

Pitch Discrimination Skill: A Cognitive Perspective

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Abstract

Pitch discrimination skills are important for general musicianship. The ability to name any musical note or produce orally any named note is called Absolute Pitch (AP) and is comparatively rare. AP has historically been regarded as being innately acquired. This paper will examine the notion that pitch discrimination skill is based on knowledge constructed through a suite of experiences. That is, it is learnt. In particular, it will be argued that early experiences promote the development of AP. Second it will argue that AP and RP represent different types of knowledge, and that this knowledge emerges from different experiences.

This paper will report a pilot study into the similarities and differences between the musical experiences of AP possessors and the manifestation of their AP skill. Interview and questionnaire data will be used for the development and proposal of a preliminary model for AP development.

The development of an effective model of the development of pitch discrimination skill is fundamental to the selection of appropriate curriculum design and pedagogy for aural training in school music programs. There are a variety of ad hoc approaches to aural training in schools which tend to be founded on popular opinion rather than research evidence. This paper should provide the foundation for a more effective approach to aural training in schools.

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Pitch Discrimination Skill: A Cognitive Perspective

Advanced musicianship is often characterised by a clear ability to pitch label. Such pitch labelling skill allows a musician to visualise melody and to transform the written score into music at sight. There are two fundamental approaches to pitch labelling. The first is direct naming without comparison, absolute or perfect pitch (AP), and the second is indirect naming by comparison to a known reference, relative pitch (RP) (Cohen & Baird, 1990). These definitions do not make clear the level of accuracy and latency required before an individual can be considered an AP possessor and varied standards have been set by different researchers.

Either the AP or RP approach can be used to extreme levels of accuracy, but musicians hold AP in much greater esteem (Ward & Burns, 1982). Generally, however, the AP skill is reputedly of no particular advantage over highly developed RP skill for general musicianship. It is the apparent rarity of AP and the mystique surrounding its acquisition that underpins the general esteem for AP skill rather than RP.

AP ability is considered rare at least amongst western musicians. Interestingly, this rarity is not mirrored in some Asian cultures (Myazaki, 1992). Bachem (1955), Profita and Bidder (1988) and Takeuchi and Hulse (1993) have each independently reported that less than one hundredth of 1% of the general western population demonstrate AP and that this has stimulated great interest for musicians and psychologists. Even if the incidence rate has been under-reported, the observation that AP is rare in western society occurs consistently in the literature (eg. Baggaley, 1974; Benguerel & Westdal, 1991; Cohen & Baird, 1990; Chaloupka, Mitchell & Muirhead, 1994; Zatorre & Beckett, 1989). Costall (1985) suggested that it is this considered rarity that has resulted in AP possession to be regarded almost mystically. Levitin (1994) describes the ability as "somewhat mysterious" (p. 414). Folkloric tales of genius and the extreme value of the lucky prize are largely due to the general lack of understanding that exists regarding its definition and nature. Corliss (1973) suggests that "there probably are a fairly large number of people with the tone recognition facility that we call AP" (p.1737), concluding that the ability may seem rarer than it is because there are fundamental misunderstandings regarding the nature of its expression.

Prominent and influential researchers into pitch labelling skill have assumed AP to be innately determined (eg. Bachem, 1937; Revesz, 1953). Combined with the notion that it exists as a dichotomous or, all or nothing skill, many researchers have drawn a sketch of AP that excludes a consideration of the role of knowledge in the expression of the skill. Supporting evidence for this view has been the apparent difficulty surrounding the deliberate training for AP, when the skill is usually simply "noticed" by possessors without any specific prior effort (Burns & Campbell, 1994; Costall, 1985; Hantz et al, 1992; Takeuchi & Hulse, 1993; Wynn, 1993).

The underlying assumption, however, that AP occurs dichotomously ignores the increasing evidence that the pitch labelling skill by AP possessors may be variably influenced by features of the sound such as timbre and range. Recent research suggests a familiarity role, but does not fully explore the impact of experience on demonstrated AP skill (Miyazaki, 1990). It is possible that early experience, prior to the age of 4 or 5 years, has a determining influence on the development of particular strategies for pitch labelling or particular frames for pitch knowledge (Cohen & Baird, 1990). This view has not, however, yet been researched comprehensively.

