Memory & Cognition
1977, Vol. 5 (6), 658-665

Incidental retention of speaker's voice

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Geiselman and Bellezza (1976) concluded that any retention in memory of the sex of a speaker of verbal material is automatic. Two possible reasons for this were hypothesized: the voice-connotation hypothesis and the dual-hemisphere parallel-processing hypothesis. In Experiment 1, the to-be-remembered sentences contained either male or female agents. Incidental retention of sex of speaker did not occur. This result does not support the dual-hemisphere parallel-processing hypothesis, which indicates that retention of voice should be independent of sentence content. In Experiment 2, the sentences contained neutral agents and incidental retention of sex of speaker did occur. The results of Experiments 1 and 2 support the connotation hypothesis. The different results with regard to incidental retention of speakers's voice found in Experiments 1 and 2 were replicated in Experiment 3 using a within-subjects design. Experiment 4 was conducted to determine if a speaker's voice does, in fact, influence the meaning of a neutral sentence. In agreement with the voice-connotation hypothesis, sentences spoken by a male were rated as having more "potent" connotations than sentences spoken by a female.

Several studies have demonstrated that the sex of the speaker of various verbal materials is remembered better than chance even when the subjects are not instructed to attend to the speaker's voice (Cole, Coltheart, & Allard, 1974; Craik & Kirsner, 1974; Geiselman & Bellezza, 1976; Hintzman, Block, & Inskeep, 1972; Light, Stansbury, Rubin, & Linde, 1973).

Light and Berger (1974) have suggested that experiments designed to measure the incidental retention of peripheral attributes of a stimulus, such as speaker's voice, may to a large extent be measuring the intentional processing of these attributes. For example, if subjects are simply told to try to remember the semantic content of sentences to be presented auditorily, and then some of the sentences are spoken by a male and some are spoken by a female, the subjects may become suspicious of the experimenter's motives. If the intersentence intervals are reasonably long, the subjects may intentionally process some characteristics of the speaker's voice for each sentence in addition to what is said.

Addressing this issue, Geiselman and Bellezza (1976) tested an automatic-coding explanation and also a cognitive-coding explanation of the incidental long-term retention of the sex of a speaker. The automatic-coding hypothesis implies that the storage of speaker's voice does not require any processing time beyond that needed to encode the meaning of the sentence. Consequently, this hypothesis predicts significant long-term recognition memory for the sex of the speaker of each sentence without a decrease in sentence free recall as compared to sentence recall in a control condition. Alternatively, the cognitive-coding hypothesis predicts that any significant increase in the recognition of the speaker's voice should be accompanied by a decrease in sentence recall. This is because cognitive coding of the attribute of sex of speaker *in addition to* cognitive coding of the sentence would require extra processing time. Without a difference in speakers, voice would not constitute a dimension on which the sentences could be differentially encoded.

Geiselman and Bellezza (1976) presented sentences to subjects auditorily with half the sentences spoken by a male and the other half spoken by a female. In the incidental voice-retention condition, the subjects were told to remember the content of each sentence, but no reference was made to the different speakers. The subjects in the control group were presented the same sentences, but all of the sentences were spoken

Experiments 1 and 2 were supported in part by grants from the Ohio University Research Committee and the Field-Wiltsie Foundation to the second author. Experiments 3 and 4 were supported in part by a grant from the National Institutes of Health (1F32 MH35783-01) to the first author. The authors would like to thank Nancy Andow for her assistance in collecting the data in Experiment 1 and would like to thank Ohio University Computer Services for making computer time available. Portions of this research were presented at the annual meeting of the Psychonomic Society, St. Louis, November 1976. Requests for reprints should be sent to Francis S. Bellezza, Department of Psychology, Ohio University, Athens, Ohio 45701.

either by the male or by the female only. The results indicated that the sex of the speaker of each sentence was remembered better than chance, that is, for .68 of the sentences, and without a significant decrease in sentence recall compared to a control group to whom all the sentences were presented in the same voice. It was concluded that the sex of the speaker was automatically coded along with the semantic content of each sentence. The authors have replicated these results in an unpublished experiment using the same stimulus materials.

