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Absolute pitch.

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The ability either to identify the chroma (pitch class) of any isolated tone, using labels such as C, 261 Hz or *do* (‘passive’ absolute pitch), or to reproduce a specified chroma – for example, by singing or adjusting the frequency of a tone generator – without reference to an external standard (‘active’ absolute pitch (AP): Bachem, 1937; Baggaley, 1974; Ward, 1982). Both skills may be called ‘tone-AP’. Absolute pitch 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); this skill is known as ‘piece-AP’.

Cognitively, both tone- and piece-AP involve two separate sub-skills: 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 and Muirhead, 1994). A musician with only one absolute pitch reference (e.g. *a*' = 440 Hz) 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 they are names of pieces and texts of songs.

The popular term ‘perfect pitch’ is misleading. Musicians claiming tone-AP 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 and Campbell, 1994). AP possessors can typically tune pitches to within 20–60 cents of target frequencies (Rakowski and Morawska-Büngeler, 1987). In passive tasks, they regularly make semitone errors (Lockhead and Byrd, 1981; Miyazaki, 1988), and are not necessarily better than other musicians at identifying octave registers (Rakowski and Morawska-Büngeler, 1987; Miyazaki, 1988). There is nothing ‘perfect’ about absolute pitch.

Nor does absolute pitch appear to correlate with other musical skills. Composers with tone-AP (e.g. Mozart, Skryabin, Messiaen, Boulez) have not written indisputably better or worse music than composers without it (e.g. Wagner, Tchaikovsky, Ravel, Stravinsky: see 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, musicians with tone-AP can be less skilled than other musicians, calculating intervals and chords from note names rather than hearing them directly (Miyazaki, 1991–2, 1993–4). Moreover, their constant awareness of musical pitch labels can detract from their enjoyment of music.

Only about one person in 10,000 claims to have tone-AP (Profita and Bidder, 1988). The distinction between possessors and non-possessors is not clearcut: the former can usually label 70–100% of randomly selected middle-range piano tones (Miyazaki, 1988), while the latter identify up to 40% of the tones – well above the chance level of 8· 3% (Lockhead and 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, 1977). Even songbirds (Hulse, Cynx and Humpal, 1984), wolves (Tooze, Harington and Fentress, 1990) and monkeys (D'Amato, 1987–8) demonstrate absolute pitch memory.

Clearly, tone-AP must be learnt from exposure to music containing fixed pitches, coupled with knowledge of pitch labels (Wedell, 1934; Levitin, 1999). Chroma identification rates are higher, and response times lower, for white piano keys than for black (Miyazaki, 1989–90; Takeuchi and Hulse, 1991), presumably because white keys occur more often in piano music and have simpler labels (see Rosch, 1975). Similarly, piece-AP relies on repeated exposure to pieces played in the same key. Tone-AP may also be ‘unlearnt’ during musical acculturation in which familiar music and pitch relationships are regularly transposed into different keys; this may explain its rarity (Abraham, 1901–2; Watt, 1917).

Like language, tone-AP usually develops during a critical period in early life (Ward, 1982). Musicians who start musical training early are more likely to acquire tone-AP than those who start late (Wellek, 1938; Sergent, 1969). Younger children acquire piece-AP more easily than older children (shown by singing a song in its regular key: Sergeant and Roche, 1973). Tone-AP can be acquired in later life, but only with considerable motivation, time and effort (Meyer, 1899; Cuddy, 1968; Brady, 1970). Late acquirers of tone-AP 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 and Clifton, 1985) and adults (Wedell, 1934) seem able to perceive pitch absolutely within a range of about three semitones. According to the ‘innateness hypothesis’ (Révész, 1913; Bachem, 1937) newborns vary in their predisposition to acquire tone-AP, that is, 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, 1995). The search for an absolute-pitch gene (Profita and Bidder, 1988) or brain centre (Schlaug and others, 1995) may be in vain, given that, in a learnt skill, ‘nature’ and ‘nurture’ cannot easily be separated (Jeffress, 1962) and that absolute pitch involves several neurally separate sub-processes (pitch perception, classification, labelling, storage in long-term memory, retrieval from memory: Levitin, 1999).

Absolute pitch can be enhanced by association or integration with other perceptual or cognitive parameters (Siegel, 1974; Zatorre and Beckett, 1989). For example, tone-AP is enhanced by linking pitches to colours (*chromaesthesia*: Peacock, 1984–5; Rogers, 1987). Musicians with tone-AP tend to identify the tones of their main instrument more reliably than other timbres (Lockhead and 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 and Seewann, 1983–4), and non-musicians can sing well-known tunes in the same key on different occasions (Halpern, 1989; Heaton, 1992), or in the keys in which they learnt them (Levitin, 1994), at levels considerably exceeding chance. Piece-AP is further facilitated by the use of everyday linguistic labels rather than abstract note names.

Tests for absolute pitch should be designed to prevent other parameters from facilitating tone recognition. It is impossible to rule out the use of relative pitch (Ward, 1982; 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 absolute pitch experiments using pure tones should be interpreted with caution.

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