Absolute Pitch

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Absolute pitch (AP) is the ability either to *identify* the chroma (pitch class) of any isolated tone, using labels such as C, 261 Hz, or *Do* (*passive* AP), or to *reproduce* a specified chroma, e.g. by singing, or adjusting the frequency of a tone generator (*active* AP), without reference to an external standard (Bachem, 1937; Baggaley, 1974; Ward, 1999). Here, we call both these skills *tone-AP*. AP may also involve recognizing whether a familiar piece is played in the correct key (passive), or singing a familiar song in the correct key (active); we call this *piece-AP*.

Cognitively, both tone- and piece-AP involve two separate subskills: long-term pitch memory, and an appropriate form of linguistic coding for attaching labels to stimuli (Levitin, 1994). "True" tone-AP requires individual internal pitch standards for all 12 chroma. This template can shift with age by as much as two semitones (Vernon, 1977; Wynn, 1992); shifts can also be induced neurochemically (Chaloupka, Mitchell, & Muirhead, 1994). A musician with only one absolute pitch reference (e.g. A-440) and good relative pitch has *pseudo-AP* (Bachem, 1937); so has an experimental participant who internalizes several, but not all, pitches of the chromatic scale (Cuddy, 1970). The labels used in tone-AP are musical note names; in piece-AP, names of pieces, and texts of songs.

The popular term "perfect pitch" is misleading. Musicians claiming tone-AP (hereafter: *APers*) are not necessarily better at discriminating tones of almost the same frequency, or at perceiving small deviations in intonation, than other musicians (Bachem, 1954; Burns & Campbell, 1994). APers can typically tune pitches to within 20-60 cents of target frequencies (Rakowski & Morawska-Büngeler, 1987). In passive tasks, they regularly make semitone errors (Lockhead & Byrd, 1981; Miyazaki, 1988), and are not necessarily better than other musicians at identifying octave register (Miyazaki, 1988; Rakowski & Morawska-Büngeler, 1987). Clearly, there is nothing "perfect" about AP.

Nor does AP appear to be correlated with other musical skills. Composers with tone-AP (e.g., Mozart, Berlioz, Scriabin, Messiaen, Boulez) did not necessarily write better or worse music than composers without it (e.g., Berlioz, Wagner, Tchaikovsky, Ravel, Stravinsky) (cf. Slonimsky, 1988). While tone-AP is sometimes an advantage (helping horn players to imagine tones before playing them, singers to perform atonal music, and theorists to follow large-scale tonal structures by ear), it can also be a hindrance (e.g., when playing or singing in a key other than written). Regarding *relative* pitch, APers can be *less* skilled than other musicians, calculating intervals and chords from note names rather than hearing them directly (Miyazaki, 1992, 1993). Their constant awareness of musical pitch labels can detract from their enjoyment of music. As more than one tone-APer has complained: "I don't hear melodies, I hear pitch names passing by."

Only about 1 in 10,000 people claim to have tone-AP (Profita & Bidder, 1988). The distinction between possessors and non-possessors is not clear-cut: APers can usually label 70-100% of randomly selected, middle-range piano tones (Miyazaki, 1988), while musicians not claiming AP identify tones above chance levels (1/12 = 8.3%) with rates up to 40% (Lockhead & Byrd, 1981; Miyazaki, 1988). This is not surprising given that neurological information on absolute pitch is available at all levels of the auditory system (Moore, 1997). Even songbirds (Hulse, Cynx, & Humpal, 1984), wolves (Tooze, Harington, & Fentress, 1990) and monkeys (D'Amato, 1988) demonstrate absolute pitch memory.

Clearly, tone-AP must be *learned* from exposure to music containing fixed pitches, coupled with knowledge of pitch labels (Levitin, 1999; Wedell, 1934). Thus, chroma identification rates are higher, and response times lower, for white piano keys than for black (Miyazaki, 1989; Takeuchi & Hulse, 1991), presumably because white keys occur more often in piano music and have simpler labels (cf. Rosch, 1975). Similarly, piece-AP relies on repeated exposure to pieces played in the same key. Tone-AP may also be *unlearned* during musical acculturation in which familiar music and pitch relationships are regularly transposed into different keys; this may explain its rarity (Abraham, 1901; Watt, 1917).

Like language, tone-AP usually develops during a critical period in early life (Ward, 1999). Musicians who start musical training early are more likely to acquire tone-AP than those who start late (Sergent, 1969; Welleck, 1938). Younger children acquire piece-AP more easily than older children (shown by singing a song in its regular key: Sergeant & Roche, 1973). Tone-AP can be acquired in later life, but only with considerable motivation, time, and effort (Brady, 1970; Cuddy, 1968, 1970; Meyer, 1899). Late tone-AP acquirers are generally less spontaneous and accurate in their identification of pitches; they tend not to develop a complete internal chroma template, filling the gaps by means of relative pitch.

Both infants (Clarkson & Clifton, 1985) and adults (Wedell, 1934) seem able to perceive pitch absolutely within a range of about three semitones. According to the *innateness hypothesis* (Bachem, 1937; Révész, 1913), newborns vary in their predisposition to acquire tone-AP, i.e. to reduce this range to one semitone and apply chromatic labels. This hypothesis has not been confirmed experimentally. Even if it were, it would not provide unequivocal support for innateness: newborns have at least four months of prenatal auditory experience (Lecanuet, 1996). The search for an AP gene (Profita & Bidder, 1988) or brain centre (Schlaug, Jäncke, Huang, & Steinmetz, 1995) may be in vain, given that, in a learned skill, "nature" and "nurture" cannot easily be separated (Jeffress, 1962), and that AP involves several neurally separate subprocesses (pitch perception, classification, labelling, storage in long-term memory, retrieval from memory) (Levitin, 1999).

AP can be enhanced by association or integration with other perceptual or cognitive parameters (Siegel, 1974; Zatorre & Beckett, 1989). For example, tone-AP is enhanced by linking pitches to colours (*chomasthesia*: Peacock, 1984; Rogers, 1987). APers tend to identify the tones of their main instrument more reliably than other timbres (Lockhead & Byrd, 1981), suggesting an intrinsic cognitive link between pitch and timbre. For similar reasons, piece-AP, involving complex, meaningful sound objects, is more widespread than tone-AP: musicians not claiming tone-AP can recognize whether a familiar piece is played in its correct key (Terhardt & Seewann, 1983), and non-musicians can sing well-known tunes (e.g., *Happy Birthday*) in the same key on different occasions (Halpern, 1987; Heaton, 1992), or in the key in which they learned them (e.g., pop records: Levitin, 1994), at levels considerably exceeding chance. Piece-AP is further facilitated by the use of everyday linguistic labels rather than abstract note names.

Experiments to test AP should be designed to prevent parameters other than absolute pitch from facilitating tone recognition. It is impossible to rule out the use of relative pitch (Ward, 1999; Costall, 1985), although

slow reactions can be reliable evidence of its use (Bachem, 1954). Use of timbre can be completely eliminated by randomly varying the spectral envelope of presented tones, or by having participants sing their responses. Because the pitch of a pure tone depends on its intensity (Stevens, 1935), results of AP experiments using pure tones should be interpreted with caution.

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