AP is a unique research phenomenon because it spans the fields of cognition and perception, in that it links verbal labels with physiological sensations, and because of its rarity. It may provide a vantage for investigating the nature/nurture of musicianship; expertise; knowledge structure development; and the role of knowledge in perception. The study of AP may inform educational practice and curriculum design both in music and cross-curricular. However, before its nature and genesis can be examined there must be agreement regarding its definition.

Toward a Definition for AP

The precise definition of the term AP has been the focus of controversy since the 1880's when Stumpf first noted its existence in his review of the "talents" of great composers, where he described Mozart's precocity as noticeable from the early childhood emergence of an AP "gift" (in Ward & Burns, 1982). Broadly, researchers agree that the term AP refers to an ability to name heard tones or to sing or whistle a named tone without comparison to a reference (Cohen & Baird, 1990; Neu, 1947; Petran, 1932; Revesz, 1953; Sergeant, 1969; Vernon, 1977). The degree of accuracy, consistency, immediacy and extent of the demonstrated labelling ability required before an individual should be considered as an "AP possessor" are, however, points of contention.

Pitch labelling skill conforming to the broad definition of AP appears to be quite variable at a finer level as evidenced by the wide range of skill accepted as AP by different researchers (refer Table 1). Some people can identify only one tone, some can identify notes within a limited range or of only a specified timbre, and some can seemingly identify anything with minimal error. When deciding if actual AP is in evidence, acceptable error levels, type of error, the presence or absence of an internal referral standard, and the acceptable speed of responses varies from study to study (eg., Bachem, 1937, 1954, 1955; Balzano, 1984; Brady, 1970; Cuddy, 1970; Miyazaki, 1990). At a fine grained level then, a clear definition for AP is distinctly absent as a foundation to the field of research.

For many researchers, the ability of an individual to name only one note or a limited group of notes in isolation may not be sufficient to consider them as an "AP possessor" (Bachem, 1940; Petran, 1932; Revesz, 1953). In essence they claim that such limited skill is not worthy of the prized label "AP". However, they do not attempt to restate the broad definition of AP to account for such "quality control". Such researchers demand minimum performance standards with respect to a range of accuracy and latency measures. They may accept lesser than those set performance standards as demonstrating advanced pitch labelling skill but not necessarily AP (Costall, 1985) even though such performance ability may fit the broad definition for AP. Bachem in particular has gone to great lengths to qualify "lesser" supposed pitch labelling performance skill with labels such as "quasi" or "pseudo" AP (Bachem, 1937).

If researchers could agree on a lower limit for performance standard for the allowable attribution of the label "AP possession", then it would be a fairly simple task to amend the broad definition to reflect these agreed standards. However, researchers do not agree on these "quality" guidelines (Takeuchi & Hulse, 1993) (refer Table 1). As shown in Table 1, the

preferred minimum performance standard for clear attribution of the AP label to an individual's skill varies for different researchers (Takeuchi & Hulse, 1993). This is especially noticeable in the early research and this may have prompted Bachem's treatise on AP skill categorisation the late 1930's (Bachem, 1937).

Recent researchers appear to accept more liberal parameters for AP skill. Takeuchi and Hulse (1993) suggest that "we cannot determine the lower limit of AP because this limit is confounded with the question of what defines an AP possessor, (but) we can study the upper limit of AP " (p. 346). This is to some extent an avoidance of the issue, perhaps the inference is, then, that AP definition is not an important foundation for research into a phenomenon. This betrays logic. It is not possible to effectively research any phenomenon that is ill-defined.

