Commentary on Gruhn et al.'s "How Stable is Pitch Labeling Accuracy in Absolute Pitch Possessors?"

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ABSTRACT: In this commentary, I discuss the results and implications of "How stable is pitch labeling accuracy in absolute pitch possessors?" by Gruhn, Ristmägi, Schneider, D'Souza, and Kiilu (2018). Their work provides some new insights on the accuracy of single tone labeling by absolute pitch (AP) possessors as a function of the spectral content of the presented tones. Previous findings on the effects of the familiarity of timbre and pitch chroma and early training in music are replicated and confirmed, indicating a role of learning and exposure in AP development. Prospects for future research are discussed, including the necessity of a validated psychometric instrument for measuring AP ability, and the need for longitudinal developmental research to more precisely isolate the factors that contribute to AP acquisition.

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IN their article "How stable is pitch labeling accuracy in absolute pitch possessors?" Gruhn, Ristmägi, Schneider, D'Souza, and Kiilu (2018) assess the ability of absolute pitch (AP) possessors to label different types of single tones. Their results show a decrease in pitch labeling accuracy as the amount of spectral information decreases, from complex instrumental tones, to slightly out-of-tune pitches, to tones with missing fundamentals, and finally to sine (pure) tones. This result corroborates and extends previous evidence that AP possessors are more accurate in labeling complex tones compared to pure tones (e.g., Athos et al., 2007), thus indicating that pitch chroma identification in AP is influenced by the spectral composition of a sound. This finding is also conceptually related to previous evidence that AP possessors perform more accurately at labeling timbres they are more familiar with (Sergeant, 1969). Gruhn et al. provide further evidence for a role of familiarity by reporting that notes corresponding to white keys on the piano are identified more accurately than black key notes (white key notes are typically taught from an earlier stage in music lessons, and may appear more frequently in music than black keys), which replicates results from other previous research such as Bermudez and Zatorre (2009), Marvin and Brinkman (2000), and Miyazaki (1988). Taken together, these results support the idea that AP is not just a genetically predetermined ability, but that at least part of this capacity is learned through training of the associations between sounded pitches and verbal labels (although such training is usually not deliberate, i.e. most AP possessors report having developed AP without making a concerted effort to do so).

Another interesting, and perhaps more unique, aspect of the work by Gruhn et al. is the effort to investigate differences in AP labeling ability in relation to an individual's pitch perception tendencies; they use the Pitch Perception Preference Test (Schneider & Bleeck, 2005; Schneider et al., 2005) to classify participants as predominantly holistic listeners (those who tend to perceive a missing fundamental pitch) or predominantly spectral listeners (those who tend to perceive the harmonics that are physically present but not the missing fundamental). Unfortunately, the overrepresentation of holistic listeners in their sample precluded the authors from drawing any strong conclusions, and it appears difficult to disentangle pitch perception tendency from instrument played (e.g., most pianists were holistic listeners). Thus, more work is needed in which AP possessors are recruited specifically based on their pitch perception tendencies, to gain a more thorough understanding of how holistic versus spectral pitch perception might affect the ability to label different types of tones (particularly tones such as those used in the work of Gruhn et al. where spectral content has been explicitly manipulated). In addition, Gruhn et al. provide some exploratory observations on the extent to which AP labeling is accompanied by visual, motor, or other sensations. This idea merits further exploration, for instance in terms of whether such multimodal cues can aid or hinder the

speed and accuracy of AP labeling, and whether attempts by non-AP possessors to develop AP could be aided by training these multimodal associations (e.g., learning to associate not just a tone with a label, but a tone *plus* its corresponding fingering/notation with a label).

To measure AP ability, Gruhn et al. made use of the Tallinn Test of Absolute Pitch (TTAP), which is a previously unpublished tool for testing AP using 150 tones across a range of octaves and three instrumental timbres (violin, clarinet, and trumpet). Their test also comprised a mixture of complex tones, out-of-tune tones, tones with missing fundamentals, and sine tones, as mentioned above. Performance on the TTAP was highly correlated with performance on another AP test developed for research a few years before (Wengenroth et al., 2014). Although this correlation is highlighted by the authors to demonstrate the validity of the TTAP, this also raises a wider issue in the AP literature, which is that there is currently no agreed precedent in terms of an existing, validated instrument for measuring AP. It has become common practice for researchers to instead create their own AP tests, which often highly resemble previous tools but may differs slightly in terms of the number of trials, range of timbres and frequencies, duration and presentation of stimuli, etc. Although many of these previous ad hoc solutions for testing AP are likely highly correlated, as seen for the two AP tests used in the work of Gruhn et al., it would be of great benefit to this field for researchers to reach some consensus in terms of the development of a standard tool that has been properly validated and documented in terms of its psychometric properties. Such a tool could combine the efforts that have been made in previous research to include pitches across a variety of timbres and frequencies, and could also make use of different response methods (e.g., labeling and producing pitches) to differentiate passive from active AP abilities.

Studies of AP almost invariably make claims or theoretical propositions about the nature-nurture debate, typically citing AP as a very good example of an ability that is a product of both genes and environment (though one could argue that most human abilities might fit this bill). Gruhn et al. make an interesting proposition as well, that "One can assume that the portion of AP that is acquired and memorized is more error-prone than the genetically determined ability" (p. 118). This is an interesting empirical question, particularly considering that several previous studies, including the work of Gruhn et al., have identified a sub-group of 'partial AP' or 'quasi-AP' possessors (e.g. Bermudez & Zatorre, 2009), which contradicts the traditional view of AP as an all-or-none, bimodal ability. This question deserves further attention, for instance by comparing the AP abilities of AP possessors with and without a genetic predisposition to AP. Evidence in favor of this proposition could indicate that even rigorous, focused training from a young age may be ineffectual for the development of the most accurate level of AP if there is no genetic predisposition, which is interesting to wider discussions about whether there exist 'limits' on musical ability that are predetermined from birth.

A final area in which further research is needed concerns the development of AP during childhood musical training. Gruhn et al. corroborate the findings of several previous studies (e.g., Deutsch, Henthorn, Marvin, & Xu, 2006; Gregersen, Kowalsky, Kohn, & Marvin, 2001; Miyazaki, 1988) that an earlier start age of musical training is related to more accurate AP labeling. However, it is also clear from these studies that early musical training alone does not explain the presence of AP, as many or most people who start music lessons at an early age *do not* develop AP. A more thorough understanding of both environmental and participant-level factors is needed to explain why some children develop AP and others do not, beyond early training in music. Intuitively, this would be most effective to test during the critical period for AP development, since trying to investigate such factors retrospectively in adults comes with a host of limitations (e.g., changes in cognitive style of the individual between childhood and adulthood (Schlemmer, 2009), forgetting details of the methods used by early instrumental teachers, such as emphasis on certain modes of listening and learning, etc.). Although such research poses many practical challenges (e.g., amount of time and resources required for longitudinal developmental research, large sample sizes needed to combat the fact that many children do not develop AP), I believe that we have reached a point in this domain where quality is more essential than quantity; a large amount of psychological research on AP has been conducted for more than a century (e.g. Abraham, 1901; von Kries, 1892), yet we know little more about the preconditions for its development than we did 20 or more years ago. Thus, I would advocate that to develop a more comprehensive understanding of AP acquisition, researchers in this area should combine their efforts toward producing longer-term and larger-scale (e.g., multi-center and collaborative) research studies, rather than continuing to explore correlational relationships in adults who have already had AP for many years in single experiments.

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