Geiselman and Bellezza (1976) offered two explanations of how the coding of speaker's voice without extra processing time might occur. The first hypothesis is the voice-connotation hypothesis, which states that the connotation of a speaker's voice is sometimes incorporated into the meaning of each sentence without requiring an increase in processing time. Perhaps a sentence spoken by a male does not have the same meaning as the same sentence spoken by a female. In other words, the voice-connotation hypothesis implies coding of speaker's voice, but the voice attribute is not "attached" to the code for the item in memory. Rather, it may become an integral part of the code itself and may not require extra processing time to be remembered. Performance on the voice-recognition test in the experiment of Geiselman and Bellezza (1976) may have been mediated by the masculinity or femininity of the subject's recollection of the meaning of each sentence.

Carterette and Barnebey (1975) have suggested that different speakers' voices are initially represented in memory by small sets of sensory attributes such as fundamental frequency, intensity, and intonational pattern, and that these attributes may be automatically recoded in a linguistic fashion for storage in long-term memory. In this regard, the process of reconstructing the original speech signal for an utterance, as opposed to some other speech signal, may be mediated by the semantic representation of the utterance which has been influenced by its auditory presentation. More specifically, the connotation of a speaker's voice may sometimes be incorporated into the meaning of what is said.

The second hypothesis offered by Geiselman and Bellezza (1976) was the dual-hemisphere parallel-processing hypothesis, which states that the linguistic aspects of each sentence are processed by the left cerebral hemisphere, and characteristics of the speaker's voice are processed simultaneously by the right hemisphere. The dual-hemisphere parallel-processing hypothesis may seem implausible, but there is some evidence available to support it. The notion is generally accepted that, for most individuals, linguistic aspects of language are processed primarily in the left cerebral hemisphere (Kimura, 1967). There is also evidence that nonlinguistic sounds such as music, pitch contours, and environmental noises are processed primarily by the right cerebral hemisphere (Curry, 1967; Faglioni, Spinnler, & Vignolo, 1969; Kimura, 1967). Blumstein and Cooper (1974), using a binaural presentation of filtered speech followed by a perceptual matching task, found a left ear (right hemisphere) advantage for recognition of intonation contours. These authors suggested: "Normal language perception may involve the simultaneous analysis of the input in both hemispheres—with the analysis of the phonetic and semantic components of language conducted primarily in the left hemisphere and the analysis of intonational and perhaps other components of the speech signal conducted primarily in the right hemisphere" (Blumstein & Cooper, 1974, p. 156). How the linguistic and nonlinguistic traces for the same input might be labeled to correspond in memory is not apparent from the available research.

The primary purpose of Experiment 1 was to test the voice-connotation hypothesis and the dual-hemisphere parallel-processing hypothesis by creating a competing masculine-feminine dimension in the list of sentences. This was done by using male and female agents in the sentences. Since the masculine-feminine dimension would be used to encode the content of the sentences themselves, under the connotation hypothesis the sex of the speaker should have a smaller influence on the memory code for each sentence and should not be remembered better than chance. Further, instructing the subjects to remember the sex of the speaker, in addition to the sentences themselves, should produce a significant tradeoff between sentence recall and sex of speaker recognition (Geiselman & Bellezza, 1976). Under the dual-hemisphere parallel-processing hypothesis, the content of the sentence should not affect incidental retention of the speaker's voice.

EXPERIMENT 1

Method

Subjects. The subjects were 64 male and 64 female undergraduate volunteers from introductory psychology courses at Ohio University.

Materials and apparatus. The stimulus materials were 20 simple active sentences constructed in the past tense, and all sentences were of the following form: "The (male or female agent) (action verb) the (inanimate object)." In addition, an attempt was made to construct sentence predicates relatively free of masculine or feminine connotations. Two examples are: "The gentleman entered the house"; The queen spent the money." The 20 sentences were randomized with respect to the sex of the agent, with the only sequencing restriction being that not more than two instances of either sex could appear in a row.