Table 1: Comparison of performance standards required by various researchers for the attribution of AP (adapted from Takeuchi & Hulse, 1993, p. 347)

Study	No. AP possessors tested	% correct		Timbre	Pitch Register & Range ^a	No. tones tested
		Range	M			
• Balzano (1984)	3	84.3-91.2	87.7	Sine	A2-G#5	36
• Benguerel & Westdal (1991)	10	62-100	88	Sine	C3-C5	25
• Carroll (1975)	5	79.7-95.3	86.6	Piano	A3-C5	16
		48.0-92.8	71.0	Piano	A1-C7	64
• Crummer, et al (1994)	10		89.5	Piano	C1-C7	73
• Eaton & Siegel (1976)	4	100	100	Sine	F4-F5	20

• Hantz et al (1992)	12		89.5	Piano	C1-C7	73
• Lockhead & Byrd (1981)	4		99.0	Piano	C1-A7	82
			58.0	Sine	C2-A8	82
• Miller & Clausen (1997)	20	29.2-85		Synthesised Piano/ Sine	C3-B4	24
• Miyazaki (1988)	7	90.2-99.4	94.1	Sawtooth	C3-C6	60
	22	45.0-99.7	82.7	Synthesised piano	C3-C6	180
• Miyazaki (1989)	7	64.8-97.9	91.6	Piano	C1-B7	84
			74.4	Sine	C2-B7	72
			80.4	Synthesised piano	C1-B7	84
• Miyazaki (1990)	10	53.3-99.6		Synthesised piano	C2-B6	60
• Takeuchi & Hulse (1991)	19	58.4-100	83.1	Synthesised piano	E3-D#5	24
• Zatorre & Beckett (1989)	21	27.1-100	74.8	Piano	C2-G6	12
		37.3-100	89.5	Piano	C4-C5	13

a C4 is middle C (261.6 Hz). The range of the piano is A0-C8

Some authors purport to make important contributions to our understanding of AP without ever attempting to define their use of the term (eg., Balzano, 1984; Hartman, 1954) implying, by omission, that AP possession is a consistently understood and defined phenomenon that has been adequately outlined in terms of measurement parameters by other research. Revesz (1953) actually claimed "we have covered everything worth knowing about the musical ear" (p. 111). Revesz apparently believed that the issue of AP was closed in the 1950's. This was far from the truth, and the issue continues to be debated in recent literature. For instance, Houtsma observes recently (1995) that our understanding of the AP phenomenon is still rather poor, and Ward and Burns (1982) write that "the issue can hardly be regarded as closed" (p. 447).

Jeffress (1962) identified the definition of AP as suffering from a kind of "sliding scale". Definitions range from those that attempt to set criteria for accuracy in measurement of the skill (Baggaley, 1974; Brady, 1970b; Petran, 1932), to those that describe AP as a special type of pitch identification strategy or strategies that may not be open to direct and objective study (Costall, 1985). The "sliding scale", as described by Jeffress affects the defining point between what can be accepted as AP skill, and what should be considered non-AP (op cit).

Fine-grained definition of AP in the present paper does not rely on the specification of limiting speed or accuracy benchmarks, nor does it advocate a sliding scale view. That is, neither an uni-dimensional type of continuum or a dichotomous conception of AP seems to adequately describe the presentation of any skill. By comparison, it would be difficult and illogical to define walking in terms of speed or accuracy benchmarks, and if AP is to be regarded as a skill, then such an approach seems equally limiting. This paper supports a multi-dimensional conception of AP as first proposed by Takeuchi and Hulse (1993).

Multi-dimensional Model for AP

Takeuchi and Hulse (1993) suggest that a continuous and multidimensional measure of AP should be constructed. They suggest that performance should be measured on a continuum from a fixed zero point along several dimensions (such as timbre and range) and may vary in accuracy and/or latent speed of response along these dimensions. In this way individual performance may be represented as a profile of AP skill. This approach may better inform understanding and research into the genesis and aetiology of AP. The task then is to select the dimensions that best describe the profile of AP skill. That is, the dimensions along which AP performance may vary. This would also restrict the confusion caused by defining a skill by its measurement.

In summary then, for this paper AP will be defined as a note labelling skill whereby individuals are able to name a tone without comparing it to a reference. This skill may be multidimensional, with performance varying in an individual way along several dimensions such that an individual profile of AP skill can be described. These dimensions may include, but not be limited to, such attributes as: aural acuity; timbre; pitch range and temperament; latency of response; and accuracy.

Such a new perspective on AP provides a range of opportunities for future research in a number of fields. This paper will explore evidence for the learnedness, or knowledge base for AP as a multi-dimensional skill. The heredity debate, has framed much of the early research into AP, and exists as a counterpoint to the knowledge position proposed here.

