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# Delayed Auditory Feedback and Retention Testing Time

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DELAYED AUDITORY FEEDBACK AND  
RETENTION TESTING TIME

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A Thesis  
Presented to  
the Graduate Faculty  
Central Washington State College

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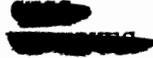
In Partial Fulfillment  
of the Requirements for the Degree  
Master of Science

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by  
Wayne K. Miller  
June, 1967

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APPROVED FOR THE GRADUATE FACULTY

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## CHAPTER I

### THE PROBLEM

Normal speech sounds are controlled by the speaking person in three ways: by air conducted feedback which involves the sound waves passing through the air and being received by the ear; by bone conducted feedback which involves the transmission of the sounds through the bones; and by kinesthetic feedback which is the feedback from the movements of the muscles involved in speech.

The most efficient source of feedback involved in speech is air conducted feedback. Lee (1950, 1951) described a phenomenon which has been variously called side-tone delay, the Lee effect, and delayed auditory feedback (DAF) in which the air conducted feedback is delayed and slightly amplified to partially mask the bone conducted feedback. DAF occurs by having a subject read orally into a microphone which is connected to a tape recorder with two heads--a record head and a playback head which operate simultaneously. There is an adjustable distance between these two heads which causes a recorded sound to be played back a fraction of a second after it has been recorded. The subject's spoken sounds come back to him through headphones a fraction of a second after the sound is spoken. In addition to the above mechanical definition, there is a behavioral definition which is typified by the occurrence of an artificial stutter, an increase in the

frequency and intensity of the voice, a heightened GSR reading, and a decrease in reading/speaking rate (Fairbanks, 1955).

Early researchers (Lee, 1950, 1951; Fairbanks, 1955; Chase, 1958) have attempted to isolate variables that are important contributors to the phenomenon and determine the conditions under which the speech disruption is the greatest. Fairbanks (1955) was concerned, among other things, with the delay interval. He varied the delay interval from 0.1 to 0.8 seconds, finding that a delay of 0.2 seconds was the most disruptive to normal speech.

There have been many studies exploring variables that contribute to the appearance of the phenomenon, but strikingly few studies attempting to relate DAF to learning. Since sensory feedback is very important to behavior and especially learning, it would seem that the DAF phenomenon could yield some significant information for learning. Since DAF is a disruption of sensory input, which is very important in learning, the next question to arise is whether DAF is disruptive to learning and if so, to what extent and under what circumstances.

Another question at this point is whether the effects of DAF are due to anxiety, as has been suggested by King and Wolf (1965). If DAF does function as an anxiety state, then would it be reasonable to make the same predictions

about the effect of DAF on learning as are made with other types of anxiety states and learning?

King (1963) conducted one of the few pioneer studies attempting to relate DAF to learning. He tested retention under DAF and found that the control group, who received normal feedback, scored significantly higher on his retention test than the group that received DAF with a delay interval of 0.2 seconds. King also told half of the subjects in each group that they would be tested on the material they read. He found no difference between subjects who were told they would be tested and those who were not told.

However, Shearer and Simon (1966) found that subjects who were told they would be tested on the material they read did significantly better than those who were not informed in both DAF and control groups. Shearer and Simon also investigated the pronounceability difficulty of the material and found that the easier the material was to pronounce (as rated by Underwood and Schulz, 1960), the more that was retained.

King and Wolf (1965) compared immediate and delayed retention. Their subjects were tested immediately after reading a 221 word story and again 24 hours later. The control group who received normal feedback showed no difference between immediate and delayed retention. The DAF

group (0.2 seconds delay) did significantly better on the delayed test than on the immediate. On the delayed test only, there was no significant difference between DAF and control.

King and Wolf (1965) also tested the hypothesis that the superior retention on a delayed test under DAF was due, in part, to the emotional arousal of the subjects. Both heart rate and GSR were measured. Under DAF, both GSR and heart rate increased significantly. Mild shock was given to a third group to approximate a known arousal state and they too had increased GSR and heart rate.

Although this evidence is far from conclusive, King and Wolf (1965) offer it as support for Walker and Tarte (1963) who were able to demonstrate that immediate recall was inhibited and later recall enhanced under conditions of high arousal on a paired-associates learning task.

In both of the above cited studies by King, a written measure of recall was used. King and Dodge (1965) used an oral recall and obtained the same results, that is, delayed retention (24 hours) was superior to immediate retention for subjects under DAF. Again, there was no difference between immediate and delayed retention for controls. The retention test used by King (1963), King and Wolf (1965) and King and Dodge (1965) consisted of having the subjects reproduce the story as close to the original

as possible. The number of correct words in context was then used as the measure of retention.

