INFLUENCE OF ALCOHOL AND NONMEDICAL DRUG USE ON ABSOLUTE PITCH PERCEPTION

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Abstract

Absolute pitch (AP), the ability to identify musical notes without an external reference, is often regarded as a stable perceptual trait. However, recent work has raised questions about the extent to which short-term neurochemical or environmental factors may influence AP perception. The present study examined whether nonmedical drug and alcohol use are associated with self-reported changes in pitch perception among individuals with demonstrated AP ability. Participants (n = 120) completed an online AP assessment alongside a self-report survey measuring substance use history, musical background, and perceived perceptual shifts of AP as a function of substance use. Results from binomial logistic regressions revealed that alcohol consumption quantity significantly predicted self-reported pitch distortions, with individuals who consumed two or more drinks per session being more likely to report changes in their perception of pitch. In contrast, no significant predictors emerged for pitch changes following nonmedical drug use, although qualitative responses indicated subjective perceptual variability among a small subset of users. Among participants with AP who consumed alcohol, 31.6% reported experiencing some degree of pitch shift as a function of drinking alcohol, while 68.4% did not. In the nonmedical drug use group, 21.4% reported a shift as function of nonmedical drug use, compared to 78.6% who did not. These findings contribute to a growing body of evidence suggesting that AP, while typically stable, may be susceptible to temporary state-dependent alterations. The results highlight the need for further investigation into how chemical and contextual variables may influence specialized perceptual systems and call for a more dynamic framework for understanding the boundaries of perceptual expertise.

Keywords: *absolute pitch, auditory perception, alcohol use, psychoactive drugs, perceptual plasticity, pitch stability, environmental impacts*

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Introduction

Absolute Pitch (AP), often defined as the capacity to quickly identify or reproduce musical notes without relying on an external reference, is typically treated as a dichotomous ability within cognitive neuroscience and auditory perception research (Athos et al., 2007). However, interpretations of AP research are complicated by substantial variation in how the ability is operationally defined and tested, with some evidence suggesting that AP may exist on a continuum (Leite et al., 2016). These distinctions may be influenced by differences observed between commonly employed AP assessments (e.g., using timed versus untimed tests, assessing variability in responses versus simply assessing whether the response was correct or incorrect).

This ability, found in only a small subset of the population, provides a unique lens to explore the interplay between genetic, environmental, and neurocognitive factors that shape human perception. In Western cultures, AP is exceedingly rare, with estimates placing its prevalence at less than 0.01% of individuals (Deutsch, 2013; Vanzella & Schellenberg, 2010). Other studies suggest that the prevalence of AP may be considerably higher in populations with regular musical training, such as music students, where it has been estimated at approximately 18% (Leite et al., 2016).

Background on AP

The development of AP is shaped by a combination of genetic predispositions and environmental influences, with early experiences playing a particularly crucial role. Genetic contributions to AP have been increasingly recognized, with twin and sibling studies identifying heritability as a factor (Zatorre, 2003; Gingras et al., 2015). Specific genetic loci associated with auditory processing and memory have been implicated in the heightened perceptual capacities characteristic of AP (Gingras et al., 2015). The precise mechanisms by which these genetic factors interact with neural systems remain incompletely understood. Current findings suggest that genetic predispositions establish the neural architecture conducive to AP, which is subsequently shaped and refined through environmental factors (Gingras et al., 2015).

Individuals with AP display a unique capacity for precise and consistent pitch-labeling, attributed to enhanced neural connectivity between the auditory cortex and associative regions implicated in memory (Gingras et al., 2015). This precision underscores AP's potential to provide broader insights into how sensory inputs are encoded and stored in memory systems (Di Stefano & Spence, 2024).

Environmental influences play an equally critical role, particularly during heightened neural plasticity in early childhood, operating within critical developmental windows (Gingras et al., 2015). Early childhood is often identified as a sensitive period for AP development, during which exposure to musical training appears essential (Deutsch et al., 2004). For instance, structured musical training, initiated before ages 9 to 12, strongly correlates with AP development, likely due to its role in reinforcing pitch-label associations through repeated exposure and practice (Zatorre, 2003).

Additionally, cultural and linguistic contexts, particularly those involving tonal languages such as Mandarin and Cantonese, appear to bolster the development of AP significantly (Gingras et al., 2015). Exposure to structured and intensive musical environments within these cultural settings is disproportionately represented among those with AP facilitating the development of AP associations during early developmental periods (Zatorre, 2003; Gingras et al., 2015).

While this critical period framework has long been supported, more recent evidence suggests a more nuanced view. Some cases of adult acquisition have been demonstrated (Van

Hedger et al., 2019; Wong et al., 2020; Wong et al., 2025) outside of a critical period of development. Skill acquisition theory suggests explicit perceptual training might allow individuals to improve AP performance at any age, with some exceeding thresholds for genuine AP inclusion following training (Van Hedger, Heald, & Nusbaum, 2019). However, findings suggest these improvements are typically modest and often do not reach genuine AP performance, highlighting potential constraints aligned with the critical period framework (Van Hedger, Heald, & Nusbaum, 2019).

Environmental Malleability of AP

Although there has been considerable research devoted to understanding the underlying mechanisms of how AP is acquired, less work has been conducted to assess how AP categories might change as a function of different environmental experiences. This could be because of the assumption that AP categories are stable throughout an individual's life once acquired (Ward & Burns, 1982). However, an accumulating body of research has shown that various environmental factors continue to influence AP perception throughout life.

