 heard items were presented in the test phase with a new set of 30 words not encountered before in the experiment. Each test word was first presented for perceptual identification followed immediately by a combined test of recognition memory and modality discrimination. In both the study and test phase of the experiment, words were presented in random order, with the restriction that words representing each of the conditions occurred evenly throughout the list. Three formats were constructed by rotating words through conditions in such a way that across formats each word appeared as read, heard, or new equally often. An additional 24 low-frequency nouns, five and six letters long, were used at the beginning of the experiment to allow the test rate for the perceptual identification task to be individually calibrated.

**Procedure.** An Apple IIe computer interfaced with a Zenith Data Systems monitor with a  $20 \times 25$ -cm screen was used to present the visual stimuli. Words were presented in lowercase letters of approximately  $5.7 \times 6.6$  mm. Subjects were seated at a viewing distance of 70 to 75 cm from the screen.

The index of perceptual identification was the probability of identification of words exposed for a brief interval. That interval was determined individually for each subject in a titration procedure at the beginning of the experiment, so that the probability of perceptual identification for new items was approximately .30. In the titration procedure, a list of 24 words was presented in three blocks of eight words each. A mask preceded and followed each word. Words were presented for 80 ms in the first block and 48 ms in the second block. Words in the third block were presented at either a shorter or longer duration to produce the .30 probability of perceptual identification. Because of the refresh cycle of the monitor, the presentation interval of the word changed in steps of 16 ms. To achieve the desired level of perceptual identification, the word was either followed immediately by the mask, or a blank interval of 16 ms intervened between the offset of the word and the onset of the mask. Presentation parameters determined for individual subjects in the titration phase were later used in the critical test of perceptual identification.

Subjects were told that the experiment was a study of the processes involved in perception and memory. Prior to the titration of perceptual identification level, subjects were informed that words would be flashed on the screen and that they were to report each word immediately after its presentation. Subjects were encouraged to respond to each test item, guessing if necessary. The sequence of events in the test of perceptual identification was as follows: First, the message "Press return when ready" appeared on the screen and remained there until the subject pressed the return button. The message then left the screen, and a set of two short horizontal lines appeared on the screen for 500 ms, marking the location in which the word would be presented. A mask (a series of six ampersands) appeared for 80 ms, followed by presentation of the word for the duration determined as described earlier. A second mask followed the word and remained on the screen for 80 ms. After the subject responded and the experimenter had recorded the response, the sequence of events was repeated for the entire list.

In the next phase of the experiment, the study phase, words were presented one at a time at a 2-s rate. The subject was instructed to study all the words for a recognition test later in the experiment. A word or a series of dashes appeared on the screen in random order. If a word appeared, the subject read it aloud. If a series of dashes appeared, the experimenter, sitting beside and slightly behind the subject, read the word aloud from a list. A tone sounded before each presentation to alert the subject and experimenter.

A perceptual identification test combined with a modality judgment test immediately followed the study phase. The procedure for the perceptual identification test was the same as that used in the titration of perceptual identification level. The mean presentation rate used in perceptual identification was 48 ms, with no blank time prior to the presentation of the postmask. The range of perceptual identification durations was 32-80 ms, with 0-16 ms of blank interval prior to the presentation of the postmask. The subjects were informed that an additional question would follow their attempt to perceptually identify each item. After the subject attempted to identify the briefly presented word, the subject pressed the return button. The word that had been presented for perceptual identification was then presented on the screen in full view, with the question "Read, heard, or new?". Subjects then decided if the word had been presented during the study phase, and, if so, whether they had read it or heard it. This combination of recognition memory and modality test was self-paced. The experimenter recorded both the word reported during perceptual identification and the source decision.

# **Results and Discussion**

Perceptual identification performance indirectly revealed memory for modality. The probability of perceptual identification of new (.32), heard (.44), and read (.56) items differed as predicted, F(2, 30) = 39.48,  $MS_e = 0.006$ . Comparisons between means, using the Neuman-Keuls statistic, indicated that the probability of perceptual identification for heard items was significantly higher than for new items, and the probability of perceptual identification for read items was significantly higher than for heard items. Thus, we found significant cross-modal repetition effects, as well as superior perceptual enhancement when modality was held constant between study and test. Some studies have found no evidence of cross-modal repetition effects (e.g., Jacoby & Dallas, 1981). Detection of these effects may depend on whether modality is varied between subjects (Jacoby & Dallas, 1981) rather than within subjects as in the current study (see also Kirsner & Smith, 1974) and on other factors affecting power (cf. Clarke & Morton, 1983, Experiment 2 vs. Experiment 3).