Two tape recordings were made of the 20 sentences with 5-sec intersentence intervals using a Sony TC-106A tape recorder. For the first recording, half of the sentences with male agents and half of the sentences with female agents were spoken by a male and the remaining 10 sentences were spoken by a female. Only one male and one female speaker were used and no more than two instances of either speaker occurred in

a row. Hence, the variables of sex of agent and sex of speaker were uncorrelated. For the second recording, the sex of the speaker for each sentence was reversed as a counterbalancing measure. Both speakers were graduate students at Ohio University and their dialect can be described as standard American. Analysis of the two tape recordings indicated that the intensity levels for the male speaker and for the female speaker covered approximately the same dynamic range. The average fundamental frequency for the male speaker was 131 Hz and for the female speaker was 219 Hz.

Design. The experimental design was a 2 by 2 by 2 by 2, with the specific factors being sex of experimenter, sex of subject, instructions (incidental or intentional retention of sex of speaker), and sex of speaker. The sex of speaker factor was a within-subjects factor.

Procedure. The 64 male and 64 female subjects were tested in groups of 8 subjects each. Half of the sessions were conducted by a male experimenter and half were conducted by a female experimenter to control for possible experimenter effects. In addition, half of the groups heard the first tape recording and half heard the recording with the sex of the speaker for each sentence reversed.

The groups of subjects that received incidental voice-retention instructions were told that they would be presented 20 simple sentences on a tape recorder and would later be asked to write down as many of the sentences as they could remember in any order that they wished. The groups of subjects that received intentional voice-retention instructions were further told that following the sentence-recall test they would be given a sheet of paper with the sentences on it and would be asked to indicate the sex of the speaker of each sentence. After the presentation of the 20 sentences, all groups of subjects were given an unrelated deductive reasoning problem to complete within 45 sec. Then, all subjects were allowed 4 min for free recall, followed immediately by a combined sex-of-agent and sex-of-speaker recognition test. For the latter test, the sentences were randomized with respect to input serial position and the agent in each sentence was deleted. The subject's task was to circle one of two alternatives for the agent of each sentence and to indicate the sex of the speaker for each sentence with an M or F. As an example, for the sentence, "The aunt found the shoes," the alternatives for the agent were "aunt" and "uncle." Enough time was given so that all subjects could complete this task.

Analysis. There were three dependent variables: sentence recall, recognition of sex of agent, and recognition of sex of speaker. An analysis of variance was conducted on each of these variables as outlined in the Design section. Two t tests were done to determine whether recognition of sex of speaker was significantly greater than chance either under incidental or intentional voice-retention instructions. In addition, an intercorrelation matrix for the three variables was computed for both the incidental and intentional conditions.

Results

Sentence recall. The analysis of variance conducted on the sentence recall data showed a significant main effect of instructions [$F(1,120) = 25.20$, $p < .001$, $MSe = .25$], indicating that the proportion of sentences recalled was greater under incidental voice-retention instructions (.31) than under intentional instructions (.21). The main effect of sex of speaker was also significant [$F(1,120) = 7.89$, $p < .005$, $MSe = .22$], with the proportion of recalled sentences spoken by the male being greater (.28) than the proportion of recalled sentences spoken by the female (.21).

Agent recognition. The analysis of variance conducted on the agent recognition data showed a significant main effect of instruction [$F(1,120) = 34.55$, $p < .001$, $MSe = .16$], indicating that the sex of the agent for each sentence was recognized more frequently under incidental voice-retention instructions (.86) than under intentional instructions (.77). Hence, not only were more sentences recalled under incidental voice-retention instructions, but the sex of the agents was recognized more often as well. The main effect of sex of speaker was not significant, but the Sex of Subject by Sex of Speaker interaction effect was significant [$F(1,120) = 7.83$, $p < .01$, $MSe = .12$]. A Cicchetti (1972) test showed that for male subjects, agent recognition was greater for sentences spoken by the female (.84) than for sentences spoken by the male (.78) ($p < .01$). There was no difference for the female subjects, and the proportion of agents correctly recognized was .82. There was no apparent reason why the agents in sentences spoken by the female voice were better recognized by the male subjects.