For instance, specific kinds of musical training (e.g., playing a "fixed do" versus a "moveable do" instrument) have been associated with the stability of AP perception, emphasizing how training systems influence cognitive associations with pitch (Wilson et al., 2011). Even after the presumed critical period, active musical training has been linked to increased pitch accuracy and adaptability, illustrating that AP may be more dynamic and maintained via environmental experiences than previously thought (Dohn et al., 2014).

Long-term influences, such as aging and hormonal cycles, have also been associated with changes in AP perception. Aging correlates with subtle declines in pitch-labeling accuracy, indicating that AP is subject to gradual shifts over the lifespan (Athos et al., 2007). Hormonal cycles have demonstrated short-term pitch perception modulation, indicating the dynamic nature of AP (Wynn, 1972).

Research also reveals that AP is not entirely fixed and may exhibit plasticity in response to more immediate environmental context. Exposure to altered tuning, such as consistent exposure to detuned musical scales, shifts pitch categories, even if the experience with the altered tuning is on the order of seconds, highlighting the malleability of AP in response to shorter-term auditory context (Hedger et al., 2013; Van Hedger et al., 2018).

Evidence also suggests that pharmacological interventions, such as Valproate and Carbamazepine, can modulate aspects of pitch perception in possessors of AP. Gervain et al. (2013) report how Valproate, a drug commonly prescribed for mood disorders and epilepsy, has been shown to improve pitch categorization in individuals without AP. This finding suggests that pharmacological agents temporarily enhance or disrupt perceptual abilities related to pitch identification, possibly by influencing neural plasticity within auditory processing networks.

Carbamazepine, another drug frequently used for the treatment of epilepsy and mood disorders, has also been shown to induce significant alterations in auditory perception by shifting pitch perception in AP possessors, indicating that neurochemical modulation plays a role in pitch processing (de Kleine et al., 2022; Fujimoto et al., 2004). Specifically, Carbamazepine produces upward frequency shifts in spontaneous otoacoustic emissions (SOAEs), with shifts ranging from 30 to 104 Hz at frequencies between 1.3 and 2.3 kHz– corresponding to changes of 2.3 to 4.5% (Fujimoto et al., 2004). Several case studies report that Carbamazepine causes a lowered pitch perception, particularly in those possessing AP, perceiving a pitch shift of approximately one semitone downward during intake (Fujimoto et al., 2004; Konno et al., 2003). This effect is largely reversible, with pitch perception normalizing upon discontinuation of the medication (de

Kleine et al., 2022). These findings underscore the ability of some ototoxic drugs to induce temporary changes in auditory processing and pitch perception, further supporting the notion that pharmacological agents can influence neural mechanisms associated with auditory precision. Valproate and Carbamazepine have been found to increase dopamine release in the prefrontal cortex through activation of the 5-HT1A receptor (Ichikawa & Meltzer, 1999), further supporting their role in modulating cognitive and sensory processes.

Taken together, these findings push back against the notion that AP is a fixed trait once acquired. Indeed, while some research on environmental influences on pitch perception among AP possessors dates back several decades, substantial evidence has emerged more recently, highlighting both short- and long-term environmental factors associated with changes in AP. This suggests the perception of pitch may be more plastic in AP possessors than previously assumed; however, there are several environmental factors – including the use of alcohol and nonmedical drugs – that remain underexplored as potential modulators of pitch perception. The findings raise intriguing questions about whether other substances might be perceived to impact AP similarly. While the results suggest a theoretical basis for drug-induced changes in pitch perception, analysis of the effects of psychoactive substances on individuals with AP remains notably absent.

This gap is particularly striking given the increasing cultural relevance of drug use in music-related contexts, where substances like alcohol, LSD, MDMA, and cannabis are frequently consumed to enhance sensory experiences (Kavanaugh & Anderson, 2008; Winick, 1959). While such environments are known to influence emotional and perceptual engagement with music, there has been no systematic investigation into whether these substances disrupt or augment the fine-grained auditory precision required for AP. The absence of targeted research in this area highlights the need for studies that move beyond generalized cognitive impacts to focus on the nuances of pitch perception in individuals with AP.

Background on Psychoactive Substances and Perception

Understanding psychoactive substances, particularly when used in nonmedical or recreational contexts, represents a significant area of inquiry within cognitive neuroscience and perceptual psychology due to recent increases in cultural and scientific exploration. Lysergic Acid Diethylamide (LSD), 3,4-methylenedioxymethamphetamine (MDMA), and other novel psychoactive compounds are known to alter perceptual, emotional, and attentional processes, often in profound ways (Tracy et al., 2017). While significant historical research has examined the general impacts of these substances on sensory experiences, the question of how they affect specialized perceptual categorization, such as AP, remains unexplored (Winick, 1959).

Nonmedical drug use refers to the consumption of substances for recreational or experimental purposes. These substances can be categorized into groups based on their primary mechanisms of action and effects: alcohol, stimulants, hallucinogens, and cannabinoids (Tracy et al., 2017). The impact of psychoactive substances on sensory processing and cognitive functions has been well-documented, particularly in the domains of emotional regulation, memory, and attention (Tracy et al., 2017).