The Heredity Debate

AP is regarded by some as an innate skill. These few writers despite their lack of number have been particularly influential on research into AP. Their assertion is that those who demonstrate the AP skill are born with the ability, and that such ability can be traced back through their family. Genealogical research has aimed at establishing the type of genetic relationship that might be involved (eg., Revesz, 1953). Much of the evidence used to support the innateness argument has been anecdotal (eg., Pruett, 1987; Vernon, 1977). This type of research has relied heavily on autobiographical recollections or the retelling of family "legend" (eg., Vernon, op cit), but has not closely examined the contextual elements that may have supported the development of AP. That is, the assumption that AP was innate has resulted in a rather blinkered approach to data collection and analysis.

There are 4 main claims used in the argument to support heritability of AP, these are:

1. AP presents very early in life (before the age of 5) (e.g., Grebelnik, 1984),
2. AP is acquired very quickly (e.g., Burns & Campbell, 1994),
3. AP is acquired without effort (e.g., Takeuchi & Hulse, 1993), and
4. AP runs in families (e.g., Revesz, 1953).

Those who believe AP to be inherited generally claim that it is a skill a person is born either "with" or "without". That is, they view the entire population as being divided into two neat groups, those who are innately blest and those without AP skill (Brady, 1970). You either have it all, or you don't have any (Brady, 1970; Profita & Bidder, 1988; Stark, 1985; Terhardt & Seewann, 1983), a position that was difficult to support in a climate of speed and accuracy bench marking.

Yet another basis for criticism of research into AP is its confusion with Relative Pitch (RP). RP skill is quite distinct from AP. RP is defined as the ability to correctly name a tone having compared it directly to a reference tone (Costall, 1985; Houtsma, 1995; Revesz, 1953; Ward & Burns, 1982), and is a skill claimed by most musicians to some degree (Takeuchi & Hulse, 1993). RP skill responds to training, and can be confused with AP skill especially when RP pitch labelling skill has developed to a high level of accuracy with a short latency for response. That is, RP can result in the same observable naming skill as those who claim AP (Lockhead & Byrd, 1981; Takeuchi & Hulse, 1993). The distinction is, however, in the strategy used to choose a label for any particular tone. Those with RP, work within the tonal

system to explore or recall the relationships between tones, and thereby arrive at a name, or they label the tonal relationships directly (Costall, 1985; Houtsma, 1995; Revesz, 1953; Ward & Burns, 1982). By contrast, those with AP, identify individual tones directly without any reference to their relation to other tones in the tonal system.

It is most frequently assumed that most musicians have either RP or AP, and that they are mutually exclusive skills. This has been exemplified in studies that report AP possessors to have difficulty identifying the relations between notes without first going through a complicated process of individual tone labelling and then deducing the relation (Corliss, 1973; Costall, 1985). Recent research by Benguerel and Westdal (1991) however, has found that AP possessors can identify intervals directly and as such demonstrate some RP skill in addition to their AP skill, but this finding has not been replicated to date. RP possessors however, are generally unable to name notes in isolation. Both RP and AP possessors can label tones, but their strategies may differ. In this lies the confusion that often occurs.

It is very difficult to objectively discern a pitch naming strategy (Costall, 1985; Takeuchi & Hulse, 1993). AP definitions that rely solely on setting an accuracy level for the note labelling skill do not always clearly discriminate between RP and AP. RP can use very accurate strategies to arrive at a label for a tone, and performance can compare readily to those who claim AP. Definitions that set only a required minimum speed of response to discriminate between RP and AP can also fail to separate the skill types. RP, with extensive practice, can be extremely efficient comparing readily to the speed of response possible using AP.

Therefore, research advocating the innateness position with regard to the acquisition of AP, in relying heavily on speed and accuracy measures to discriminate between the "haves" and the "have nots", have often discarded participants from the AP set that would otherwise fit the AP broad definition. They then have confounded their results, by including these participants as RP controls. There can therefore be limited confidence in the general applicability of research findings from the innateness perspective, and this paper asserts the alternate view, that AP is primarily based on knowledge.

How could knowledge be involved in AP development?