In the King series of studies, when delayed retention was measured, the same subjects were used that had taken the immediate recall test. This leaves open the possibility that a practice effect may have had some influence. King and Dodge (1965) do suggest, however, that if delayed recall scores alone were obtained from the subjects, that the material read under DAF would be retained better than the material read under normal feedback.

The present study is a modification of the work done by King and his associates. It has been here proposed that a delay time of only a few minutes (rather than 24 hours) would produce the same results as obtained by King and associates, that is, that delayed recall would be superior to immediate recall for subjects reading under DAF. The delay of retention testing has here been varied in three ways to try to determine how long the inhibitory effects of DAF last. The experimenter was also concerned with knowing if the subjects would retain content and meaning (as measured by multiple-choice and true-false questions) rather than a rote replication of the material. Also, all readings were timed to have an objective measure of the amount of disruption under DAF.

In view of the above factors and the lack of research in this area, the following hypotheses were derived. Delayed retention would be superior to immediate retention for material presented under DAF. All control groups would read faster and retain more than their corresponding DAF group.

## CHAPTER II

### METHOD

Subjects. 28 male and 32 female Ss were used. They were all undergraduate students enrolled in general psychology at Central Washington State College and between the ages of 18 to 21. Ss were randomly assigned to groups, the only restriction was that an approximately equal number of males and females appeared in each group. Only the middle 82 per cent of the population was used (in terms of reading speed and comprehension of the Washington Pre-College Grade Prediction Test).

Apparatus. A sound shielded room was used for all testing. DAF was achieved through a modified Viking model 87 tape recorder, having a delay of approximately 0.25 seconds, played through a Beltone model 15c speech audiometer at a sound pressure level of 63 db, 150, through a set of headphones which were calibrated to the audiometer. The passage of material read by the Ss consisted of a five paragraph, 436 word story about crows taken from a standardized test of diagnostic reading (see appendix). A 60 minute stop watch was used for timing. Ss were seated at a low table upon which were two manila folders, one contained the material to be read and the other contained the retention test (see appendix) and a pen.

Design. The present experiment is based upon a 2X3 analysis of variance. The first factor ( $A_1, A_2$ ) represents DAF and Control. The DAF groups received DAF for the middle section of the material they read.

These groups were then broken down into three subgroups each ( $B_1, B_2, B_3$ ) which represented the time of retention testing, Immediate I, Immediate II and Delay. In Imm I, Ss were tested immediately after they had finished the middle (DAF) section of the material; Imm II were tested when they had finished the complete passage; Delay finished the passage and waited ten minutes before testing.

Procedure. S was greeted and seated at a low table and assisted with putting on the microphone and headphones. E then left the room and was seated at the control panel. E and S could see each other through a double window. E then spoke to the S via the microphone and instructed him to begin reading orally at his normal rate when told to do so. S was then instructed to open the folder which contained the reading material and begin reading.

When the S had finished reading the second paragraph, E switched on the DAF circuit if S was a DAF and did nothing if S was a control. E switched off the DAF circuit at the end of the third paragraph and allowed Ss to finish reading the passage unless S was in Imm I, in which case he was

tested at that time. The Imm II groups were tested when they finished reading the passage and the Delay groups were instructed to sit quietly for a ten minute period before testing. The test consisted of seven multiple-choice and ten true-false questions. All ten true-false questions were taken from the third (DAF) paragraph. The multiple-choice questions were taken from all five paragraphs. After an S had finished the test, E went into the S chamber and told him that his job was completed. Ss were then thanked for their cooperation, encouraged to remain silent about the experiment, and dismissed.

## CHAPTER III

### RESULTS

A 2X3 analysis of variance was performed on the retention test scores. As the Ss in the Imm I groups did not read the last two paragraphs, questions pertaining to that material were omitted from their data. This necessitated transforming the scores into percentages of correct answers. Results indicated that there was no significance on either of the main effects. DAF-Control came close to significance ( $F=2.74$ ,  $df=1/54$ ,  $0.15 > p > 0.10$ ). Retention testing time also came close ( $F=2.22$ ,  $df=2/54$ ,  $0.15 > p > 0.10$ ). The interaction effect was negligible ( $F=0.34$ ,  $df=2/54$ ,  $p > .05$ ). A Cochran's test for homogeneity of variance was run on this data and all groups were found to be homogeneous. A graphic representation of the differences between individual means is presented in Figure 1.