Alcohol, classified as a central nervous system depressant, primarily exerts its effects by enhancing the activity of gamma-aminobutyric acid (GABA), an inhibitory neurotransmitter, and suppressing excitatory neurotransmitters like glutamate (Witkiewitz et al., 2019). Acute alcohol consumption is associated with temporary feelings of euphoria and relaxation, while chronic overuse is linked to neurotoxic effects, particularly in regions governing memory, executive function, and emotional regulation (Oscar-Berman & Marinković, 2007). Additionally, alcohol has been shown to blunt auditory processing, increasing hearing thresholds in critical frequencies, particularly those important for speech discrimination, such as 1000 Hz (Upile et al., 2007). These auditory effects suggest alcohol disrupts the neural mechanisms required for some auditory tasks, raising questions about its potential to impair specialized auditory abilities such as AP perception.

Stimulants, such as amphetamines (e.g., Adderall) and MDMA (ecstasy), act primarily by increasing availability of neurotransmitters like dopamine and serotonin in the brain. This results in heightened energy, feelings of euphoria, and enhanced focus, but excessive use is associated with neurotoxic effects, particularly in the areas of the brain responsible for regulating mood and cognition (Tracy et al., 2017). Stimulants, like MDMA, enhance emotional and social processing by elevating serotonin levels, which contributes to feelings of empathy and connectedness (Kavanaugh & Anderson, 2008). However, these substances can also impair executive functions, including attention and working memory, particularly with chronic use (Tracy et al., 2017). In musical contexts, MDMA has been associated with heightened emotional responses to music while actively under the influence, though its long-term effects on specific auditory skills, such as pitch accuracy, remain underexplored (Kavanaugh & Anderson, 2008).

Hallucinogens, including LSD and psilocybin, interact with serotonin receptors, particularly 5-HT2A, to produce profound changes in sensory perception and cognition (Tracy et al., 2017). These substances significantly influence sensory integration across multiple modalities, including both visual and auditory pathways. Within the auditory system, their effects begin at the cochlear nucleus and extend through subcortical regions to the primary auditory cortex, ultimately altering neuronal responses to auditory stimuli (Tang & Trussell, 2015; Hurley, 2006; Hurley & Sullivan, 2012; Riga et al., 2016, as cited in Barrett et al., 2018).

The effects on auditory processing are consistent with their broader impact on sensory perception including in the visual system. Hallucinogens are also known to disrupt sensory and perceptual integration significantly. For instance, studies using neuroimaging have shown that LSD increases functional connectivity in the visual cortex and decreases alpha brainwave activity, correlating with the vividness of visual hallucinations (Carhart-Harris et al., 2016). The disintegration of stable brain networks under hallucinogenic conditions provides a valuable model for studying altered states of auditory perception.

Cannabinoids, such as THC and CBD, both found in cannabis, act on the endocannabinoid system, influencing neurotransmitter release and neural activity (Zou & Kumar, 2018). This class of substances is associated with mood alteration (e.g., anxiogenic and anxiolytic effects; Sharpe et al., 2020), changes in sensory perception, and impairments in short-term memory and executive functioning (Tracy et al., 2017). Cannabinoids impact sensory perception by modulating neural pathways in the endocannabinoid system (Zou & Kumar, 2018). Cannabis use, for instance, is frequently linked to distortions in time and space perception as well as auditory processing anomalies (Sewell et al., 2013). Studies have reported mixed effects, with some individuals experiencing enhanced appreciation for music and auditory detail while others exhibit impairments in tasks requiring precise auditory discrimination (Winick, 1959; Freeman et al., 2017; Darakjian et al., 2024). Together, these categories provide a framework for understanding how different classes of psychoactive substances affect the brain, often through distinct but overlapping neurobiological mechanisms that influence cognitive and perceptual domains.

Research Question and Hypothesis

The present study explores the environmental effects of nonmedical drug and alcohol use on the self-reported accuracy and stability of AP perception. By focusing on individuals across the AP continuum rather than exclusively on AP possessors, this research aims to elucidate how psychoactive substances may disrupt, enhance, or otherwise alter the mechanisms underlying pitch perception. Situated at the intersection of cognitive psychology, music perception, and psychopharmacology, this investigation can advance our understanding of the malleability of AP and the external influences that may shape it.

To explore this under-investigated area, this study poses the following research question: Does alcohol or nonmedical drug use impact AP perception regarding accuracy and auditory processing? This question is designed to uncover whether the consumption of psychoactive substances alters the perception of pitch for AP possessors, potentially disrupting the precise pitch-label associations that define this ability.

The null hypothesis reflects the assumption that AP, as a highly specialized ability, may exhibit stability even under the influence of alcohol and psychoactive substances. However, the alternative hypothesis aligns with evidence suggesting that substances like LSD and MDMA disrupt sensory integration and cognitive functions, potentially causing pitch identification errors and variability (Carhart-Harris et al., 2016; Winick, 1959). Testing these hypotheses will contribute to a nuanced understanding of the extent to which external factors influence AP, with implications for broader inquiries into the plasticity and resilience of sensory and cognitive systems.

This research framework seeks to evaluate the immediate effects of psychoactive substance use on AP accuracy and provide insights into how such influences might inform theories of perception, memory, and auditory processing. By situating the study within this broader context, the research aims to bridge gaps in current knowledge while contributing to interdisciplinary discussions on the interaction between pharmacology and specialized cognitive abilities.

