Absolute Pitch Does Not Depend on Early Musical Training

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ABSTRACT: The etiology and defining characteristics of absolute pitch (AP) have been controversial. To test the importance of musical training in the development of this skill, we developed a new paradigm for identifying AP that is independent of a subject's musical experience. We confirm the efficacy of the paradigm using classically defined AP and non-AP musicians. We then present data from a nonmusician who nevertheless appears to possess AP. We conclude that musical training is not necessary for the development of AP.

KEYWORDS: absolute pitch (AP); learning; tonal memory

INTRODUCTION

For most individuals the perception of melodic sequences is based on understanding the relationships between different tones. This skill is referred to as "relative pitch" (RP). A small subset of the population is also capable of identifying quickly and accurately the absolute frequency of tonal stimuli. This skill is referred to as "absolute pitch" (AP).

A central point of controversy in the study of AP has been the relative roles of heredity and early learning. Early models of AP suggested that "true" AP was a genetically determined trait.[1,2] Recent evidence supports this model.[3,4] A second model advocates that AP is the result of early musical experiences[5,6] in which some individuals memorize the exact frequency of each musical note. Thus, according to this model, AP is largely a categorical phenomenon. Indirect evidence in support of this theory indicates that all individuals known to have AP have had musical training[2,6] and that the degree of AP tends to correlate with the years of musical experience.[5]

Historically, most paradigms that test for AP ask subjects to name a series of tones according to the Western musical scale. Because performance on such a test is

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predicated on a basic level of musical knowledge, these methods are insensitive to the possibility of discovering AP in either a nonmusician or a musician of non-Western training. As such, there is no convincing evidence that only musicians possess AP.[7]

To address these issues, we designed a new paradigm that qualifies subjects as AP possessors or nonpossessors independent of their musical experience. Using this method, we tested the following predictions of the early learning model: (1) AP is a musical, and therefore categorical, phenomenon; and (2) it is impossible to develop AP without musical training.

PART 1

Method

Participants. Twenty-seven experienced musicians were recruited (6 with AP, 21 with non-AP [NAP], as categorized with a classic note-naming test). Additionally, we tested subject R.M., a 25-year-old man with minimal musical experience. R.M. was incapable of accurately naming musical notes, but nevertheless claimed to have AP.

Stimuli and Procedure. Subjects were played a pure sine tone followed by a silent interval (2, 8, or 16 seconds), after which they were required to reproduce the original target using a digital sine function generator. Individuals were not given feedback on their performance until the completion of all tasks, and at no time was a reference tone provided.

Data Analysis. Responses were octave corrected and distance was calculated in half-steps away. Constant error (CE) was used as a measure of bias and standard deviation (sd) as a measure of variability. Thus, accurate performance would yield a normal distribution centered at zero (low CE and low sd) and random performance would produce a uniform distribution of responses (low CE but high sd).

Results

AP vs NAP comparisons (Fig. 1). The AP and NAP groups differed significantly with respect to sd ($F(1,75) = 45.60$; $P < 0.0001$) but not with respect to CE ($F(1,75) = 0.024$; $P > 0.80$). Neither group was affected by the time delay, and both groups differed significantly from the prediction of the null hypothesis ($P < 0.01$).

Subject R.M. vs AP and NAP Groups. With respect to CE, subject R.M. did not differ from either group ($P > 0.40$). With respect to sd, subject R.M. was mildly different from the NAP group ($t(20) = 2.00$; two-tailed $P < 0.10$), but not from the AP controls ($t(5) = 1.89$; $P > 0.10$).

These data demonstrate that both AP and NAP subjects were able to reproduce the target stimulus accurately and that performance did not decay for intervals of up to 16 seconds.

PART 2

Motivation

Passive exposure to interfering tones is known to differentially affect performance of AP possessors and nonpossessors, presumably by destroying individuals'

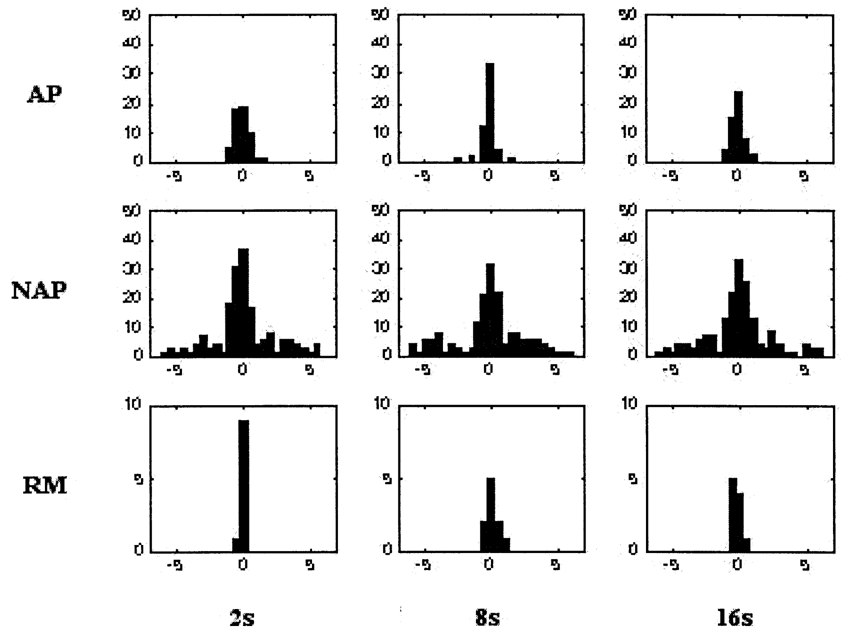

FIGURE 1. Histogram of responses by the absolute pitch (AP) and non-absolute pitch (NAP) groups and subject R.M. for silent delays of 2, 8, and 16 seconds.

