

# The Historical Construction of Absolute Pitch Rarity and Unlearnability: A Critical Review

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## Abstract

The belief that absolute pitch (AP) cannot be acquired in adulthood has persisted for over seven decades. This review argues that the unlearnability claim was not established independently, but was sustained in part by a rarity estimate that framed AP prevalence as a fixed biological constant, structurally excluding the possibility of deliberate acquisition. This review traces the construction of both claims, examines the logical and methodological gaps that sustained them, and surveys the growing body of evidence that challenges each. Training studies have demonstrated adult AP acquisition under controlled conditions, while pitch memory and phenotyping research supports the conclusion that AP exists on a measurable continuum and that the perceptual foundation for it may be more common than previously recognized. Implications for music education, auditory neuroscience, and adult perceptual learning are discussed.

**Keywords:** absolute pitch · auditory neuroplasticity · perceptual learning · critical period · pitch perception · music cognition

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## 1. Introduction

Absolute pitch (AP), the ability to identify or produce a musical note without an external reference, characteristically with high accuracy and speed (Miyazaki, 1988), has been regarded as one of the rarest perceptual abilities in Western populations, with prevalence estimates as low as 1 in 10,000 (Bachem, 1955). For much of the 20th century, the consensus within both the scientific and music education communities was that AP could only develop during early childhood and was not acquirable through deliberate training in adulthood.

It is well established that AP can and does develop during childhood, particularly in individuals who receive early musical training or who grow up speaking tonal languages in which pitch carries semantic meaning (Deutsch et al., 2004, 2006). The existence of this developmental pathway has never been in dispute. This review traces how a prevalence estimate became embedded in the definition of AP, and how the resulting consensus suppressed the very research that would have challenged it.

## 2. Origins: Bachem (1955) and the 1-in-10,000 Statistic

The foundational claim that AP occurs in approximately 1 in 10,000 individuals originates from Albert Bachem's 1955 study "Absolute Pitch," published in *The Journal of the Acoustical Society of America*. Bachem evaluated 103 individuals who self-identified as possessors of AP. In characterizing this cohort, he described the ability as "acquired spontaneously" and "not acquired through practice" (Bachem, 1955).

It is important to note that this characterization was descriptive rather than experimental. Bachem was reporting how his participants described the onset of their own ability; they had not undertaken deliberate training programs. No training intervention was attempted, proposed, or evaluated. The statement that AP was "not acquired through practice" reflected the self-reported experience of a self-selected group of existing possessors, not the outcome of an experiment testing whether practice could produce the ability.

Several additional methodological concerns are evident by contemporary standards. The sample consisted exclusively of self-identified possessors, introducing selection bias that precludes any valid estimate of population prevalence. The 1-in-10,000 figure was subsequently propagated through the literature as though it represented a measured prevalence rate derived from population-level sampling, when it was in fact an estimate from a convenience sample. Even recent attempts to correct the figure, such as Carden and Cline (2019) estimating at least 4% among experienced musicians, illustrate how the discourse has continued to center on identifying a more accurate fixed ratio rather than questioning whether a fixed ratio is a valid framing.

Beyond the methodological issues, the propagation of a specific prevalence ratio had a subtler but more durable consequence. The framing of AP prevalence as a fixed ratio implies that the occurrence of the ability is a constant. A constant, by definition, cannot be influenced by behavior. This framing made the unlearnability conclusion structurally resistant to challenge: it was not merely a finding to be tested, but a definitional constraint that excluded the possibility of training a priori.

Despite these limitations, Bachem's descriptions were widely interpreted as conclusions, and established the conceptual framework that would dominate AP research for the next half-century: AP as a rare, innate, and immutable trait.

### **3. Codification: Takeuchi and Hulse (1993)**

The characterization of AP as unlearnable was formalized in the 1993 meta-analysis by Takeuchi and Hulse, published in *Psychological Bulletin*. This review synthesized the existing literature and reported that individuals classified as AP possessors demonstrated pitch-naming accuracy between 70-99%, compared to 10-40% for non-AP individuals. The estimated prevalence was approximately 0.01% of the general population.