Method

Participants

A total of 244 individuals accessed the study. However, only 120 participants were included in the final dataset after exclusions. Seven individuals were excluded for failing to provide consent, four were excluded for being under the required age of 16, and the remaining were excluded for not completing the survey. The number of incomplete responses is expected, as many individuals may have taken the test primarily to receive their performance-based AP results (which occurred relatively early in the study) rather than to provide details related to how their perceptions of pitch have shifted as a function of various factors.

Participants were recruited from online forums for AP possessors, such as Reddit and Facebook. Additionally, the Canadian Federation of Musicians shared the survey with its members, and participants were also directed to the survey via a webpage (https://perfect-pitch-test.com/) maintained by the Huron Auditory Perception (HAP) Lab, which receives occasional traffic from relevant web searches (e.g., appearing on the third page from the search query "test my perfect pitch"). Given the recruitment methods, the sample disproportionately represents individuals who are already aware of their AP status or interested in AP-related research. This should be considered when generalizing findings to the broader population.

This study was approved by the Huron University Research Ethics Board (09-202203). All participants provided informed consent before participation, and all responses were anonymized to maintain confidentiality. Participants did not receive direct monetary compensation for their participation. However, they were entered into a raffle for a $25 gift card and received personalized feedback on their pitch performance as an incentive. In total, the study took approximately 10-15 minutes to complete.

Materials

Absolute Pitch (AP) Test

Participants completed an online AP assessment, which was embedded within the main survey and hosted on a separate lab server. The test required identifying 12 isolated musical piano tones. The piano notes were taken from two different octaves (C3-B3 and C5-B5), with octave register interleaved across trials. This was done to ensure that at least 13 semitones separated consecutive judgments, in an effort to discourage participants from using relative pitch cues to respond (e.g., see Van Hedger et al., 2020 for a similar approach). Responses were recorded using either standard Western musical notation (i.e., A-B-C..) or “fixed-do” *solfege* notation (i.e., Do-Re-Mi…), including options for sharps and flats. Participants had the option of selecting which labels they wished to use prior to the test. Each trial was limited to 5 seconds to prevent excessive deliberation and encourage real-time pitch recognition.

Performance was evaluated in terms of accuracy (proportion correct), as well as a composite measure that used response time (logarithmically scaled) and mean absolute deviation (in semitones) from the correct response. This approach has been shown to be more sensitive to variations in pitch labeling ability (e.g., Bermudez & Zatorre, 2009). We used *k*-means clustering to group responses into three groups, similar to Van Hedger et al. (2020). The first group included participants who were at chance in labeling pitches, which comprised our “non-AP” group. The second group included participants who were, on average, above chance in labeling pitches, but were less accurate than the top performers in the sample. The third group included participants who were essentially at ceiling in labeling pitches. In the present study, we included participants from groups two and three in our “AP” group. We opted for this liberal approach in constructing our AP group for several reasons. First, thresholds for designating “genuine” AP are often arbitrary (Van Hedger et al., 2019). Second, given the study topic, we did not want to unintentionally exclude individuals who might have experienced shifts in pitch (e.g., due to aging or other factors) and thus might have performed relatively poorly in terms of mean accuracy, even if their mean absolute deviation from the correct note was consistent. Third, given the study topic, we were interested in collecting perspectives from all participants who were able to demonstrate at least some stable absolute pitch categories.

Self-Report Measures

In addition to the AP test, participants completed a Qualtrics-administered survey assessing their musical background, substance use, and AP-related perceptual shifts.

Participants provided information about their musical training history, including whether they had received formal music lessons (*Yes, No*), the number of years they had trained, and the instruments they studied. Years of musical training were assessed via a Likert-type response, ranging from 1 (*Less than 2 years*) to 5 (*More than 15 years*). Studied instruments were assessed via a provided list, from which participants could select multiple options as well as write in their own responses if needed. Participants also reported their primary instrument using the same response screen as how they indicated their studied instruments, whether they actively played (*Yes, No*), and the number of hours they practiced per week. Hours practiced per week were assessed via a Likert-type response, ranging from 1 (*Less than 1 hour/week*) to 5 (*More than 8 hours/week*). If participants did not report having received music training, the subsequent music training questions were skipped. If participants did not report that they were actively playing music, the final question related to the number of hours practiced per week was skipped.

To assess the relationship between substance use and pitch perception, participants answered questions about their alcohol consumption, recreational drug use, and prescription medication use. They indicated whether they had consumed alcohol in the past year (*Yes*, *No*). If participants indicated that they had consumed alcohol in the past year, they were asked follow-up questions related to the frequency and quantity of their alcohol consumption (number of alcoholic drinks consumed per drinking session). Frequency was measured through a Likert-type response, ranging from 1 (*Once a month or less*) to 5 (*Daily or almost daily*), and quantity was similarly measured through a Likert-type response, ranging from 1 (*1 alcoholic drink*) to 5 (*5 + alcoholic drinks).* Following these questions related to frequency and quantity, participants were asked whether alcohol had ever affected their pitch perception (*Yes, No*). If participants responded with "Yes", they were asked several follow-up questions, including the frequency with which they experienced alcohol-related pitch changes (*Rarely*, *Sometimes*, *Often/Almost Always*) and the specific nature of the pitch changes (*Pitches sound less than 50 cents sharp, Pitches sound more than 50 cents sharp, Pitches sound less than 50 cents flat, Pitches sound more than 50 cents flat*). Participants were able to select more than one option for describing the direction of the pitch changes to account for the possibility that the specific direction of the pitch shifts were variable. Finally, participants were provided with a free response option to describe their experienced alcohol-related pitch changes in greater detail if they wished.