AP, by definition then, requires the knowledge of stimuli labels, so named because of their position within a set or series of stimuli. These series are cultural conventions rather than artefacts of "nature", and the labels are arbitrary. Further, the common timbres themselves arise from human inventiveness over many centuries. It seems improbable that such accidents of creativity in the development of music and music systems over history would reflect a natural order that would be genetically inscribed in any way. Clearly these arbitrary names and systems must be learnt at some stage, as only familiarity would allow facility in the application of labels.

Research has demonstrated that:

- AP possessors have no "super hearing discrimination" ability (e.g., Baggaley, 1974; Serafine, 1988; Sergeant, 1969; Siegel, 1972),
- AP possessors have no "super memory" ability with respect to tonal recall (Rakowsky, 1990; Siegel, 1974; Takeuchi & Hulse, 1993).

In fact it appears that the sensory and encoding equipment of AP possessors are largely indistinguishable from those with RP (Takeuchi & Hulse, 1993). That AP possessors actually demonstrate any labelling skill that differs from that possessed by other people, would suggest that experience and knowledge must play some potent role.

The difference between AP and RP is primarily one of strategy. RP and AP strategies are mutually exclusive. That is, if you choose to attend to the relationships between tones, then you are also choosing to ignore the absoluteness of them and vice versa. Schema theory would propose that extended experience with a set of stimuli prompts an individual to begin a knowledge construction framework for those stimuli, such that future encounters with similar events would be perceived in the light of those knowledge constructions (e.g., Lamont & Cross, 1993; Marshall, 1995). If a knowledge structure for musical tones is formed on relational information rather than the absoluteness of each tone, then it would seem that the perceptual choice will be predetermined, and therefore will be relational. That is, RP begets RP. Alternatively, if the knowledge frame or schema is founded on absolute tonal representation, then future encounters would be perceived absolutely as dictated by the existent knowledge construction. That is AP begets AP. This may explain why AP possessors reputedly have little success developing RP, and of course, why RP possessors have little success in the deliberate acquisition of AP.

An individual's pitch perception skill development may therefore be coloured and sometimes blocked by prior experience. This is not a new concept (e.g. Anderson, 1975; Derry, 1996), however, it is usually reported that deliberate and motivated practice over extended periods of time can facilitate knowledge restructure in most fields of endeavour (Lamont & Cross, 1994). That AP appears to have a "critical age" for onset would support this idea that the nature of first, and not just the frequency of experience may have a salient effect on the subsequent development of perceptual knowledge. This paper will explore the nature of the earliest musical experiences for AP and RP possessors with a view to demonstrating any consistent differences that may exist to determine the direction of their pitch perception knowledge construction.

Music is a cultural pastime, and musicality represents a form of acculturation. The perception of musical tones occurs within this rich cultural context. Current cognitive research supports the notion that an individual's knowledge construction is dependent on social and environmental contexts and cues (e.g., Davydov, 1995). Semiotic facility and the acquisition of cultural tools such as language are enabling elements for the acquisition of skills and knowledge (Vygotsky [1960] 1981). It may be possible therefore by examination of social and cultural contexts in a musician's early life to establish the nature of the cultural tools, support, and social influences that may have predicated the development of specific pitch labelling skill.

Social learning theory and Vygotskian social cognition theory describe potent roles for the social context and modelling in the development of knowledge and skill. The presence of a strong role model reputedly promotes the development of knowledge. These characteristics include:

- Attractiveness, (physical and social) in that they appear attractive to the learner,

- Social power, (over reward and punishment) in that they have some perceived power with respect to the activities of the learner,
- Status, at least by comparison to the learner in the field of interest or generally,
- Competence, that they appear capable in the field of interest,
- Nurturance, that they have a nurturing type relationship with the learner,
- Interaction level, degree and energy level of contact,
- Similarity, perceived or expected by the learner (McInerny & McInerny, 1998).

This paper will attempt to elucidate the salience of a model for the development of particular pitch labelling skill with a view to demonstrating that the existence of quite specific social contexts and relationships impact on the potency of the first experiences with musical learning. Specifically, how the attention to absolute or relational tonal features may be effectively guided or scaffolded by a suitable model.

