Can Perfect Pitch Be Learned?

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In 1893 one of the original psychologists of music, Carl Stumpf, in his *Tonpsychologie* stated that perfect pitch was an inborn talent which a select few possessed. As evidence he cited the case of Wolfgang Amadeus Mozart who reportedly possessed that ability in early childhood. In 1919 the famous constructor of music tests, Carl Seashore made a similar statement in his *Psychology of Musical Talent.* He indicated that absolute pitch was an inborn disposition which manifests itself during childhood in a striking, immediate, and spontaneous manner. Such a conviction is still held by many psychologists and most musicians with whom I have spoken.

In order to distinguish absolute or *perfect pitch* from another kind of discriminative behavior, *pitch discrimination,* we consider that in the former a *pitch naming* response is called for. A given tone is presented without any frame of reference and the respondent must name the tone regularly and accurately. In pitch discrimination, at least one reference tone is allowed and the subject simply has to tell if one is higher or lower than the other. Incidentally, these two kinds of discriminations are not necessarily related as I had previously thought, for we have found subjects who have very acute pitch discrimination who do not *name* pitches at all well.

In our laboratory investigations on perfect pitch at Hamilton College, we are not attempting to disprove directly the "inheritance" hypothesis. However, we feel we are giving strong evidence to support the belief that the kind of pitch naming responses called for in perfect pitch can be learned, and the implications are strong that in all probability this is what happens in a less contrived situation in one's developmental history outside the experimental laboratory. It is a generally accepted premise in psychology that principles discovered in the laboratory are applicable to behavior in our everyday existence.

In order to investigate perfect pitch experimentally and determine to what degree it could be developed if the proper training techniques were applied, we set up the following criterion. A subject is presented with a random series of musical tones within certain limits of the musical scale and if he can identify all of them correctly without any reference to other objectively presented and already named pitches, we say he is exhibiting perfect pitch. Accordingly, we contrived an experimental situation which would meet this criterion and proceeded to train individuals so they could name the pitches when these were presented randomly and without prior reference tones.

In our original training procedure we used five male college students as subjects, two of whom had claimed before the start of our experiment to "have" perfect pitch. It turned out immediately that they did not. Two others had had some formal musical training, and a fifth was musically naive in that he could not read musical notation and had had no formal training on a musical instrument or other musical education.

A Magnichord high fidelity stereophonic tape recorder was used to present the tonal stimuli. Piano tones were taped covering the two octave range of 24 notes beginning at middle C and running chromatically upward to high B. In each of eight series, the 24 tones were taped in random order, each tone being used only once in a given series although the subjects were not informed of this fact. The subject sat in a soundproof booth and listened to the tones through the earphones. In front of him was a response panel upon which were mounted two vertical columns of 12 buttons each. Each column represented one of the two musical octaves used in the experiment. Progressing in an orderly fashion from bottom to top, the individual buttons represented the notes in ascending scale and were labeled appropriately C, C♯, D, D♯, etc. First of all this arrangement gave a bottom to top spatial relationship of low to high tones within the octave and secondly it divided one octave from another.

The buttons on the response panel served to activate lights on an enlarged metal replica of the musical staff which was placed at a distance of 10 feet outside the booth and in front of the subject. This could be viewed through a glass window of the booth. The 24 lights on this scale represented the 24 notes used in the experiment and they could be activated individually by the subject's pressing the corresponding buttons on his response panel.

After preliminary acquaintance with the apparatus and method, all subjects were given a pre-training accuracy test. To each tone in a series, he responded by pressing the button corresponding to the note he heard. After each presentation, the subject signaled the experimenter via another switch on his panel that he was ready for the next stimulus presentation. At no time during this pre-training test, was the subject given any indication of the correctness of his responses.

There then followed the actual training procedure. Each subject was given the same tone listening and button pressing procedure used in the pre-training test trial. However, he was given immediate knowledge when he had named a pitch correctly. When he was incorrect in a particular tone-note match, he was immediately notified not only of his error but the number and direction of the semitones that he had erred from the correct note. This feed-back, or reinforcement as it is called in contemporary learning theory, was given when he flipped an answer switch provided for him. The answer switch opened a circuit from the musical staff to the experimenter's own control panel on which the correct lights for each tone could be preset. When the subject heard and named a tone, he pressed the button which he judged to correspond to the note he heard and that note became illuminated on the staff. He then flipped the answer switch. If he had named the tone correctly, that note become perceptibly brighter indicating to him that he was correct. In the case of an incorrect response, a flip of the answer switch illuminated the correct note along with the note he had named. This gave him a visual picture of the difference in half steps between the note named and the correct one. He then was required to correct his error by pressing the button corresponding to the right note. About 20 seconds elapsed between each tonal presentation, making it difficult if not impossible for the subject to use the previous stimulus as a reference tone.

Subjects were placed on a daily running schedule, the series of tones was selected at random from one session to another so that a subject never got the same series twice in a row, nor did he get it frequently enough to memorize any of the pitch intervals. Following the training series, the subjects were given a post-test to afford a measure of the improvement in the perfect pitch training.

After 36 training sessions, all subjects showed marked improvement. None of the subjects had demonstrated at the beginning of the experiment in the pretraining test that they had perfect pitch. Two of the subjects met our criterion of perfect pitch in the post-test. Had the training continued longer, it is possible that two others might have also succeeded. Another effect of the training was a marked decrease in half step errors. The decrease was most marked for the subjects who started off poorest, for the "good" subjects seldom made more than half step errors even on the pretraining test. Each subject tended to have his own pattern of errors. One tended to flat rather consistently from the correct note, while another tended to sharp, his errors being generally in an upward direction. It is possible that the kinds of errors may be related to the types of musical training the subjects had, as the singer tended to flat and a B-flat clarinet player tended to sharp.