This general structure was followed for the categories of nonmedical drug use and prescription medication. Participants were initially asked whether they had used nonmedical drugs in the past year or were currently taking prescription medication (*Yes*, *No*). If participants reported using nonmedical drugs in the past year, they were asked to indicate which drug they used most frequently (*Cannabis*, *Psychedelics*, *Opioids*, *Other*), as well as the frequency with which they engaged in nonmedical drug use (using the same Likert-type scale as the alcohol frequency use). If participants reported currently taking prescription medication, they were asked to list their medication information, including dosage and frequency. For both nonmedical drugs and prescription drugs, participants were asked if they had ever noticed changes in their perception of pitch as a result of these experiences. If participants answered *Yes* for either question, they were asked the same questions related to the frequency of occurrence, the direction of the pitch shift, and a free response option to elaborate on their experiences.

Additionally, participants were asked whether they had noticed any changes in their perception of pitch due to aging (*Yes*, *No*). If so, participants were asked to indicate the direction of the pitch shift (using the same response options as described earlier) and were provided with a free response text box to describe further details (e.g., severity of the changes, when the changes were first noticed). Finally, participants were asked to indicate whether they had noticed changes in their perception of pitch due to any other factors not already indicated (e.g., listening to loud music, listening to music with altered tuning, drowsiness, sickness). If participants responded *Yes* to this question, they were asked to indicate the frequency with which they experienced these changes, the direction of the pitch shift, and were also given space to describe their experiences in detail.

Handedness was assessed via the modified 8-item Edinburgh Handedness Inventory (Williams, 2020). Participants were provided with eight different scenarios (e.g., writing, using a toothbrush) and had to indicate which hand they used to perform these actions (*Always left, Usually left, No preference, Usually right, Always right*). A Laterality Quotient was calculated by first discarding the *No preference* responses, and then separately tallying up the left-hand and right-hand preferences (with the "*Always"* responses counting for double). Then, the difference of right versus left scores was divided by the summation of the right plus left scores and multiplied by 100. As such, the Laterality Quotient could range from -100 (complete left-hand dominance) to 100 (complete right-hand dominance).

Survey Format & Duration

The survey was administered online via Qualtrics and structured into sections covering AP possession, musical background, substance use, and perceptual changes. Participants self-reported their responses, and the survey was estimated to take approximately 10–15 minutes to complete.

Procedure

Upon accessing the study link, participants were presented with a Letter of Information, which outlined the study's purpose, eligibility criteria, voluntary participation, confidentiality measures, and potential risks. After reading this document, participants had to provide informed consent before proceeding with the study.

Participants first completed the AP assessment. Prior to beginning the assessment, participants were given the opportunity to adjust their volume and were asked whether they were wearing headphones to ensure optimal listening conditions. No practice trials were provided before the test. Participants did not receive immediate feedback after each response but rather were provided with their overall test results at the end of the AP assessment (percentage correct, mean absolute deviation in semitones from the correct response, and response time). Participants were not permitted to retake the AP test, and the responses were analyzed based on a three-point classification system.

Following the AP test, participants completed the self-report questionnaires. Although participants were encouraged to complete the AP test in one sitting, they were able to return to the survey later as long as the survey tab remained open.

Participants first completed the questions related to their musical training. Then, participants reported their use of alcohol, nonmedical drugs, and prescription medication use including frequency, substance/medication type (in the case of nonmedical drugs and prescription medication), and whether they had noticed any changes in pitch perception while under the influence of any of these substances. Following these substance-related questions, participants answered the questions related to whether they had noticed pitch changes as a function of aging, as well as other environmental factors that had not been covered in earlier parts of the survey.

Following these questions, participants provided demographic information (age, gender, race/ethnicity, language(s) spoken when growing up, handedness). After completing these demographic questions, participants were debriefed and provided with further information about the study’s goals. Participants were then redirected to a separate survey in which they had the opportunity to prove their email address to be entered into the prize raffle.

Compensation and Data Storage

Participants had the option to enter a raffle for a $25 CAD gift card by providing their email address at the end of the study. Email addresses were stored separately from study data on a password-protected server and were deleted upon completion of the raffle. Participants who opted to be contacted for future research opportunities had their contact information stored securely for a maximum of five years.

Results

Statistical significance was determined at $p < .05$ for all analyses. Demographic comparisons between AP possessors and non-AP possessors are detailed in Table 1. We also present demographic values as a function of whether participants with AP reported alcohol-related pitch shifts in Table 2 or pitch shifts following nonmedical drug use in Table 3.