The aim of this current research has been the investigation of the role and influences of knowledge in the development of pitch labelling skill and perception. Particular attention has been given to the exploration of evidence to support the notion of a potent role of first encounters with music in the subsequent development of skill. Consideration has been given to the nature and influence of these experiences with regard to the scaffolding provided by a suitable model in cultural context.

Method

Participants

The participants for this study were AP and RP possessors recruited from amongst music teachers, local professional and semi-professional musicians, university/conservatorium students specialising in music, secondary and primary school music students. 10 AP participants and the same number of RP participants were used for the study.

Where possible, supporting persons for each of the participants included in the study were included in the study. These supporting persons were siblings, parents or teachers of the target participants.

Materials

Personal History Questionnaire.

Participants were asked to give a personal history of their musicianship and deliberate practice schedules in response to questionnaire. Where possible, early teachers, parents and siblings were also surveyed to allow the construction of converging evidence to validate

the autobiographical accounts. These supporting persons completed the questionnaire using recollections of their respective AP possessor's musical history.

The questionnaire of 16 items was given to participants and their convergent sources who were asked to respond on items relating to their performance history on the various instruments that they claim proficiency. The principal factors being examined in this questionnaire were:

- level of proficiency (as indicated by their rating, success at competitions).
- age of onset (as indicated by their age of starting on an instrument)
- effort (years, number of teachers, number of ensembles, hours spent practising)

Semi-structured Interview.

Target participants and their supporters were also asked to respond in a structured interview designed to elaborate on their specific musicianship histories and to elucidate any links to their skill development. Each was interviewed separately and was asked to consider questions such as (paraphrased):

- What can you remember about your family musical life as a little child, even before you attended school? How did you feel about music then?
- When and what were the important decisions made about your first exposure to formal musical training? Who made these decisions?
- What was your early musical training like? How did you feel about it?
- What are the clearest early memories you have about music? Which do you think were the most important for your musical development?
- What have been the greatest influences on your musical development? How were you encouraged?
- How did you feel about practicing? What did you do? What motivated you to practice?

- How would you describe your pitch labelling skill? What can you do?
- When did you find out that you had AP/RP? What happened?

These were supported by further prompting questions, as required, to explore the detail of the participant's experiences, or to encourage a more detailed response from them.

Design and Procedure

Participants completed the questionnaire in their own time prior to their participation in the interview. Supporting participants were also required to complete the questionnaire during this time, and were requested to complete the items without conference or referral to another person. The interviews lasted for an average of an hour per participant, were audiotaped and transcribed. The transcriptions were given to them as soon as possible following the interview, and they were encouraged to review the script to ensure their intentions were recorded correctly and to add detail where they were able.

Results and Discussion

Both the questionnaire data and the interview data indicate consistent difference between the early musical experiences of AP and RP possessors. Regarding the likely learnedness of AP, the following consistent points were evident:

1. In the early childhood homes there was a presence and access to fixed pitch instruments for AP possessors that wasn't matched in RP homes. The following example comments from AP possessors illustrated this point;
 - "we had a theatre organ at home, big three manual thing that looked like an aeroplane console" (#32101)
 - "we had two pianos, we had a double story house, one upstairs and one downstairs" (#24106)

Whereas RP possessors consistently stated that there were no fixed pitch instruments in their home, or that they were not allowed to play them;

- "we had a piano at home... no I wasn't encouraged to muck around on the piano, it was very serious, you play properly" (#351101)
- "we never had a piano at home...we never had any musical instruments at home" (#330131)

This would suggest that for the AP possessors it was possible for them to conceive of tones as having absolute qualities. RP possessors however, if they did hear music would have been unaware that any heard tone had an absolute fixed quality (i.e. a defined location and activity on a fixed pitch instrument). They therefore would necessarily have relied upon the tonal relations between notes in their conception and knowledge construction of melody.