Critically, Takeuchi and Hulse stated that there were "no documented cases of adults learning absolute pitch" and that attempts to acquire AP after approximately age 9 were "rarely successful." This observation was factually accurate at the time of writing: no peer-reviewed study had documented adults achieving AP through structured training. However, the absence of documented cases reflected the absence of systematic adult training attempts, not the failure of such attempts. No structured adult training programs had been conducted and published.

The reasoning that supported the unlearnability consensus contained a logical gap that is worth stating explicitly. Because AP had been observed to develop in children without deliberate training intervention, often in association with early musical training (Baharloo et al., 1998), it was inferred that childhood represented a critical period after which AP could not develop. However, evidence that a skill can be acquired through one pathway (development during childhood) is not evidence that it cannot be acquired through another pathway (deliberate training in adulthood). The inference conflates the sufficiency of one mechanism with the necessity of that mechanism.

The Takeuchi and Hulse review was also informed by the broader influence of critical period theory in neuroscience, particularly the work of Hubel and Wiesel (1970) on visual cortex development. The conceptual transfer of critical period findings from sensory cortex development to complex auditory categorization was not empirically validated for AP specifically.

It is worth noting that the critical period inference was not unreasonable given what was known about adult neuroplasticity in 1993. The prevailing view at the time held that the adult brain was largely fixed in structure and function (Rakic, 1985). Functional magnetic resonance imaging (fMRI), first applied to human brain mapping by Belliveau et al. (1991), had only recently begun to reveal that adult brains undergo structural and functional changes in response to experience. The inference that AP acquisition required a

developmental window was therefore consistent with the neuroscience of its era. Subsequent research has since demonstrated extensive neuroplastic capacity in the adult brain (Kolb & Gibb, 2011), overturning the scientific basis for that inference.

The practical consequence was a self-fulfilling prophecy. The consensus that adults could not learn AP discouraged researchers from proposing, funding, or conducting adult training studies, which perpetuated the absence of evidence that was being cited as the basis for the consensus.

#### **4. Early Evidence for Widespread Pitch Memory: Levitin (1994)**

The first significant challenge to the rarity assumption came not from a training study, but from a production study. Levitin (1994) asked 46 participants to sing well-known songs from memory and measured the fundamental frequency of their productions against the original recordings using Fast Fourier Transform analysis with precision to within 3 cents.

Forty percent of participants produced the correct pitch on at least one trial, 12% produced the correct pitch on both trials (17 times the rate expected by chance), and 67% were within two semitones on their first attempt. Levitin proposed a Two-Component Theory of AP consisting of pitch memory (the implicit ability to encode and retain absolute pitch information) and pitch labeling (the explicit ability to assign note names to pitches). These data suggested that pitch memory is far more common than previously recognized, and that the apparent rarity of AP may reflect a labeling deficit rather than a perceptual one.

This distinction has significant implications. If most individuals possess stable pitch memory but lack the labeling component, then AP training may not require developing a novel perceptual representation. Instead, it may involve establishing an explicit naming system for perceptual information that is already encoded.

#### **5. Challenging the Immutability Assumption: Hedger, Heald, and Nusbaum (2013)**

The first direct empirical challenge to the immutability of established AP came from Hedger, Heald, and Nusbaum (2013), who demonstrated that the internal pitch references of confirmed AP possessors could be shifted through passive exposure to detuned music. In their experiment, AP possessors listened to music that was progressively shifted flat at a rate imperceptible in real time (approximately two cents per minute). After the exposure period, every participant showed a statistically significant drift in pitch identification in the direction of the detuning.

This result is significant because it demonstrates that AP, even when well-established, is not a fixed perceptual constant. If the internal reference can be altered by external stimulus, the characterization of AP as a fixed trait is inconsistent with the observed data. The finding raised a natural experimental question: if established AP can be modified by stimulus exposure, can explicit AP ability be developed in individuals who do not currently possess it?

#### **6. Adult Acquisition: Van Hedger, Heald, and Nusbaum (2019)**

Van Hedger, Heald, and Nusbaum (2019) addressed this question directly by training six adult participants in an eight-week program designed to develop AP. The training protocol incorporated multiple task types including note identification across varied timbres and octaves, with the explicit goal of establishing pitch chroma recognition that would generalize beyond the training conditions.