Effect of Alcohol on Absolute Pitch Perception

A binomial logistic regression examined whether self-reported pitch shifts due to alcohol consumption could be predicted by mean absolute deviation (in semitones) in the AP test, age, alcohol use frequency and quantity, active playing status, handedness, and/or training duration. All predictor variables were entered at the same time (i.e., we did not use a stepwise approach). Alcohol consumption quantity was a significant predictor of reported pitch shifts, with greater consumption associated with an increased likelihood of experiencing pitch shifts. Comparing participants who reported consuming one alcoholic drink per drinking session ($n = 24$) and those who reported consuming two or more drinks per session ($n = 31$) revealed that individuals in the 2+ drinks group were significantly more likely to report pitch perception shifts than those in the one-drink group, B = 2.77, $SE = 1.03$, $p = .007$.

Table 1

Demographic variables separated as a function of participant group

	AP Possessor (n = 84)	Non-AP Possessor (n = 27)	N/A (n = 9)
Gender			
Female	27	8	3
Male	47	13	6
Non-Binary	1	0	0
Prefer not to Answer	9	6	0
Age (Mean ± SD)	30.69 ± 14.12	31.42 ± 15.91	26.45 ± 7
Race/ Ethnicity			
White	41	16	6
Black	2	0	0
East Asian	13	3	3
Southeast Asian	3	1	0
South Asian	2	0	0
West Asian / Middle Eastern	4	0	0
Mixed Race	9	1	0
Did not report / Prefer not to answer	9	6	0
No option supports identity	1	0	0
Handedness			
Majority right	53	20	8
Majority left	15	1	0
Both / no preference	8	1	1
Did not report	8	5	0
Handedness LQ (Mean ± SD)	56.53 ± 76.25	58.56 ± 53.21	72.22 ± 2
Formal music training			
No training	2	4	1
Less than 2 years	4	3	1
2-5 years	10	5	2
5-10 years	19	4	3
10-15 years	15	2	0
15+	33	8	2
Did not report	1	1	0
Number of languages spoken			
1	48	17	4
2	17	3	1
3+	11	1	2
Did not report	8	6	2

Note: Participants in the N/A group did not complete the AP Test and thus were not considered in any subsequent analyses.

Table 2

Demographic variables separated as a function of AP possessors' reports of alcohol-related pitch shifts

	Shift Yes (*n* = 18)	Shift No (*n* = 39)
Gender		
Female	3	15
Male	10	21
Non-Binary	0	1
Prefer not to Answer	5	2
Age (Mean ± SD)	36.00 ± 15.6	32.21 ± 12.73
Race/ Ethnicity		
White	9	18
Black	0	2
East Asian	1	7
South Asian	1	1
West Asian / Middle Eastern	0	2
Mixed Race	3	5
Did not report / Prefer not to Answer	4	3
No Option Supports Identity	0	1
Handedness		
Majority Right	9	22
Majority Left	4	6
Both / No Preference	1	9
Did not Report	4	2
Handedness LQ (Mean ± SD)	69.64 ± 65.69	41.35 ± 67.98
Formal Music Training		
No Training	1	0
Less than 2 Years	0	2
2-5 Years	1	5
5-10 Years	4	9
10-15 Years	5	7
15+	6	16
Did not Report	1	0
Number of languages spoken		
1	12	21
2	1	10
3+	1	6
Did not Report	4	2
Drinks Consumed per Session		
1	4	20
2	6	14
3	5	1
4	1	1
5+	1	2
Did not Report	1	1

Note: Participants who did not report consuming alcohol in the past year were not included.

Table 3

Demographic variables separated as a function of AP possessors' reports of nonmedical drug-related pitch shifts

	Shift Yes (n = 3)	Shift No (n = 11)
Gender		
Woman	1	5
Man	2	4
Non-Binary	0	1
Prefer not to Answer	0	1
Age (Mean ± SD)	23.00 ± 1.63	34.82 ± 8.08
Race/ Ethnicity		
White	1	8
Southeast Asian	1	0
West Asian / Middle Eastern	0	1
Mixed Race	1	2
Handedness		
Majority right	2	8
Majority left	0	2
Both / no preference	1	1
Handedness LQ (Mean ± SD)	52.53 ± 77.49	56.25 ± 68.41
Formal music training		
No training	0	1
5-10 years	1	2
10-15 years	0	3
15+	2	5
Number of languages spoken		
1	2	10
2	1	0
3+	0	1
Nonmedical Drug Type		
Cannabis	2	10
Psychedelics	1	5
Other	1	1
Nonmedical Drug Use Frequency		
Once a Month or Less	1	3
2 to 4 Times a Month	1	3
2 to 4 Times a Week	1	0
Once a Week	0	4
Daily or Almost Daily	0	1

Note: Participants who did not report using nonmedical drugs in the past year were not included

Specifically, relative to individuals who reported consuming one alcoholic drink per drinking session (used as the reference category), individuals who reported consuming two alcoholic drinks per drinking session were significantly more likely to experience pitch shifts, B = 2.77, *SE* = 1.60, $p = .009$. This pattern of results was generally consistent for even greater amounts of self-reported drinking, with those consuming four drinks per session showing a marginally significant effect, B = 2.22, *SE* = 1.18, $p = .061$, and those consuming five or more drinks per session showing a significant effect, B = 3.21, *SE* = 1.55, $p = .038$. However, participant who consumed three drinks per session did not show a significant increase in self-reported pitch shifts relative to the reference category, B = 1.18, *SE* = 1.40, $p = .401$.