Speaker recognition. The analysis of variance conducted on the speaker recognition data showed a significant main effect of instructions [$F(1,120) = 86.42$, $p < .001$, $MSe = .24$], with the sex of speaker for each sentence recognized more frequently under intentional voice-retention instructions (.64) than under incidental voice-retention instructions (.51). Hence, there was an increase in speaker recognition under intentional voice-retention instructions, but a concomitant decrease in sentence recall and agent recognition. With incidental instructions, speaker recognition was not significantly greater than chance, but the sex of speaker was recognized greater than chance with intentional instructions [$t(63) = 2.33$, $p < .05$]. These results were no different when the analysis was performed making recognition of sex of speaker contingent on the correct recognition of the sex of the agent.

Correlations. To determine if at test the subjects matched the sex of the speaker with their recollection of the sex of the agent, as would be predicted by the voice-connotation hypothesis, a phi correlation was computed between the incorrect sex-of-speaker responses and the corresponding sex-of-agent responses for each subject. The obtained values of phi were normalized using Fisher's z transformation and then were analyzed using a 2 by 2 by 2 analysis of variance. The factors were sex of experimenter, instructions, and sex of subject. This analysis showed no significant effects, but the grand mean was significantly greater than zero ($phi = +.14$, $p < .01$, $MSe = .35$). Hence, it can be concluded that the subjects tended to match their sex-of-speaker responses with their recollection of the sex of the agent, even under intentional voice-retention instructions.

The correlation between sentence recall and agent recognition was significant both with incidental voice-retention instructions ($r = +.22$, $p < .001$) and with intentional instructions ($r = +.25$, $p < .001$). However,

speaker recognition was correlated with sentence recall and agent recognition only under intentional voice-retention instructions ($r = +.31$, $p < .001$, and $r = +.11$, $p < .001$, respectively). The correlations for those subjects not instructed to remember the speaker's voice were not significantly different from zero. These results suggest that sentences that were easier to remember may have allowed more time for intentional processing of the sex of the speaker. However, this extra processing time may have been used to encode other sentences under the incidental voice-retention instructions.

Discussion

Using male and female agents, automatic processing of speaker's voice was not observed. Speaker recognition was greater than chance only when there was intent on the part of the subjects to remember the sex of the speaker, and only at the expense of sentence recall. These findings support the voice-connotation hypothesis and do not support the dual-hemisphere parallel-processing hypothesis. Processing of the physical properties of the voice by the right hemisphere should be independent of the semantic content of the sentence. If the masculine-feminine dimension is used for purposes of encoding the denotative meaning of the stimulus item itself, then the sex of the speaker appears to have little influence on the code for the item in memory. In fact, under intentional voice-retention instructions, speaker recognition was correlated with sentence recall as well as with agent recognition. This suggests that sentences that were easier to remember allowed more time for the additional cognitive coding necessary to remember the speaker's voice.

When the subjects could not remember the sex of the speaker under incidental or intentional voice-retention instructions, their guesses tended to correspond with their recollections of the sex of the agent. These results support the voice-connotation hypothesis.

EXPERIMENT 2

The results of Experiment 1 combined with the results of Geiselman and Bellezza (1976) suggest that the sex of the speaker of each sentence is remembered better than chance only when the content of a list of sentences does not contain a masculine-feminine dimension. This relation was tested further in Experiment 2, by constructing sentences from nouns and verbs that had been rated as being neutral with respect to masculinity and feminity. If the voice-connotation hypothesis is correct, then Experiment 2 should show significant incidental recognition memory for the sex of the speaker of each sentence, and without a decrease in the number of sentences recalled.

Method

Subjects. The subjects were 32 male and 32 female undergraduate volunteers from introductory psychology courses at Ohio University.