Recognition memory performance also indirectly revealed memory for modality. Items that were presented in the same modality at study and test—that is, originally read items, were recognized significantly more often than items presented in a different modality at study and test (.89 vs. .73), F(1, 15) =44.27,  $MS_e = 0.005$ , with a false alarm rate for new items of .41. As predicted, consistent modality between study and test may have increased the familiarity of items, producing the higher hit rate for read items relative to heard items.

Performance on the direct test of modality for items called old was equally accurate for items originally read (.75) as for items originally heard (.76). As predicted by our interpretation that modality judgments are based on relative fluency, false alarms were more likely to be judged as heard (.72) than read. The bias to judge items as heard is similar to the "it had to be you" effect described by Johnson and her colleagues (e.g., Johnson & Raye, 1981; Johnson, Raye, Foley, & Foley, 1981). They asked subjects to identify the source of items as either self-generated or other-generated. When a new item was experienced as familiar, subjects were biased to attribute it to the external source.

Most important to our hypothesis is the relation between visual perceptual identification and judging an item read rather than heard. As shown in Table 1, perceptually identified items were more likely to be called read than were unidentified items regardless of actual status of the item as read, heard, or new, F(1, 15) = 12.80,  $MS_e = 0.054$ .

| Table 1   |
|---|
| Experiment 1: Probability of Judging an Item as Read as a |
| Function of Perceptual Identification Performance (PIP)   |

| PIP    | Item type |       |     |  |  |
|--------|-----------|-------|-----|--|--|
|        | Read      | Heard | New |  |  |
| PI     | .73       | .29   | .27 |  |  |
| Not PI | .61       | .11   | .06 |  |  |

Note. PI = perceptually identified; Not PI = not perceptually identified.

We assessed the contingency between perceptual identification and modality judgments by computing gamma coefficients (Nelson, 1984) for items subjects had judged old. As predicted, there was a positive relation between perceptual identification and the probability of calling an item read rather than heard. The gamma coefficients averaged .48, which differs significantly from 0, t(15) = 7.08, p < .01. When items judged old had also been perceptually identified, subjects were more likely to say they had been read (.59) than heard. In contrast, when items had not been perceptually identified, subjects were more likely to say the items were heard (.65) then read. The difference in probability of calling items read for perceptually identified (.59) versus unidentified items (.35) is significant, t(15) = 5.94, p < .01.

Our interpretation of the dependence between perceptual identification and modality judgments is that fluent perceptual processing is experienced by subjects as familiarity. Items perceived relatively fluently are experienced as more familiar and, therefore, as having been presented in the same modality at test as at study.

#### Experiment 2

It is possible that the correlation in Experiment 1 between perceptual identification and probability of calling items read rather than heard is spurious: Originally read items may be more memorable on any test, including perceptual identification and modality judgments. However, this unidimensional trace strength argument lacks plausibility, given that the relation between identifiability and calling an item read holds for new items and heard items as well as read items.

The degree of dependence observed between two tests can be an artifact of intertest biases. Shimamura (1985) noted that when a fragment completion test precedes a recognition memory test, the words that were completed as fragments (predominately old words) are more likely to be recognized because they have benefited from an additional presentation. That is, the intertest influences can bias the relation between fragment completion and recognition toward dependence. In the first experiment, the perceptually identified words may have been experienced as more familiar on the modality test and hence judged as having been previously read rather than heard because they were read on the perceptual identification test. In contrast, if the dependence between perceptual identification and modality judgments truly reflects the use of perceptual fluency as a basis for familiarity, then we should be able to manipulate the degree of dependence in a predictable fashion on the basis of our understanding of fluency.

Familiarity is only one potential basis for judging whether the modality is the same at test as at study. Subjects could explicitly encode information about modality at study and then retrieve that information on the modality judgment test. If subjects shift to this alternative basis for judging modality, then the degree of dependence between perceptual identification and modality judgments should be reduced.