2. In AP homes, parents or older siblings demonstrated musical literacy. This was not the case for RP homes. Some AP comments on this point were:

- "my father sings and he used to play trumpet"
- "my mother is a pianist and teaches music at home" (#32101)
- "I come from a musical family. My mother is a music teacher" (#24106)

Comparison AP comments were:

- "neither of my parents are musically literate or play an instrument" (#351101)
- "my mum was a church organist, although she hadn't, she wasn't playing music when I was around" (#330131)

It would appear likely that musically literate parents in the presence of fixed pitch instruments would use the appropriate labels for the tones forming any performed music. This would provide the tools for the construction of pitch knowledge in an absolute manner. The RP possessors however did not have the opportunity to acquire these tools when they were first engaging with music as a very young child. It would seem likely then that conception of the music for these RP possessors would necessarily be on a relational base.

3. The parents or older siblings of AP possessors were musically able and active, but not the parents or older siblings of RP possessors.

AP possessors demonstrated this point in comments such as:

- "mum taught most afternoons"
- "mum has organ lessons as well and her organ teacher came to the house" (#32101)
- "people would come to the house to hear mum play"
- "my mother, at one stage had about 45 students that she taught theory and accordion" (#24106)

For RP possessors this was not the case:

- "no-one played" (#351101)
- "she wasn't playing music..." (#330131)

It would seem that not only were the parents of AP possessors capable of providing tone labels for the music their child may have heard, they had a heightened involvement with music performance. They were regularly modeling concern for the theoretical basis for music and would have strengthened the notion that the application of absolute labels for heard tones was valuable and important. That is, that the acquisition of labels as a cultural tool for the conception of music was appropriate and valued in these homes. Parents of RP possessors were not providing a similar model. Their involvement with music did not provide a model of the value of specific labels as a cultural tool for the understanding of music. Therefore RP possessors were obliged to consider the music they heard by relational features in the absence of absolute labels.

4. In AP homes there was evidence that the parents actually taught notation to their children.
 - "mum taught me, when I was nearly four, Twinkle Twinkle Little Star with two hands"
 - " well mum had taught me, you know, she taught me to read music and things like that" (#32101)
 - "mum would sit down at the piano with me" (#24106)

This wasn't the case for RP homes:

- "no-one played" (#351101)
- "(at 9 1/2) I had no idea how to read music" (330131)

It would appear then, that not only was there opportunity and an environment conducive to the valuing of labels for tones in AP homes, these labels were explicitly taught by role models. Again, the absence of these factors in RP homes would have predicated the development of relational rather than absolute frames or schema for tones.

5. AP possessors were consistently encouraged to play by ear from a very early age. RP possessors were actively discouraged from doing so. AP comments were:
- "I have always played by ear" (#24106)

Whereas RP possessors said:

- "the musical training I had as a really young child said that it was bad to play things by ear, because you weren't reading the notes....and there wasn't much relationship between the notation and the sound. ' (#351101)
- "but it was one of things that you know, the piano shouldn't be touched. You know, you don't play with the piano. If you play the piano that's OK but you don't play with the piano, you know, play around on the piano." (#330131)

This suggests that AP possessors had a heightened level of experience with fixed pitch instruments in their very first exposure to music. They didn't have to wait until they had some formal understanding of the theoretical complexities of notation before being allowed to actively engage in the musical culture present in their homes. They learnt to play music in a way that would reinforce the incorporation of specific correct notes for which names were available.

By contrast, RP possessors had a low exposure to fixed pitch instruments, and it is reasonable to expect that their first engagement with music would have encouraged a relative notion of tonal understanding. That is, they would have sung Happy Birthday and Twinkle Twinkle Little Star, but they would not necessarily have sung them in exactly the same key each time. The important thing for their attempts to form a recognised tune would have been that the intervals sung were correct. The absoluteness of the notes, nor that they had names at all in any other context, would have had no bearing on the development of their tonal understanding. Hence RP would have been predicated.

The comments reported here are representative and consistent between all of the participants interviewed. It appears that the circumstances may exist for AP and RP to be learnt skills, and that this learning may be founded on a complex network of environmental and cultural contexts surrounding the early experiences of music. These first experiences may provide the defined start point for pitch perception development. Further these start points may obstruct the development of alternative knowledge structures. Comments by AP possessors demonstrate the adherence to AP strategy even in circumstance where RP strategies would be more effective, that is, in the identification of intervals:

Researcher OK, So when you hear um a couple of notes played at the same time, simultaneously, do you hear the interval or do you listen for both, like the individual notes

JC I'd tell you the notes. (#32101)

JR I'd hear the individual notes, name the notes and say the interval from that. (#24106)

AP participants consistently reported that they would identify intervals by first naming the component notes and then deriving the interval through their knowledge of music theory. This strategy actively avoids the development of RP knowledge structures, and is adhered to simply because it works. In such a way AP may be antagonistic to the development of RP. This too appears to be a learnt approach.