Materials. Twenty sentences with the same syntactic structure as those used in Experiment 1 were constructed from nouns and verbs obtained from the Jenkins, Russell, and Suci (1957) norms. Each word used had a mean masculine-feminine rating of between 3.25 and 4.75, which indicated a relative absence of a masculine or feminine connotation. Two examples of the sentences are: "The puppy dreamed the discomfort," and "The youngster ate the food."

Four tape recordings were made of the 20 sentences: one with 10 randomly chosen sentences spoken by the male speaker and the remaining 10 sentences spoken by the female speaker; a second tape with the speaker of each sentence being the opposite of the speaker on the first tape; a third tape with all 20 sentences spoken by the male speaker; and a fourth tape with all 20 sentences spoken by the female speaker. The latter two recordings were presented to subjects comprising the control groups. The same speakers as in Experiment 1 were used.

Procedure. The 32 male and 32 female subjects were tested in groups of 8 subjects each. One group of male subjects and one group of female subjects heard each recording. All subjects were given incidental voice-retention instructions; that is, no mention was made of the speakers. Also, all subjects were given a deductive reasoning problem to solve following the presentation of all 20 sentences. After a free recall test for the sentences themselves, a two-alternative agent recognition test was administered to all subjects with the correct response randomly paired with the agent from one of the other sentences. In addition, the subjects who were presented one of the tape recordings with 10 sentences spoken by the male and 10 sentences spoken by the female were asked to indicate the sex of the speaker for each sentence with an M or an F. The control subjects did not receive the sex-of-speaker test.

Analysis. For the subjects who were presented half of the sentences in the male voice and half in the female voice, the sentence recall, agent recognition, and speaker recognition data were analyzed separately using a 2 by 2 analysis of variance. The factors were sex of subject and sex of speaker. The sex-of-speaker factor was a within-subjects factor. Also, three t tests were done to determine (1) whether the mean number of sentences recalled differed from the mean number of sentences recalled by the control subjects, (2) whether the mean number of agents correctly recognized differed from the mean number of agents recognized correctly by the control subjects, and (3) whether the recognition of sex of speaker for the noncontrol subjects was significantly greater than chance.

Results

Sentence recall. For the subjects who were presented half of the sentences in the male voice and half in the female voice, the analysis of variance conducted on the sentence recall data showed no significant effects. The mean number of sentences recalled by the control subjects was 4.00 sentences, as compared to a mean value of 4.28 sentences for the subjects who were presented half of the sentences in the male voice and half in the female voice. The difference was not significant.

Agent recognition. The analysis of variance conducted on the agent recognition data also showed no significant effects. The mean number of agents

recognized correctly by the control subjects was 16.88 agents, as compared to a mean value of 16.84 agents for the subjects who were presented half of the sentences in the male voice and half in the female voice. The difference was not significant. Hence, varying the sex of the speaker within the list of sentences had no effect on sentence recall or agent recognition.

Speaker recognition. The analysis of variance conducted on the speaker recognition data showed no significant effects, either when the results were conditionalized on correct agent recognition or when they were unconditionalized. The unconditional probability of speaker recognition was .69, which is significantly greater than chance [$t(31) = 3.78$, $p < .001$]. Hence, using sentences constructed from words that are relatively free of masculine or feminine connotations, the sex of the speaker is recognized better than chance under incidental voice-retention instructions and without a decrease in the number of sentences recalled or the number of agents recognized correctly. Also, the correlation between sentence recall and speaker recognition was not significant. This is compelling evidence against the notion that some subjects were able to use some of the intersentence interval to process speaker's voice in addition to the sentence presented (Light & Berger, 1974). The correlation between sex-of-speaker recognition and agent recognition was also not significant, but as in Experiment 1, the correlation between sentence recall and agent recognition was significant ($r = +.15$, $p < .01$).