In the second experiment, we attempted to manipulate the degree of dependence between perceptual identification and modality judgments by providing half the subjects with an alternative to perceptual fluency as a basis for recognizing modality. Subjects in a mnemonic condition were instructed to use a mnemonic to encode whether items were originally read or heard. Use of the mnemonic should lessen the dependence between perceptual identification performance and modality judgments. In addition, performance on the item recognition test as an indirect test of modality should no longer discriminate read from heard items when people shift from familiarity-based judgments to retrieval of mnemonic information.

# Method

Subjects and design. Thirty-six subjects were randomly assigned to one of two groups, the incidental versus the mnemonic encoding of modality. The study list consisted of 60 words, 30 read and 30 heard. There were two orders of presentation of items in the study phase. The 90 items in the test phase were either originally read, heard, or new, as a within-subjects factor.

Procedure. The procedure followed the method used in Experiment 1. In the study phase, half the items were read aloud by the subject, and half were heard. Subjects in the incidental condition were presented with items at a 2-s rate, and told to "study them for a later memory test." Subjects in the mnemonic condition were given a mnemonic for remembering modality. For items that were read, they were instructed to think about positive aspects of the item, whereas for items they heard, they were instructed to think about negative aspects of the item. For example, if the item rugby was presented visually, subjects could encode rugby as an exciting and fun sport. If rugby was presented auditorially, they could encode it as a brutal, bloody sport. The good/bad encoding of auditory versus visual presentation was reversed for half the subjects. Pilot testing indicated that subjects needed more than 2 s to use the mnemonic; thus, items were presented to subjects in the mnemonic condition at a 3-s rate.

The test of perceptual identification and modality judgment was essentially the same as in Experiment 1, with one change. After attempting to perceptually identify items, subjects responded to the query "Old or new?" and then decided whether an item had been read or heard, rather than responding to the single question "Read, heard, or new?" as in Experiment 1. Subjects were asked to guess the modality for items that they judged as new.

## **Results and Discussion**

The probability of perceptual identification again discriminated among items that were originally read (.62), heard (.44), or new (.29), F(2, 34) = 127.40,  $MS_e = 0.06$ . Neither the main effect of condition nor the interaction effect of condition and type of item on perceptual identification performance approached significance.

Recognition as an indirect test of modality. As one would expect following elaborative processing, item recognition was better in the mnemonic condition than in the incidental condition, as reflected by the significantly higher hit rate of .83 versus .71, F(1, 34) = 10.0,  $MS_e = 0.03$ , and false alarm rates of .17 versus .24, F(1, 34) = 3.09,  $MS_e = 0.015$ , p < .10. Items that were originally read were recognized more often (.86) than items that were originally heard (.67), F(1, 34) =90.6,  $MS_e = 0.007$ . As predicted, the recognition memory test indirectly revealed memory for modality when recognition was primarily reliant on familiarity (the incidental condition) to a greater extent than when it was primarily reliant on retrieval of mnemonic information. There was a significant interaction of condition with item type, so that the recognition advantage of read over heard items was larger in the incidental condition (.84 vs. .57) than in the mnemonic condition (.87 vs. .78), F(1, 34) = 22.4,  $MS_e = 0.007$ . Thus, match of modality between study and test was more important for recognition memory in the incidental condition than in the mnemonic condition. This difference in magnitude of effects can be understood in terms of multiple bases for recognition judgments. The pattern of results parallels those found by Geiselman and Bjork (1980) regarding the impact on recognition of imaginally reinstating a speaker's voice. Reinstatement of voice had a greater effect on recognition after repetition than after meaningful elaboration. In the present experiment, the availability of the mnemonic mainly improved item recognition for heard items by providing an alternative to familiarity as a basis for recognition.

Modality judgments. Availability of meaning as a basis for modality judgments did not lead to a significant improvement in accuracy. Overall accuracy of modality judgments for items that subjects recognized did not differ between the mnemonic (.81) and incidental (.76) conditions, F(1, 34) =2.01,  $MS_e = 0.02$ , p < .17. For both conditions, the source of items that had originally been heard was more often correctly identified (.83) than the source of items that had originally been read (.74), F(1, 34) = 7.51,  $MS_e = 0.02$ . As in Experiment 1, that difference seems to reflect a bias toward calling items heard. New items were more likely to be called heard (.77) than read.