Two of the six participants (identified as S2 and S5) achieved accuracy and response times indistinguishable from lifelong AP possessors when tested across eight different timbres spanning seven octaves. Participant S5, a non-musician, reported that notes had taken on “unique perceptual qualities,” a qualitative description consistent with the phenomenological accounts of individuals who possess AP from childhood. Follow-up testing conducted months after the training period confirmed that the acquired ability had persisted.

This study provided the first documented cases of adults achieving AP performance at a level consistent with lifelong possession. The absence noted by Takeuchi and Hulse (1993) had been a gap in investigation, not in biological possibility.

## **7. Replication and Extension: Wong et al. (2019, 2020, 2025) and Bongiovanni et al. (2023)**

Subsequent studies have replicated and extended these findings across independent laboratories. Wong, Lui, Yip, and Wong (2019) conducted three experiments training adults across different octaves, timbres, and training environments. Six of the 43 participants reached 90% accuracy or above on all 12 pitch classes, meeting conventional thresholds for AP classification.

Although Van Hedger et al. (2019) had already demonstrated adult acquisition with participants who were not selected for tonal language background, Wong, Lui, et al. (2019) used tonal language speakers, raising the question of whether those specific results were influenced by the participants’ linguistic background. Given the documented relationship between tonal language exposure and AP prevalence (Deutsch et al., 2004, 2006, 2009), this raised the question of whether those specific results were attributable to linguistic background. Wong, Ngan, Cheung, and Wong (2020) addressed this confound directly by extending the training paradigm to speakers of non-tonal languages, confirming that the results of Wong, Lui, et al. (2019) were not attributable to tonal language background.

Most recently, Wong, Cheung, Ngan, and Wong (2025) trained twelve adult musicians in an eight-week online program comprising 15,327 trials over 21.4 hours. Participants learned to identify an average of 7.08 pitches (range: 3 to 12) at 90% or above accuracy with response times between 1.3 and 2.0 seconds, with the highest-performing participants reaching identification of all 12 pitch classes at accuracy and speed consistent with established AP performance. The study was designed to address potential confounds including pitch height learning, extended working memory, relative pitch strategies, and pre-existing AP abilities.

Bongiovanni, Heald, Nusbaum, and Van Hedger (2023) examined whether adult-acquired AP generalizes across tonal context, timbre, and octave, dimensions considered essential for genuine AP representation. Their findings confirmed partial generalization to untrained instruments, though octave transfer required longer training duration.

It is also notable that across these studies, participants who did not reach conventional AP thresholds nonetheless showed continuous improvement throughout the training period, with no evidence of a biological ceiling or learning plateau. The limiting factor in each case was the duration of the training program, not the trajectory of the learner.

Taken together, these studies establish that adult AP acquisition is reproducible across independent laboratories, generalizable across training paradigms, and achievable by a meaningful proportion of participants.

## **8. Further Evidence for Widespread Pitch Memory: Evans et al. (2024) and Schmidt (2025)**

More recent research has provided additional support for Levitin's (1994) finding that absolute pitch memory is common in the general population. Evans, Gaeta, and Davidenko (2024) examined absolute pitch in involuntary musical imagery ("earworms") and found that 44.7% of participants' sung recordings matched the original song key with zero pitch error, while 68.9% were within one semitone. These participants were not musicians and did not identify as having AP.

Schmidt (2025) synthesized these converging lines of evidence in a systematic review of implicit and explicit AP, concluding that "a further reason for the rarity of AP could simply be the lack of extensive appropriate training" and that implicit AP "seems to be possessed by most, even nonmusicians." This framing aligns with Levitin's Two-Component Theory: the perceptual foundation (pitch memory) appears to be broadly present even in individuals who have not developed the labeling system that characterizes explicit AP.

## **9. Reconsidering Measurement: Bairnsfather et al. (2025)**

The framing of AP as a binary trait has itself been challenged by recent phenotyping research. Bairnsfather, Mosing, Osborne, and Wilson (2025) conducted a systematic review of 160 AP studies ( $N = 23,221$ ) and found substantial variability in how AP is defined, measured, and classified. Mean accuracy for individuals classified as AP possessors was 85.9% ( $SD = 10.8$ ), while non-AP participants averaged 17.0% ( $SD = 10.5$ ).