Comments by RP possessors also support the notion that the skills may be antagonistic to each other's development:

- "I was practicing a lot... just having it on my face (trombone) probably 8 or 12 hours a day playing." (#330131)
- "I decided to do something with music. Um So then I, yes, so really methodically I would spend an hour on technical work, and then an hour on this piece and an hour on that piece and that kind of thing, yep." (#351101)

There are a number of pertinent issues evident here. Extended time in deliberate engagement with musical performance did not promote AP for these people. Nor did constant attention to the quality and nature of the specific tones comprising the music did not promote AP, even though this deliberate practice occurred at a stage in their musicianship where tonal labels have been well learnt. However, it seems similar experience for AP possessors appears to contribute to AP development if these experiences formed their earliest engagement with music. Perhaps then, this is further evidence of the antagonistic nature of incompatible schemata or strategy.

Further support for the assertion of learnedness and for the multi-dimensional nature of AP is the role tonal and timbral familiarity has appeared to play in the development of both AP and RP according to the interview data. There was not a homogenous description of AP skill. For example, two of the AP participants reported that:

- "um pitch recognition is instantaneous" (#24106)
- "I could tell you the note according to the timbre of the instrument. So if you played me a C on a piano or on a flute I could tell you it was a C. If you played me a concert B flat on a clarinet I would tell you it's a C." (#32101)

For these participants there was no question about their certainty of response. These people were confident of their AP status, and were able to independently define the term AP as it is broadly considered in the literature, although the fine-grained detail of speed and accuracy benchmarks were not described by them. However, their AP skill as described by them, reflected musical familiarity. It would appear then that environment plays some determining role in the development of tonal knowledge along the dimensions that comprise the sounds. Thus AP would appear to be both learned and multidimensional, and perhaps antagonistic to the development of other pitch labeling skill types.

The questionnaire data supports the notion of a potent early learning role in the development of AP or RP. The average age of onset of formal training on an instrument for AP possessors was 3.9 years, and for RP possessors was 6.25. AP possessors therefore experienced formal lessons in music before they experienced any type of formal schooling. They most likely learned the letter name of notes concurrent with their learning to read and write. This is very early in life, and the fact that most AP possessors do not recall actively learning components of their AP skill and assert that they have always had the ability would perhaps reflect this rather than any innate assertion.

In conclusion, pitch labeling skill appears to be learnt and reliant on a suite of experiences at a very early age. These suite of experiences include the cultural context of the early musical environment, particularly the modeling characteristics of an individual's parents or older siblings. AP appears to be a multi-dimensional skill that differs between individuals as a function of their tonal familiarity. Further, the development of either RP or AP may impede the subsequent acquisition of the alternate skill. This has very important implications for music education.

Aural training in schools is a fundamental component of musicianship training in music classes. In some cases it forms up to 25% of the assessable profile of a student in that subject. AP skill is a distinct advantage in the successful completion of aural dictation tasks, the common and traditional way to assess aural musicianship. From an equity perspective and logically it seems inappropriate to reward students in assessment for something that they haven't learnt in class, and for a skill that cannot be acquired by their classmates. Each of the musicians in the study regardless of their RP or AP ability have achieved high levels of musical expertise and acclaim, with some of them representing the pinnacle of achievement in performance their instruments (National Championships or competitive professional orchestra positions). Therefore, it would seem that high level musicianship doesn't require AP. However, if AP is useful to the developing musician, maybe aural learning needs a stronger and different focus in early childhood settings.

This is the first of a series of studies into AP and RP skill development. Future investigations will profile the speed and accuracy of AP skill to give a clearer picture of its proposed multi-dimensionality, and the manifestation of skill as a result of familiarity.

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