short-term memory traces of stimuli.[8,9] We sought to test whether a pre-categorical paradigm of this sort could be used to distinguish explicitly between AP and NAP individuals.

Method

Experiment 2b differed from Experiment 2a by filling the interstimulus interval (ISI) with a variable number of distracting tones (either a 2-second ISI with 1 distracting tone, an 8-second ISI with 31 distractors, or a 16-second ISI with 71 distractors). All other parameters were the same as those in Experiment 2a.

Results (Fig. 2)

AP vs NAP Comparisons. The AP and NAP groups differed significantly with respect to sd ($F(1,82) = 133.37$; $P < 0.0001$) but not with respect to CE ($F(1,82) = 1.05$; $P > 0.30$). The AP distributions differed significantly from the null hypothesis for all time intervals ($P < 0.01$), whereas the NAP group differed from chance for the first interval only.

Subject R.M. vs AP and NAP Groups. With respect to CE, subject R.M. did not differ significantly from either group ($P > 0.40$). With respect to sd, subject RM differed significantly from the NAP group ($t(20) = 5.34$, $P < 0.001$) but not the AP group ($t(5) = 1.20$, ns).

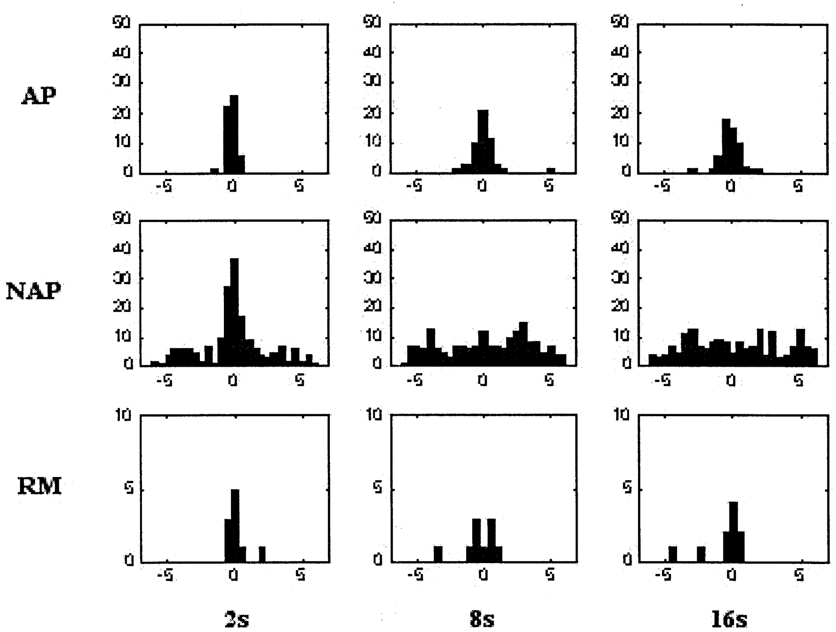

FIGURE 2. Histogram of responses by the absolute pitch (AP) and non-absolute pitch (NAP) groups and subject R.M. for conditions with 1, 31, and 71 interfering tones.

These data show that AP and NAP subjects were differentially affected by interfering tones: both groups were accurate without interference, but only AP subjects were accurate with interference.

CONCLUSIONS

The early learning theory states that absolute pitch (AP) is a categorical phenomenon and that early musical training is required for its development. However, this theory has been largely untestable in that paradigms to identify AP possessors have been predicated on a basic level of musical expertise. Based on extensive literature on pitch memory,[8–11] we constructed a new paradigm to test for AP that is precategorical and does not require any musical expertise. Whereas both AP and NAP subjects were able to reproduce target stimuli after a silent delay, we predicted that only AP possessors would be accurate in the presence of tonal interference. Our data strongly support this hypothesis and thereby demonstrate the efficacy of the method.

We also present the case report of a nonmusician, subject R.M., who is incapable of naming notes. Nevertheless, R.M.'s performance on our paradigm was significantly better than that of the NAP musicians and indistinguishable from that of the AP controls. Based on these data, we conclude that subject R.M. possesses AP. To the best of our knowledge, this is the first report of a nonmusician with AP. These data disprove the hypothesis that early musical training is required for the development of AP. Instead, they suggest that true AP may be pre-categorical and, at least in some cases, dependent on hereditary factors.

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