The review concluded that AP should be treated as a measurable continuum rather than a dichotomy, and that the characterization of the AP phenotype varies significantly based on methodological choices in measurement and scoring. This finding has direct implications for training research: if AP exists on a spectrum, then training-induced improvements that do not reach arbitrary binary thresholds still represent genuine perceptual change.

## **10. Conclusion**

The historical "fact" that adults cannot learn AP was not established through the failure of training interventions. It was constructed through a sequence of observational descriptions being interpreted as empirical conclusions (Bachem, 1955), the framing of AP prevalence as a fixed constant that structurally excluded the possibility of deliberate acquisition (Bachem, 1955), an accurate observation about the absence of documented cases being treated as evidence of biological impossibility (Takeuchi & Hulse, 1993), and an inference that the existence of a childhood developmental pathway precluded adult acquisition, which was consistent with the prevailing understanding of neuroplasticity in 1993 but has since been overturned.

The empirical record now demonstrates that: (a) AP is not an immutable trait, as established AP can be altered through external stimulus (Hedger et al., 2013); (b) adults can acquire AP performance indistinguishable from lifelong possessors through structured training (Van Hedger et al., 2019; Wong, Lui, et al., 2019; Wong, Ngan, et al., 2020; Wong et al., 2025; Bongiovanni et al., 2023); (c) the perceptual foundation for AP appears to be broadly present in the general population (Levitin, 1994; Evans et al., 2024; Schmidt, 2025); and (d) AP exists on a measurable continuum rather than as a binary trait (Bairnsfather et al., 2025).

These findings demonstrate the biological possibility of adult AP acquisition, which is sufficient to overturn the unlearnability claim without needing to establish a population-level probability of acquisition, or to identify the specific circumstances, training parameters, or individual traits that may facilitate or hinder AP development in adults. What can be stated is that adult AP acquisition is not impossible. What remains unknown is how common it can be made, and under what conditions.

More broadly, much of the historical discourse around AP has been shaped by what might be termed etiological bias: the tendency to define AP by how it was acquired rather than by its functional output. If an adult learner's accuracy, response time, and generalization across timbres and octaves are indistinguishable from those of a lifelong possessor, any remaining distinction between the two is biographical, not biological.

These findings have implications beyond music education. They contribute to the broader understanding of adult perceptual learning and auditory neuroplasticity, and suggest that other perceptual abilities assumed to require early developmental windows may also be more trainable than previously believed.

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## References

- Bachem, A. (1955). Absolute pitch. *The Journal of the Acoustical Society of America*, *27*(6), 1180-1185. <https://doi.org/10.1121/1.1908155>
- Bairnsfather, J. E., Mosing, M. A., Osborne, M. S., & Wilson, S. J. (2025). Conceptual coherence but methodological mayhem: A systematic review of absolute pitch phenotyping. *Behavior Research Methods*, *57*, 61. <https://doi.org/10.3758/s13428-024-02577-z>
- Belliveau, J. W., Kennedy, D. N., McKinstry, R. C., Buchbinder, B. R., Weisskoff, R. M., Cohen, M. S., Vevea, J. M., Brady, T. J., & Rosen, B. R. (1991). Functional mapping of the human visual cortex by magnetic resonance imaging. *Science*, *254*(5032), 716-719. <https://doi.org/10.1126/science.1948051>
- Bongiovanni, N. R., Heald, S. L. M., Nusbaum, H. C., & Van Hedger, S. C. (2023). Generalizing across tonal context, timbre, and octave in rapid absolute pitch training. *Attention, Perception, & Psychophysics*, *85*, 525-542. <https://doi.org/10.3758/s13414-023-02653-0>
- Baharloo, S., Johnston, P. A., Service, S. K., Gitschier, J., & Freimer, N. B. (1998). Absolute pitch: An approach for identification of genetic and nongenetic components. *The American Journal of Human Genetics*, *62*(2), 224-231. <https://doi.org/10.1086/301704>
- Carden, J., & Cline, T. (2019). Absolute pitch: Myths, evidence and relevance to music education and performance. *Psychology of Music*, *47*(6), 890-901. <https://doi.org/10.1177/0305735619856098>
- Deutsch, D., Henthorn, T., & Dolson, M. (2004). Absolute pitch, speech, and tone language: Some experiments and a proposed framework. *Music Perception*, *21*(3), 339-356. <https://doi.org/10.1525/mp.2004.21.3.339>
- Deutsch, D., Henthorn, T., Marvin, E., & Xu, H. (2006). Absolute pitch among American and Chinese conservatory students: Prevalence differences, and evidence for a speech-related critical period. *The Journal of the Acoustical Society of America*, *119*(2), 719-722. <https://doi.org/10.1121/1.2151799>
- Deutsch, D., Dooley, K., Henthorn, T., & Head, B. (2009). Absolute pitch among students in an American music conservatory: Association with tone language fluency. *The Journal of the Acoustical Society of America*, *125*(4), 2398-2403. <https://doi.org/10.1121/1.3081389>