Discussion

The findings of Geiselman and Bellezza (1976) and the results of Experiments 1 and 2 suggest a modest theory of how the sex of a speaker is processed by the subject under incidental voice-retention instructions. The meaning of a stimulus can be represented by a hierarchy of attributes that includes a semantic profile (Osgood, Suci, & Tannenbaum, 1957; Wickens, Dalezman, & Eggemeier, 1976; Eggemeier, Note 1). One of the dimensions in the semantic profile is the masculine-feminine dimension, which forms part of the more general "potency" factor (Osgood et al., 1957). If a stimulus item has a masculine or feminine denotation or social connotation, then the sex of the speaker would not be likely to influence the code for the item in memory because the representation of the item on the masculine-feminine dimension would be determined by aspects of the stimulus that are more central to its meaning. The results of Experiment 1 are consistent with this view, in that the subjects exhibited a response bias toward matching the sex of the speaker with their recollection of the sex of the agent.

On the other hand, if the stimulus is relatively free of a masculine or feminine component, as in Experiment 2, then speaker's voice may influence the encoding of the item and subsequently be remembered. Consistent with this notion is the finding of Gardiner and Cameron (1974) that a shift in the sex of the speaker on the fourth trial produced an increase in the recall of word triads. Further, the results of Experiment 2 indicate that the influence of speaker's voice does not represent an additional processing task demand, but rather an alternative way of forming part of the memory code (Underwood, 1969). Hence, for some of the stimulus items, remembering the sex of the speaker plus the item would require no more processing time than merely remembering the item itself. It is in this respect that the incidental retention of the sex of a speaker appears to be automatic.

Of course, there are some exceptions to this theory. For example, the sentence, "I wore a purple skirt today," has a strong social connotation; but if a male were to say this sentence, the sex of the speaker would more than likely still be remembered correctly by most subjects. Such instances are not particularly damaging to the voice-connotation hypothesis, because this sentence would probably be recalled more frequently if it were spoken by a male, and probably at the expense of the recall of the other sentences because of selective rehearsal (Rundus, 1971). The problem at issue here is the incidental retention of a speaker's voice, not the intentional processing of a speaker's voice because of its atypical context.

EXPERIMENT 3

The purpose of Experiment 3 was to replicate the findings of Experiments 1 and 2 with respect to the incidental retention of speaker's voice, but using a within-subjects design. A list of 24 sentences was presented, in which 12 of the sentences contained male or female agents and the remaining sentences contained neutral agents. If the effect of sentence type on voice retention is important, as the results of Experiments 1 and 2 seem to indicate, then the subjects should remember the sex of the speaker better than chance only for the sentences with neutral agents.

Method

Subjects. The subjects were 24 undergraduate volunteers, 12 males and 12 females, enrolled at the University of California at Los Angeles.

Materials. The stimulus materials were 24 simple active sentences constructed in the past tense, 12 of which contained male or female agents (e.g., mother, actor, king) and 12 of which contained agents that are neutral with respect to gender (e.g., citizen, character, employee). All of the predicates, such as "opened the door" and "attended the party," were designed to be relatively neutral with respect to the masculine-feminine dimension.

Half of the sentences of each type were spoken by a male speaker and the remaining sentences were spoken by a female speaker, with intersentence intervals of 5 sec. Counterbalancing procedures insured that each sentence was spoken by each speaker equally often and each predicate was paired with either

a male or female agent or a neutral agent equally often. The average fundamental frequency for the male speaker was 117 Hz and for the female speaker was 219 Hz.

Procedure. The subjects were tested in groups of six, three males and three females. All subjects were told that they would be presented a series of sentences on a tape recording and would be expected to later write down as many sentences as they could remember. The presentation of the sentences was followed by a 45-sec distractor task that consisted of one deductive reasoning problem. Following the 4 min of sentence free recall, the subjects were given a sheet of paper containing the 24 sentences randomized with respect to input serial position. First, they were asked to put a check next to any sentence that they did not remember hearing. Then, for the sentences that they did remember hearing, they were asked to indicate the sex of the speaker by writing an M or F.