Other variables, including age B = 0.02, *SE* = 0.03, $p = .570$, AP deviation B = 0.36, *SE* = 0.83, $p = .660$, handedness B < 0.01, *SE* = 0.01, $p = .514$, active playing status B = 0.65, *SE* = 1.23, $p = .597$, and training duration B = -0.26, *SE* = 0.32, $p = .415$, were not significant predictors of reported pitch shifts. A binomial test was conducted to determine whether alcohol-related pitch shifts were biased toward consistently perceiving notes as either sharper or flatter. Of the 15 reported pitch shift directions across participants[1], 10 reported shifts were in the sharp direction and 5 reported pitch shifts were in the flat direction. Although shifts in the sharp direction were thus twice as likely to be reported as shifts in the flat direction, this difference was not significant, $p = .301$. A corresponding chi-square test yielded a similar conclusion, $\chi^2(1, n = 15) = 1.67$, $p = .197$.

Qualitative self-reports, when provided ($n = 12$) described pitch shifts occurring the morning after drinking, often in association with hangovers ($n = 4$). Some participants reported

[1] Although 18 participants reported experiencing pitch shifts as a function of alcohol consumption, five did not report the direction of the pitch shift, and two participants reported both sharp and flat shifts, leaving 15 observations.

that notes sounded sharper or flatter depending on the individual, with descriptions of heightened pitch perception and shifts lasting approximately 12 hours, occasionally exceeding one semitone in pitch deviation. Overall, self-reported pitch perception shifts were more likely among participants who consumed alcohol in larger quantities, though the direction of these shifts varied and was not significantly biased toward sharper or flatter perception.

Effect of Nonmedical Drug Use on Absolute Pitch Perception

A binomial logistic regression also examined whether self-reported pitch shifts due to nonmedical drug use could be predicted by mean absolute deviation in the AP Test, age, nonmedical drug use frequency, active playing status, handedness, and/or music training duration. Similar to the alcohol model, all predictor variables were entered at the same time. None of the predictor variables were statistically significant, suggesting that these factors did not reliably explain variations in reported pitch shifts among drug users. Specifically, nonmedical drug use frequency, B = 3.69, *SE* = 164 560, *p* = 1.00; AP deviation B = 1.34, *SE* = 133 735, *p* = 1.00; age B = -4.82, *SE* = 14 766, *p* = 1.00; handedness B = -0.1, *SE* = 1 004, *p* = 1.00; active playing B = -71.29, *SE* = 348 089, *p* = 1.00; and training duration B = 16.92, *SE* = 98 759, *p* = 1.00, all failed to reach statistical significance.

A binomial test assessed whether self-reported pitch shifts associated with nonmedical drug use were biased toward perceiving notes as sharper or flatter. Of the three reported pitch shift directions across participants[2] two responses were in the sharp direction and one response was in the flat direction. This difference was not statistically significant, *p* = 1.00. These findings

[2] One participant did not respond to this question and one participant reported both sharp and flat shifts.

suggest that nonmedical drug use does not produce measurable, shifts in absolute pitch perception.

Despite the lack of statistical significance, qualitative responses indicated subjective changes in pitch perception. One participant reported losing the ability to consciously identify pitches, while another noted that their pitch perception became more accurate when using cannabis. Several participants (n = 2) described instability in pitch perception while ‘high’, reporting that pitches seemed to warp and fluctuate rather than remain consistent while using cannabis (n = 1) or psychedelics (n = 1) . These responses suggest that although nonmedical drug use may not produce systematic pitch shifts detectable through inferential testing, it may subjectively alter pitch perception in unpredictable ways.

Discussion

The present study explored whether alcohol and nonmedical drug use are associated with self-reported shifts in pitch perception among individuals with demonstrated stable pitch categories. While AP is traditionally considered a stable and specialized perceptual ability, the findings from this study add to a growing body of research suggesting that environmental factors, such as the use of alcohol and nonmedical drugs, may transiently influence pitch perception, even among those with established AP. Specifically, alcohol consumption quantity significantly predicted the likelihood of reported pitch shifts, whereas nonmedical drug use frequency did not. Nonetheless, qualitative data suggests that both substances may subjectively alter pitch shifts for a subset of individuals, emphasizing the importance of considering individual variability within perceptual experiences.

Alcohol-Related Pitch Distortions

The finding that alcohol consumption quantity was significantly associated with increased reports of pitch shifts aligns with previous research demonstrating that alcohol increases auditory thresholds and can impair fine auditory discrimination, particularly in frequencies critical for pitch perception (Upile et al., 2007). Participants who consumed two or more drinks per session were significantly more likely to report pitch perception distortions relative to those who reported consuming only one drink. These findings suggest a possible dose-related effect, with higher quantities of alcohol consumption generally associated with increased reports of pitch perception distortions. However, the relationship was not strictly linear; for example, participants who consumed three drinks per session did not show a significant increase in reported distortions compared to those who consumed only one. Notably, performance on the AP test, as measured by mean absolute deviation, did not predict whether participants reported pitch shifts. This implies that pitch labelling ability itself remains relatively stable and that distortions are more likely to reflect temporary perceptual modulations rather than trait-level degradation of AP. This interpretation is consistent with prior evidence that absolute pitch perception can be influenced by short-term contextual or neurochemical factors (Van Hedger et al., 2018; Fujimoto et al., 2004).