- Evans, M. G., Gaeta, P., & Davidenko, N. (2024). Absolute pitch in involuntary musical imagery. *Attention, Perception, & Psychophysics*, *86*, 2124-2135. <https://doi.org/10.3758/s13414-024-02936-0>
- Hubel, D. H., & Wiesel, T. N. (1970). The period of susceptibility to the physiological effects of unilateral eye closure in kittens. *The Journal of Physiology*, *206*(2), 419-436. <https://doi.org/10.1113/jphysiol.1970.sp009022>
- Hedger, S. C., Heald, S. L. M., & Nusbaum, H. C. (2013). Absolute pitch may not be so absolute. *Psychological Science*, *24*(8), 1496-1502. <https://doi.org/10.1177/0956797612473310>
- Kolb, B., & Gibb, R. (2011). Brain plasticity and behaviour in the developing brain. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, *20*(4), 265-276.
- Levitin, D. J. (1994). Absolute memory for musical pitch: Evidence from the production of learned melodies. *Perception & Psychophysics*, *56*(4), 414-423. <https://doi.org/10.3758/BF03206733>
- Miyazaki, K. (1988). Musical pitch identification by absolute pitch possessors. *Perception & Psychophysics*, *44*, 501-512. <https://doi.org/10.3758/bf03207484>
- Rakic, P. (1985). Limits of neurogenesis in primates. *Science*, *227*(4690), 1054-1056. <https://doi.org/10.1126/science.3975601>
- Schmidt, J. R. (2025). Is absolute pitch learnable? Implicit and explicit absolute pitch. *Music Perception*, *43*(2), 133-154. <https://doi.org/10.1525/mp.2025.2468410>
- Takeuchi, A. H., & Hulse, S. H. (1993). Absolute pitch. *Psychological Bulletin*, *113*(2), 345-361. <https://doi.org/10.1037/0033-2909.113.2.345>
- Van Hedger, S. C., Heald, S. L. M., & Nusbaum, H. C. (2019). Absolute pitch can be learned by some adults. *PLOS ONE*, *14*(9), e0223047. <https://doi.org/10.1371/journal.pone.0223047>
- Wong, Y. K., Cheung, L. Y. T., Ngan, V. S. H., & Wong, A. C.-N. (2025). Learning fast and accurate absolute pitch judgment in adulthood. *Psychonomic Bulletin & Review*, *32*, 1676-1688. <https://doi.org/10.3758/s13423-024-02620-2>
- Wong, Y. K., Lui, K. F. H., Yip, K. H. M., & Wong, A. C.-N. (2020). Is it impossible for absolute pitch to be acquired in adulthood? *Attention, Perception, & Psychophysics*, *82*, 1407-1430. <https://doi.org/10.3758/s13414-019-01869-3>
- Wong, Y. K., Ngan, V. S. H., Cheung, L. Y. T., & Wong, A. C.-N. (2020). Absolute pitch learning in adults speaking a non-tonal language. *Quarterly Journal of Experimental Psychology*, *73*(11). <https://doi.org/10.1177/1747021820935776>

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**Conflict of interest statement:** The author is the founder and lead research engineer of HarmoniQ, a commercially available absolute pitch training platform. This review was conducted independently and does not report data collected through the HarmoniQ platform.

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