Design and analysis. The design was a 2 by 2 mixed design with sex of subject as the between-subjects factor and sentence type (male or female agent, neutral agent) as the within-subjects factor. The dependent variables were: (1) the mean number of sentences of each type recalled by each subject, (2) the mean number of sentences of each type recognized by each subject, and (3) the mean number of correct sex-of-speaker judgments, given correct sentence recognition. Speaker recognition data was used from only correctly recognized sentences, because in Experiments 1 and 2 the analysis of speaker recognition conditional on sentence recognition gave the same results as the analysis of speaker recognition for all sentences.

Results

The analysis of variance conducted on the sentence recall data showed a significant main effect of sentence type [$F(1,22) = 53.24$, $MSe = .76$, $p < .001$]. On average, more sentences with male or female agents were recalled (3.96) than sentences with neutral agents (2.13). However, the analysis of variance conducted on the sentence recognition data showed no significant effects. The mean number of sentences with male or female agents that were recognized was 10.63, and the mean number of sentences with neutral agents that were recognized was 10.25. In addition, the analysis of variance conducted on the speaker identification for the sentences that were recognized showed a significant main effect of sentence type [$F(1,22) = 128.88$, $MSe = .003$, $p < .001$]. The probability of speaker recognition given sentence recognition was .51 for the sentences with male or female agents and .69 for the sentences with neutral agents. Only the latter value was significantly greater than chance [$t(23) = 11.18$, $p < .001$].

Discussion

The results of Experiment 3, using a within-subjects design, are remarkably similar to the results obtained in the incidental voice-retention conditions of Experiments 1 and 2. The retention of the sex of the speaker was significantly greater than chance only for those sentences that contained neutral agents. In addition, sentences containing neutral agents were more difficult to recall than sentences containing either male or female agents, even though both types of sentences were equally well recognized. Why this difference in recall occurred is difficult to say. It could be that the masculine and feminine agents may have been nouns that were more familiar or were greater in imagery value. Either of these attributes could increase recall performance (Paivio, 1971). A Mann-Whitney U test showed that the frequencies of occurrence (Kučera & Francis, 1967) were not significantly different. The mean frequency rankings for the male-female and neutral agents were 12.96 and 12.04, respectively. Imagery ratings were available for six of the masculine-feminine agents and six of the neutral agents (Paivio, Note 2). The mean ratings were 6.45 and 6.37, respectively, and were not significantly different. The two types of agents seemed to be approximately equal in familiarity and imagery value.

Also, this difference in recall is probably not the result of the subjects selectively attending to the sentences containing male or female agents at the expense of sentences containing neutral agents. In Experiment 1, in which all the sentences contained male or female agents, a mean of 6.20 sentences was recalled when no instructions were given for remembering speaker's voice. In Experiment 2, in which all the sentences contained neutral agents, only 4.14 sentences were recalled.

A major problem with the voice-connotation hypothesis is that it is somewhat circular and therefore is difficult to test. If a speaker's voice is not remembered, then it could be claimed that the connotation of the voice did not influence the meaning of what was said. What is needed at this point is more direct evidence that the connotation of the voice does in fact alter the semantic representation of the sentence in memory. This was the purpose of Experiment 4.

EXPERIMENT 4

In this experiment, the subjects were required to rate each of the sentences that were used in Experiment 2 on each of four 7-point scales. The four scales were hard-soft, heavy-light, masculine-feminine, and strong-weak. These four scales have been found to have the highest loadings on the "potency" factor in a derived semantic space (Osgood et al., 1957). Half of the subjects, comprising the experimental group, were presented the 20 sentences auditorily using a tape recorder before making the ratings. Ten of the sentences were spoken by a male and the remaining sentences were spoken by a female. The other subjects, comprising the control group, made their ratings for each sentence without prior auditory presentation of the sentences. If speaker's voice does in fact alter the meaning of what is said, the experimental group's ratings should differ significantly from those made by the control subjects.

Method

Subjects. The subjects were 20 male and 20 female

undergraduate volunteers from the introductory psychology course at the University of California at Los Angeles.