Relation between perceptual identification performance and modality judgments. Our goal in this experiment was to see whether the degree of dependence between perceptual identification and modality judgments would vary depending on whether subjects could be expected to use perceptual fluency as a basis for modality judgments (the incidental condition) or had an alternative basis for modality judgments (the mnemonic condition). As predicted, dependence between perceptual identification and judging items read versus heard for items called old was higher in the incidental condition (gamma = .46) than in the mnemonic condition (gamma = .23), F(1, 34) = 5.21,  $MS_e = 0.089$ . The probability of calling an item read (for items judged old) was equal across the mnemonic (.44) and incidental conditions (.48), but was higher for perceptually identified items (.54) than for unidentified items (.37), F(1, 34) = 41.84,  $MS_e = 0.068$ . The interaction between perceptual identification status and encoding condition was significant, so that the difference in probability

of judging an item read for perceptually identified versus unidentified items was larger in the incidental (.60 vs. .36) than the mnemonic condition (.49 vs. .38), F(1, 34) = 5.40,  $MS_e = 0.068$ .

As shown in Table 2 (for items judged old and new combined), the mnemonic primarily affected the probability of correctly identifying the modality of read items that were not perceptually identified. In the incidental condition, read items that were perceptually identified were more likely than unidentified items to be called read (.68 vs. .53). In contrast, in the mnemonic condition, unidentified items were as likely as identified items to be called read (.66 vs. .64). This pattern of results is understandable if use of the mnemonic provides an alternative to perceptual identification as a basis for judging those items as read.<sup>1</sup>

We found a variable relation between perceptual identification and modality judgments. Thus, the dependence found in the first experiment and replicated in the incidental condition of the second experiment does not seem to be an artifact of item selection. It also is not explained by intertest biases. Instead, the varying dependence across encoding conditions makes sense in terms of the relative availability of different bases for remembering modality. In the incidental condition, subjects were unlikely to be able to consciously retrieve modality-specific information. However, they should have experienced same-modality items (those that were originally read) as more familiar than changed-modality items (those that were originally heard), on the basis of enhanced perceptual processing of those items. In contrast, subjects in the mnemonic condition had elaborated upon the items in ways that enabled them to later infer that items had been read rather than heard.

#### General Discussion

The dependence between perceptual identification and modality judgments is consistent with the use of relative perceptual fluency as a basis for recognition of modality. However, perceptual fluency is not the only possible basis for such judgments. In Experiment 2, when subjects were provided with a mnemonic for encoding modality, the relation between perceptual identification and modality judgments was signif-

<sup>&#</sup>x27;We analyzed the probability of calling an item "read" using a three-way mixed model ANOVA, with condition as a between-subjects factor and with item type (read, heard, new) and perceptual identification performance (identified vs. not) as within-subjects factors. That analysis revealed a main effect of item type, F(2, 68) = 221.22,  $MS_e = 0.032$ , and a main effect of perceptual identification performance, F(1, 34) = 17.44,  $MS_e = 0.018$ , but the interaction between condition and perceptual identification performance did not reach significance, F(1, 34) = 2.21,  $MS_e = 0.018$ , p < .15. For items in the mnemonic condition that had been originally heard or for new items, there should not be a mnemonic basis for judging the modality incorrectly as read. Judgments in those conditions may be based on familiarity, and so perceptually identified items are more likely to be called read than unidentified items. Thus the predicted interaction between condition and perceptual identification performance occurs primarily for read items, as shown in Table 2.

 Table 2

 Experiment 2: Probability of Judging Items as Read as a

 Function of Perceptual Identification Performance (PIP) and

 Condition

| PIP          | Item type  |            |            |            |            |            |  |
|--------------|------------|------------|------------|------------|------------|------------|--|
|              | Incidental |            |            | Mnemonic   |            |            |  |
|              | Read       | Heard      | New        | Read       | Heard      | New        |  |
| PI<br>Not PI | .68<br>.53 | .14<br>.09 | .13<br>.02 | .66<br>.64 | .13<br>.07 | .10<br>.04 |  |

Note. PI = perceptually identified; Not PI = not perceptually identified. Judgments are for all 90 items, including items subjects judged as new.

icantly weakened. This strategy of manipulating the degree of dependence supports the notion that there are at least two bases for remembering modality: familiarity, with its underpinnings in relative perceptual fluency, and conscious recollection.