A 2X3 analysis of variance was also performed on reading times for sections I and II. A 2X2 analysis of variance was performed on section III since the Imm I groups did not read section III. There was no significance for either section I ( $F=0.84$ ,  $df=2/54$ ,  $p > .05$ ) or section III ( $F=0.97$ ,  $df=2/36$ ,  $p > .05$ ). Section II, the section read under DAF, did reveal significance ( $F=49.91$ ,  $df=2/54$ ,  $p < .01$ ).

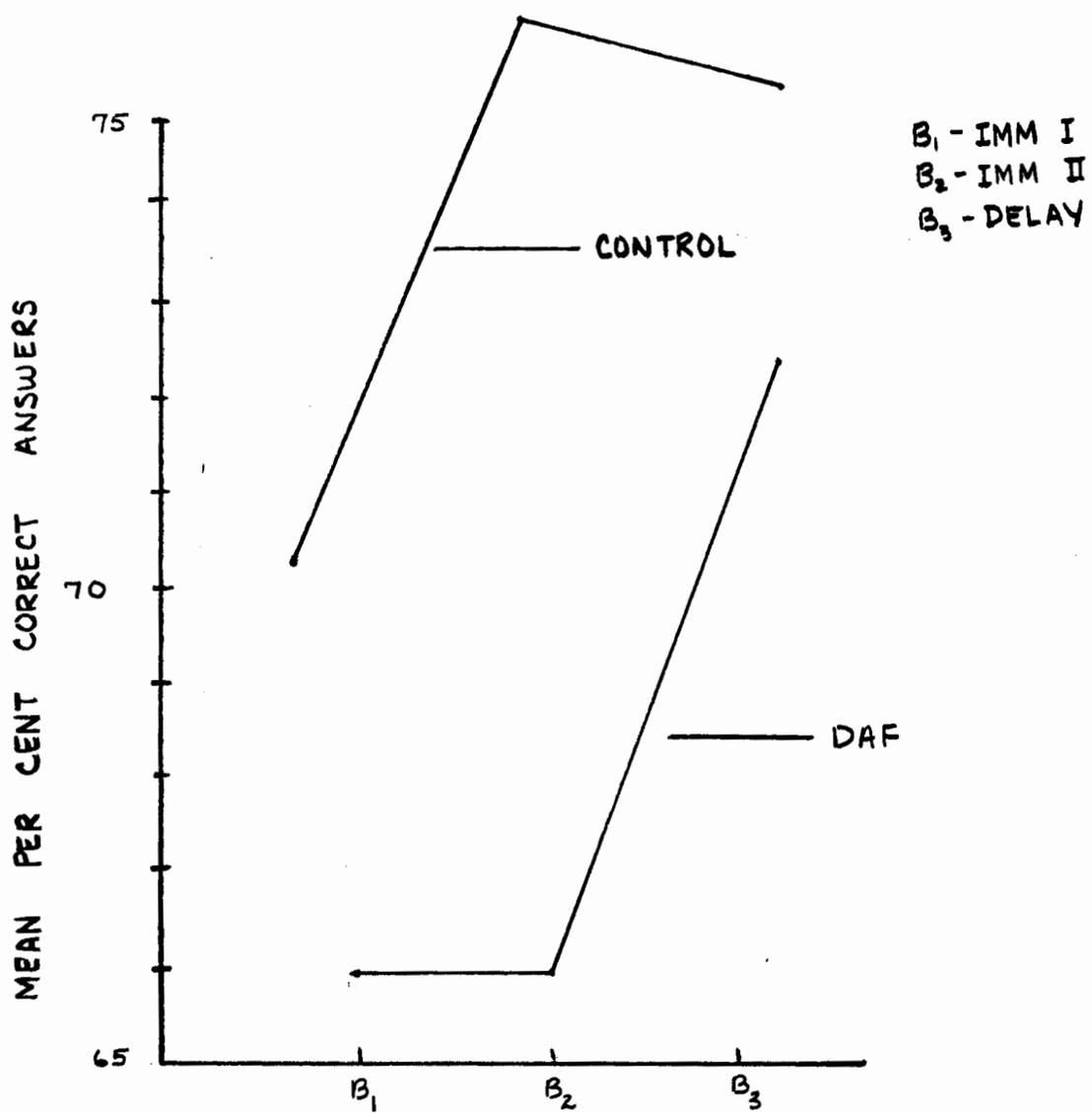


Fig. 1. Differences between individual means.