Materials. The 20 sentences that were used in Experiment 2 were again employed. These sentences were constructed from nouns and verbs that had been rated as being relatively neutral on the masculine-feminine dimension. One of the tape recordings of these sentences that was presented to the incidental voice-retention group in Experiment 2 was also used. Ten randomly chosen sentences were spoken by a male and the remaining 10 sentences were spoken by a female.

Procedure. The subjects were tested in four subgroups of 10 subjects each. Two of the subgroups, comprising the control group, were simply given a sheet of paper with all 20 sentences on it and were told to rate each sentence on each of four 7-point scales: hard-soft, heavy-light, masculine-feminine, and strong-weak. The subjects were told to rate each sentence on all four scales before going on to the next sentence and to complete the task as rapidly as possible. The other two subgroups of subjects, comprising the experimental group, were presented the 20 sentences on a tape recorder before being given the rating task. These subjects were told to "listen to the recording very carefully," but no reference was made to the different speakers or to the ensuing rating task.

Design. The experimental design was a 2 by 2 by 2, with the factors being group (experimental and control), sex of subject, and sex of speaker (as defined in the experimental group). The sex-of-speaker factor was a within-subjects factor and the dependent variables were the ratings on the four semantic scales.

Results

An initial analysis of the data indicated that the ratings on the four scales were significantly interrelated with correlations ranging from +.30 ($p < .01$) to +.60 ($p < .001$). This was expected on the basis of the results of the factor analyses that were conducted on the scales in the semantic space by Osgood et al. (1957) and others. Therefore, a composite rating of "potency" was computed for the present analysis. For each subject, the mean rating over all four scales was computed for each sentence.

The analysis of variance conducted on the composite rating scores indicated a significant main effect of sex of speaker [$F(1,36) = 15.54$, $MSe = 2.75$, $p < .001$], with the sentences spoken by the male being rated as more "potent" than the sentences spoken by the female. However, the Sex of Speaker by Group interaction effect was also significant [$F(1,36) = 6.76$, $MSe = 2.75$, $p < .025$]. A Cicchetti (1972) test showed that the experimental group rated the sentences spoken by the male as being more "potent" than the sentences spoken by the female ($p < .05$), but the difference between these two mean ratings in the control condition was not significant. Hence, the effect of sex of speaker on the potency ratings was not due to an item-selection effect. Also, on the basis of a postexperimental questionnaire administered before debriefing the subjects, it was found that only 2 of the 20 subjects in the experimental group guessed the purpose of the experiment. Hence, it is unlikely that the subjects in the experimental group were aware of the influence of the speakers' voices on their ratings. Table 1 shows the mean composite ratings as a function of group and sex of speaker.

Table 1
Mean Composite Ratings of Potency

Group	Sex of Speaker	
	Male	Female
Experimental	4.39	4.01
Control	4.26	4.19

Note–A higher rating indicates greater sentence potency as measured on the four 7-point scales.

The only other significant source of variation was the Sex of Speaker by Sex of Subject interaction effect [$F(1,36) = 6.65$, $MSe = 2.75$, $p < .025$]. Female subjects rated sentences spoken by the male more potent and sentences spoken by the female less potent than did the male subjects. There was no obvious explanation for this interaction.

Discussion

Experiment 4 provides further support for the voice-connotation hypothesis of the incidental retention of a speaker's voice, because the sex of a speaker does, in fact, influence the meaning of what is said. The effect, however, is not a strong one. The size of the effect is consistent with the reports of many subjects in the incidental voice-retention conditions. They reported that they were merely guessing the sex of the speaker for each sentence during the surprise test of speaker recognition. Perhaps the marginal influence of speaker's voice on sentence meaning can provide some insight as to why long-term speaker recognition is usually found to be only .15 to .25 above chance level.

Finally, the authors acknowledge that sex-of-speaker recognition is only a subset of speaker identification in general. But, since two different male or two different female speakers may elicit different connotations, the same process could apply for the more general case as well.

REFERENCE NOTES

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(Received for publication May 20, 1977;
accepted September 6, 1977.)