Our manipulation of the degree of relation between performance on two tests has several advantages over assuming the relation is immutable and merely needs to be measured. First and most important, a variable relation indicates multiple bases for memory judgments. When there are multiple bases for performance on direct memory tests, it makes little sense to look for "the" relation between direct and indirect tests. Second, finding a variable relation allows us to avoid the pitfall that correlations between tests merely reflect unidimensional trace strength-for example, the possibility that a strong trace supports perceptual identification and modality judgments. The mnemonic condition in Experiment 2 produced no overall change in accuracy of modality judgments and no change in perceptual identification performance, but it did produce a change in the relation between the two. Third, we avoid the problem of searching for independence between two tests, a claim that Hintzman (1980) points out is equivalent to accepting a null hypothesis.

Our strategy of manipulating the degree of relation also has advantages over attempts to show dissociations on two tests by lowering performance on one test to zero and observing that discriminability on the other test still occurs. For example, one could lower direct report of modality to zero, while still observing discriminative responding on an indirect test of modality. That strategy simply leaves empty two of the four cells in the contingency table needed to measure the degree of dependence between performance on the two tests. If there is not total dependence, then by definition there are cases in which one test shows evidence of memory while the other does not. This is not to deny that tests differ in sensitivity or that types of test can interact with factors such as differences among subject populations. However, those differences are revealed by the degree of dependence observed between the two types of tests when all four cells are available to compute contingency.

#### Perceptual Fluency as a Basis for Familiarity

Perceptual fluency can serve as the basis for direct report of attributes whenever it is discriminative, that is, when a change in an attribute from study to test disrupts the perceptual fluency gained from prior presentation. In accord with such a prediction, Kirsner and Dunn (1985) found a positive relation across studies between direct and indirect tests of memory for attributes (see also Kirsner, Dunn, & Standen, 1987). Changes in attributes such as case did not disrupt repetition effects in lexical decision, and case was not well remembered on direct tests. In contrast, a change of modality or language greatly disrupted repetition effects, and modality and language were relatively well remembered on direct tests.

Our interpretation that perceptual fluency is the basis for familiarity of modality is admittedly controversial. An alternative interpretation of the dependent relation between identification and modality judgments is that a common underlying representation is used in both tasks (Hintzman et al., 1972; Kirsner & Dunn, 1985). Humphreys and Bain (1983) suggested that it is more parsimonious to claim that correlations between perceptual identification and recognition memory performance arise from a common underlying representation than it is to claim that differences in perceptual fluency are the underpinning for the feeling of familiarity. Parsimony may be in the eye of the beholder. By the common representation account, subjects are using the perceptual record to aid their identification of a test word and are then comparing the perceptual record of the test word with the earlier perceptual record, the same record they just used to aid their identification of the test word. To us, it seems more parsimonious to claim that effects on perceptual fluency are attributed to the past and give rise to a feeling of familiarity.

We view perceptual fluency as a basis for familiarity of modality within a larger framework of remembering as the attribution of fluent operations to the past (Jacoby et al., 1989). In that framework, people interpret particular aspects of their ongoing experience as either reflecting past experience or as due to current conditions. An attribution to the past gives rise to remembering, which may be correct (real remembering) or incorrect (confabulation or memory illusions). Conversely, an incorrect attribution of effects of the past to current conditions can alter subjective experience of the present. For example, perceptual fluency can be misattributed to physical aspects of the current item, such as longer visual presentation duration (Witherspoon & Allan, 1985) or lower background noise (Jacoby, Allan, Collins, & Larwill, 1988). If relative perceptual fluency due to past presentation of an item can be used (mistakenly) by subjects to estimate duration and loudness of background noise, then it is plausible that relative perceptual fluency can also be used to assess whether an item has been presented before.

According to an attributional analysis, it should also be possible to manipulate perceptual fluency of new items and so to create illusions of memory. Jacoby and Whitehouse (1989) manipulated the perceptual fluency of items on a recognition memory test by very briefly presenting the same word (match) or a different word (mismatch) immediately prior to the recognition item. For both old and new words, a matching word increased the probability of judging the item old. They argued that the matching word increased the perceptual fluency of items, leading to an increased feeling of familiarity.