## CHAPTER IV

### DISCUSSION

The results do not indicate support for the hypotheses, but the trend of the data is in that direction. That is, that the control groups did better than the DAF groups and the the Delay-DAF group did better than either Imm I-DAF or Imm II-DAF. These statements must be made cautiously, however, because of the non-significance of the main effects on the retention test scores.

These results are in the same direction as the findings of King and Wolf (1965) and King and Dodge (1965) that DAF subjects given a retention test at some later time do better than when tested immediately.

The results of this study may also be interpreted to add further support to King and Wolf's (1965) hypothesis that DAF functions as an arousal state to inhibit memory. There are several important distinguishing features between King and Wolf's study and the present one that should be illustrated to determine the extent and limitations of possible generalizations.

The King studies tested subjects both immediately and 24 hours later. The present study used different subjects for each test. If there was any practice effect present in the King studies, the present design has controlled for that factor. The present study also shortened

the delay period to ten minutes. The results may be interpreted to indicate that the inhibition of memory under DAF may dissipate in ten minutes rather than 24 hours. That there was still some inhibition after ten minutes may be an important factor in the present results.

The King studies used a story 221 words in length and the present study used a passage considerably longer (436 words). This is probably a most important factor in the interpretation of results. The subjects were exposed to DAF for a longer time in this study than is common practice. The experimenter subjectively observed subjects to adapt somewhat to the DAF in terms of articulatory errors. This is consistent with Tiffany and Hanley (1956) who found that over 24 trials, subjects improved in articulatory errors while under DAF but not reading rate. This may have affected the results in that subjects who adapted partially to the DAF may have remembered more than subjects who did not.

In short, there were many differences between the King studies and the present one. The weak support of King's results may have been due to any one or any combination of these variables. With the data at hand, it is impossible to isolate the source(s) of difference.

That the time for section II was significantly longer for the DAF groups reveals that the DAF phenomenon

did, in fact, occur. In view of this result, it appears that one reason for the insignificant main effects of the retention scores was the insensitivity of the test. As the test was only 17 questions in length, and 14 for the two Imm I groups, it was probably not finely enough tuned to detect the predicted differences. There were three subjects who attained perfect scores on the test indicating that the ceiling was too low. Perhaps lengthening the test would alleviate this problem. Other studies in this area have used recall tests which have asked the subject to reproduce from memory the material he has read. It may also be possible that the results obtained by the King studies (1963, 1965, 1965) and by Shearer and Simon (1966), who used the above type of test, do not generalize very well to the type of test used in this study--although the trend of the present results do not favor this interpretation.

Another possible reason for the near miss on significance was the quality of the equipment. There was a constant hum in addition to the intermittent background noises of various types. Through one circuit (not an AM receiver) the local radio station could be heard. It is possible that the background noise was of sufficient intensity to nullify some of the effects of the DAF. As other experiments (Shearer & Simon, 1966) have used

feedback intensity of 85 db and upwards, perhaps this problem was not indigenous to this apparatus and a higher intensity should have been used to minimize any possible effects of background noise and to insure effective masking of bone-conducted feedback. Yates (1963) has stated that disruption under DAF increases as the intensity of DAF increases.

Difficulty of the material may have been another factor. The passage used was taken from a diagnostic reading test with a large sample of words difficult to pronounce. Shearer and Simon (1966) have demonstrated that the easier the material is to read, the more that is retained under DAF. However, one might expect this factor to affect the control groups as well.

One striking feature of the DAF phenomenon subjectively observed by the experimenter was that the subjects seemed to read with less hesitation and articulatory errors after DAF than before. This may indicate that as a result of concentrating very hard while the DAF was in effect, the concentration perhaps carried over to the next section of material, effecting the improved oral reading.

If this hypothesis is valid, then DAF would be extremely valuable in training public speakers and orators or even school teachers who often read orally passages of considerable length.

In conclusion, the experimenter feels that the DAF phenomenon is well deserving of intensive study in the hope that a wealth of information valuable to speech and psychology will result. It is hoped that the present study has added to the area if only to serve the purpose of generating new hypotheses and raising new questions.

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APPENDIX

Material Read by All Students

The common crow, with his three closely related varieties, the Florida crow, southern crow and western crow, is found practically all over our country east of the Rocky Mountains, as well as in sections of the Northwest and along our western coast down to Southern California.