Error analyses of the scores indicated that for most subjects the natural tones (corresponding to the white keys on the piano) were most often judged accurately. The tone judged most often correctly was middle C, then A, followed by D, E, and G in that order for the first octave. Sharps were consistently more difficult to judge correctly and, in general, the second octave gave more difficulty than the first.

It is clear that all subjects improved significantly as a result of this training procedure. The feed back they received would appear to be a significant variable in that the subjects were able to get immediate knowledge of their results. The effect that training had on behavior outside the laboratory situation is also interesting. From interviews with the subjects during and after training, we found that one subject, a singer, indicated he found his vocal production much improved, at least as far as pitch was concerned, but was more annoyed by people who sang slightly off pitch. Another subject, a pianist, indicated a similar annoyance in that he was unable to play on pianos that were slightly out of tune.

This technique bears a resemblance to devices used for presenting programmed learning of verbal materials (teaching machines). It further demonstrates the application of modern reinforcement learning theory to a musical situation. In an earlier article ("Musical Learning and Reinforcement Theory," *Music Educators Journal*, February-March 1960) I suggested some ways that learning theory could be applied to music.

Bearing all this in mind, we entered upon the second phase of our investigation which is still in progress. We asked ourselves, if subjects can be trained in perfect pitch when the tones are presented randomly, would not the task be made easier if we presented the easiest notes first and gradually progressed by small steps as in programmed learning until the most difficult notes could be named? Going on the theory that learning would take place more quickly if the easier to identify notes were presented, we selected another five subjects and made 14 tapes which were graded as to difficulty. The first tapes contained only the easy natural tones. Gradually in successive tapes we began to introduce sharps in order of F♯, C♯, G♯, D♯, A♯. In these tapes some of the tones would be repeated, and it was not until the last tapes that all 24 tones were again used, in a completely random order. In this revised procedure, the major difference was the selecting out of particular tones to be presented, eliminating the "harder" tones at the beginning. Furthermore, subjects could proceed at their own rate. Some might find it necessary to remain with the easier tones longer than others. Like programmed learning of verbal materials, a subject progressed by small easy steps. In our case, as soon as a subject had responded correctly to the tapes with the easier tones, he could then progress gradually to the more difficult discriminations.

Some subjects learned faster than others but all made remarkable improvements. Introducing a "test" in the middle of training (that is a trial in which no information or feedback is given) we found, for example, that after 10 trials, one subject had made 700% improvement, another 600%, another 200%, and so on. It is evident, of course, that in the beginning these subjects who showed such marked improvements started out with very few correct responses.

We are finding again that the range of errors is greatly reduced as a result of training. In one subject, out of 120 responses, only four of his errors were greater than a half step. Even though all our subjects in this second group had had some musical training prior to experimentation, two of them, for example, made only one correct response at the beginning of pitch training.

We feel that our techniques have merit for training purposes in musical identifications. We have not claimed that all our subjects can be trained in perfect pitch. What we have demonstrated is that *some* can, and all can make remarkable improvements. Every subject we have used, regardless of how pitch deficient he has been at the beginning of training, has made changes in the direction of better pitch naming.

There are many other facets of the problem which we would like to explore; for example, how do the kinds of responses made relate to a person's previous musical training? What will be the transfer effect if we use pure tones in the training procedure instead of piano tones, or can this technique be applied profitably to younger subjects of high school and grade school age? and finally, is there a "decay" following training if the subject does not continue to apply what he has learned to musical situations outside the laboratory?

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Current Issues in Graduate Music Education Programs

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pedantry and length is often justified in many dissertations. The advantage of the shorter dissertation would be of benefit to both the faculty and student. The faculty committee would have more time to read the dissertation and would not hesitate to have it redone, if it were poorly written or unscholarly. Students could spend more time perfecting a shorter dissertation.

Articulation Between Undergraduate and Graduate Programs

Many music undergraduate and graduate programs appear to be unrelated. There is very little effort in many universities to prepare the better student for the scholarship necessary for successful graduate study. Many classes that should have been requirements for the completion of an undergraduate degree, are included in graduate degree programs. It is necessary that masters degree programs for teachers should, in part, be based on the skills and competencies needed to teach music to children and adolescents. There is, however, a need for the type of course that will develop independent and creative thought. The continual proliferation of music education courses is one of the most glaring defects of graduate music education programs. Music education has not, however, been alone in this proliferation and overlapping of courses. Areas such as music theory, music history and literature, applied music, as well as professional education, have committed the same academic sins. An attempt should be made to develop undergraduate and graduate music programs that are related. There is a special obligation to challenge the talented music student at the undergraduate level in order that he will be interested in continuing his education. Too much time has been spent helping and guiding the average and weak students.

The Lag Between The B.A. and Ph.D. Programs

There have been numerous surveys in total graduate programs indicating that the percentage of students completing graduate programs was extremely low. Rosenhaupt[7] has pointed out that at Columbia, between 1940 and 1956, only 49 per cent received graduate degrees, and only 3.2 per cent received the doctorate. The picture in all sections of the country appears to be approximately the same. This is especially true of doctoral programs where the degree that is publicized as requiring three years of study beyond the Bachelor of Arts, turns out in actual practice to require on the average of seven to twelve years.[8]

Among superior music students the uncertainty about the length of time to complete a doctorate program is a real problem. In a period when we are seeking outstanding students, certain practices often discourage students from completing graduate programs. Rigorous programs and requirements are needed but not uncertainty.

There are many reasons reported for the plight of

[7]Rosenhaupt, Hans. *Graduate Students Experience at Columbia University, 1940-56*, New York: Columbia University Press, 1958, p. 84.
[8]Carmichael, Oliver C., op. cit., p. 34.