As in the case of perceptual illusions, illusions of memory may not occur under all conditions. Watkins and Gibson (1988) manipulated the perceptual identifiability of auditory words and the exposure time of visually presented words but found no relation between probability of perceptual identification and the likelihood of a judgment of old in a recognition memory test. The particular conditions of Watkins and Gibson's experiments may have provided subjects with a readily accessible alternative to perceptual fluency as a basis for recognition (Jacoby & Witherspoon, 1982; Johnston et al., 1985; see also the mnemonic condition in our second experiment). When subjects have multiple bases for memory decisions, it is important to know what basis they are using on a direct test when attempting to manipulate performance or when studying the relation between performance on direct and indirect tests.

## Multiple Bases for Attribute Recognition

In Experiment 2, we found a variable relation between indirect and direct tests of modality, in support of multiple bases for memory for modality on direct tests. Other dual process models of recognition of attributes also postulate both familiarity and retrieval (e.g., Mandler, 1980). For example, Bartlett, Gernsbacher, and Till (1987) investigated the use of familiarity versus retrieval (which they refer to as image sampling) in judging whether the left-right orientation of pictures had changed or remained the same between study and test. They found that familiarity was affected by repeated presentation of the pictures, whereas conscious recollection was affected by the delay between study and test. We predict that perceptual fluency underlies familiarity judgments of picture orientation. Therefore, perceptual identification of pictures ought to correlate with orientation judgments, particularly under conditions in which familiarity dominates responses (e.g., testing after a 1-week's delay).

The different bases for modality judgments may be viewed in terms of the distinction between data-driven and conceptually driven processes (Jacoby, 1983). Modality judgments based on perceptual fluency would be primarily data driven, whereas modality judgments based on the mnemonic would be conceptually driven. Perceptual identification is also data driven. Dissociations between tasks can come about when one task is data driven and the other is primarily conceptually driven (Roediger & Blaxton, 1987; Roediger, Weldon, & Challis, 1989). Multiple bases may exist for many memory judgments, and so the variable relation we found between direct and indirect tests may be a general phenomenon.

Given that people potentially can make memory judgments either on the basis of familiarity or retrieval of item-specific information, what determines the basis used? One might argue that familiarity is the default option: If people can't consciously remember an attribute or event, then they are forced to rely upon overall familiarity. However, that does not imply that familiarity is seldom used nor that it is a poor basis for judgment. For example, in our second experiment, it was quite difficult for subjects to encode modality in a way that allowed them to later explicitly remember it. In pilot work, instructions to encode modality did not change the relation between perceptual identification and modality judgments, which led us to devise the mnemonic for modality. Furthermore, the mnemonic did not prove to be a better basis for judgments: The level of performance on the direct test of modality did not differ across the incidental and mnemonic conditions. In everyday life, with long time delays and predominantly incidental encoding, familiarity may be widely used as a basis for memory judgments.

Even though instructing people to remember modality did not produce any advantage in the accuracy of judgments relative to those made by people in the incidental learning condition, the mnemonic did produce a qualitative change in the basis used for judgments. This point is an important one because others have taken a lack of an effect of incidental versus intentional encoding of attributes as evidence that an attribute is encoded "automatically" (e.g., Hasher & Zacks, 1979; Lehman, 1982). Automatic encoding of modality does not seem to be a particularly apt description of the basis for modality judgments in the incidental condition. In that condition, memory for modality was integral to memory for the item rather than being represented by a separate proposition. When the two are not separate, it makes little sense to ask whether or not a modality attribute was automatically encoded as the item was processed. To do so is akin to asking whether or not people's laps automatically appear when they sit down. A lap is not separate from sitting, nor is the representation of an item necessarily separate from representation of its modality. Instead, use of perceptual fluency as a basis for modality judgments makes it reasonable to talk in terms of memory "attributions" rather than memory attributes (e.g., Jacoby et al., 1989; see also Begg, Maxwell, Mitterer, & Harris, 1986).

Many researchers are now familiar with the notion of direct versus indirect tests of occurrence. However, the ability to report context is still taken as a hallmark of conscious recollection of a prior episode, and failure to report context is interpreted as a failure to encode context. In contrast, the importance of our experiments is to demonstrate that such a conclusion for source can be as much in error as claiming no memory for occurrence after a direct test alone. Indeed, in some instances there may be an inverse relation between ability to report source and the effects of reinstating source on performance (cf. Kirsner, 1973). For example, if the elderly are more likely than the young to base recognition memory judgments on familiarity, their recognition of occurrence will be more constrained by reinstating modality or other source characteristics. Thus, the elderly might be less able to report modality than younger subjects but may be more reliant upon it for recognition memory.

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