In building their nests, as in everything else, crows prove that they are individualists. Most often the nest, a bulky structure of coarse sticks, twigs, grasses and tree bark, lined with soft rootlets of fur or moss, is in an evergreen, and is about thirty feet from the ground. They often decorate their nests by inserting in them a shiny pebble or glittering pieces of glass.

As crows are always more or less clannish, there are usually a number of nests within a small area, and the occupants exercise their sly mischievousness by stealing each other's nesting materials. When one of the nesters flies off to feed for a while, one of his dark neighbors rushes to the unprotected nest, removes from it the choicest bits of moss and rootlets, and hides them in his own nest. Then, when the thief is absent from his nest for a while, the recently burglarized bird flies over and regains all the stolen goods, plus half a dozen other choice bits. This pilfering is probably a friendly joke, for actually crows are devoted to one another and are bound by a sense of unity that leads them to show each other extraordinary courtesy and understanding.

The young stay in the nest about three weeks, consuming their weight in food every day, and by the time they are ready to leave they look almost like their parents except that their coats have less luster. For several days they practice flight maneuvers and wing drills before the critical elders of the flock. The oldsters show them the lay of the land and teach them the rules of the community of fifty or sixty crows nesting in the neighborhood.

Despite the individualism of its members, a flock is as disciplined as an army. It posts sentinels in a high tree to keep watch while the others feed. It has special flight maneuvers: low, fast and scattering for the mornings; high, slow and single-file for the evenings; forty-five miles per hour in absolute silence when the sentry signals that a man with a gun is coming. When traditional enemies such as owls or foxes are sighted, it is a rule that all flock members must raise a terrific rumpus. Only when the young have been trained in these practices are they ready for adulthood.

Taken from: Diagnostic reading tests survey section, Form A.  
Committee on diagnostic reading tests, inc., Mountain Home,  
North Carolina, 1963.

APPENDIX

Retention Test Given to All Subjects

PLEASE ANSWER THESE QUESTIONS TO THE BEST OF YOUR ABILITY.  
CIRCLE THE CORRECT ANSWER.

1. Crows frequently
  - a. steal each other's nesting materials.
  - b. lay their eggs in the nests of other birds.
  - c. conceal their nests to prevent other crows from stealing their eggs.
  - d. attack and kill the young in the nests of other crows.
  
2. Relationships among the crows in each flock are best described as
  - a. independent and unfriendly.
  - b. deceitful and suspicious.
  - c. aggressive and quarrelsome.
  - d. friendly and courteous.
  
3. A community of crows during the nesting season usually includes
  - a. ten or twelve members.
  - b. fifty or sixty members.
  - c. four or five hundred members.
  - d. several thousand members.
  
4. When the young crows are ready to leave their nests, the adults
  - a. instruct them in the rules of the flock.
  - b. abandon them to forage for themselves.
  - c. try to prevent them from flying away to join other flocks.
  - d. hold a meeting and choose the future leader of the flock.
  
5. If in the early evening, you were standing near the night roosting place of a flock of crows, you might expect to see them flying in to roost
  - a. from all directions, singly.
  - b. fast and in groups of threes and fours.
  - c. slow and single-file.
  - d. at forty-five miles per hour in absolute silence.
  
6. When crows discover a fox, they usually
  - a. swoop down and attack the animal.
  - b. remain absolutely silent until the animal is out of sight.
  - c. fly off in all directions, as quietly as possible.
  - d. all start cawing noisily.

7. After the young crows have left the nest, they
- frequently refuse to eat unless their food is carefully washed for them.
  - are extremely independent and insist on getting their own food as early as they possibly can.
  - try to get their parents to feed them as long as possible.
  - frequently kill each other unless they are carefully guarded by their parents.

NOW TRY THESE. IF YOU THINK THE STATEMENT IS TRUE, CIRCLE THE T; IF YOU THINK THE STATEMENT IS FALSE, CIRCLE THE F.

- T F 1. Crows are not clennish.
- T F 2. There are usually several nests within a small area.
- T F 3. Crows rob food from their neighbor's nests.
- T F 4. Crows seldom have many crow friends.
- T F 5. Nesting material is pilfered from other crows' nests.
- T F 6. Crows are quite courteous to each other.
- T F 7. The third paragraph describes how crows learn the rules of the community.
- T F 8. A type of revenge is quite commonplace among crows.
- T F 9. The young usually stay in the nest about two months.
- T F 10. Crows demonstrate malice to each other.

If you have any comments about the experience you have just had, use the space below.