Although reports of pitch shifts in the sharp range were twice as frequent as those in the flat range, this difference did not reach statistical significance. Qualitative responses, however, indicate that some participants experienced perceptual disruptions the morning after drinking, often in the context of hangovers. These morning-after shifts were typically described as temporary, with altered pitch perception persisting for several hours. These findings indicate that some AP possessors might experience temporary alterations in their perception of pitch as a function of residual alcohol effects, such as dehydration or changes in neurotransmitter balance (Oscar-Berman & Marinković, 2007), in addition to effects experienced during intoxication.

The results lend further support to a growing perspective that AP may be more malleable than traditionally assumed. While earlier literature characterized AP as a stable, all-or-nothing trait acquired during a critical period (Ward & Burns, 1982), more recent findings emphasize the influence of environmental factors, pharmacological agents, and even short-term auditory contexts (e.g., Hedger et al., 2013; Van Hedger et al., 2018). The current findings complement this more dynamic framework by demonstrating that temporary shifts in neurochemical state, such as those induced by alcohol, may modulate the perceived stability of pitch categories among AP possessors (Fujimoto et al., 2004).

Drug-Related Distortions in AP Perception

In contrast to alcohol, nonmedical drug use frequency was not significantly associated with reported pitch perception distortions. However, this null result warrants cautious interpretation given the small number of participants who identified drug-related pitch shifts (n = 3). The lack of statistical significance may be due to the limited sample size, variability in the types of substances used, or individual differences in response to psychoactive substances. For example, participants reported using a variety of drugs, including cannabis and psychedelics, each of which acts through different neurochemical mechanisms and may yield distinct perceptual effects (Tracy et al., 2017).

Given the relatively small number of participants who reported nonmedical drug use, additional statistical analyses comparing effects across specific drug types were not conducted. Although participants indicated a range of substances used, including cannabis, psychedelics, and other psychoactive agents, the sample sizes within each category were insufficient to support meaningful statistical comparisons. Attempting to evaluate pitch perception shifts by substance type under these conditions would have risked underpowered analyses and potentially misleading interpretations. As such, drug class-specific effects remain an open question that warrants further investigation with a larger and more balanced sample.

Despite the lack of significant quantitative findings, qualitative reports from participants who used nonmedical drugs provided insight into possible perceptual changes. One participant noted a temporary inability to consciously label pitches while under the influence of cannabis, while another reported increased pitch clarity. Others described pitch perception as unstable, with notes warping or fluctuating during substance use. These accounts, though not generalizable, suggest that drug-induced perceptual distortions may occur at the individual level and may not be captured effectively through binary outcome measures or regression models.

This variability aligns with prior research on psychoactive substances, which consistently demonstrates that perceptual effects are highly context-dependent and shaped by both pharmacological and psychological factors, including set and setting (Tracy et al., 2017). While the present study did not find consistent patterns across users, the presence of subjective reports nonetheless supports the need for further investigation into how psychoactive substances may influence pitch categorization and auditory perception more broadly.

Broader Theoretical Implications

Together, these findings provide tentative support for the idea that AP may be sensitive to certain environmental and neurochemical factors. The fact that alcohol consumption, but not pitch test performance, predicted perceptual distortions suggests that AP may be more resilient to long-term changes than previously thought but still susceptible to short-term disruptions. This is consistent with findings from pharmacological studies demonstrating that substances like

Carbamazepine and Valproate can temporarily shift pitch perception among AP possessors (Fujimoto et al., 2004; de Kleine et al., 2022), as well as work showing that altered auditory contexts can modulate AP responses (Van Hedger et al., 2018).

These findings also contribute to ongoing conversations in cognitive neuroscience regarding the plasticity of perceptual systems. Absolute pitch has long served as a model for studying auditory expertise and memory (Zatorre, 2003), and its apparent sensitivity to state-based influences suggests that even high-level perceptual abilities may operate within a more flexible cognitive architecture than traditionally assumed. While these conclusions are based on self-reported perceptual changes and should be interpreted with appropriate caution, they nonetheless offer preliminary support for the idea that perceptual expertise is context-sensitive and influenced by state-dependent conditions (Van Hedger et al., 2018; Fujimoto et al., 2004). Rather than conceptualizing AP as a rigid and immutable trait, these findings support a framework in which AP abilities are maintained through ongoing interaction between perceptual, cognitive, and environmental systems.

Limitations and Future Directions

Several limitations of the current study should be acknowledged. First, the sample size of participants who reported pitch shifts due to nonmedical drug use was small, limiting the statistical power and generalizability of those findings. Additionally, the variety of substances reported, ranging from cannabis to psychedelics to an ambiguous ‘other,’ prevented substance-specific analyses and further exploration. Future research should aim to isolate the effects of specific drug classes on pitch perception and explore dose-response relationships where possible.

Second, all substance-related effects were assessed via self-report, which is subject to memory biases and inaccuracies in introspection. Although qualitative data added nuance to the statistical analyses, future studies would benefit from controlled, within-subject designs in which pitch perception is assessed before, during, and after substance use in a laboratory setting. Such designs could help determine whether observed pitch distortions reflect actual changes in auditory processing or instead represent fluctuations in confidence, attention, or other cognitive processes.

Finally, while the study found an association between alcohol use and increased reports of pitch shifts, the underlying mechanisms driving these distortions remain unclear. It is possible that the perceptual changes attributed to alcohol use may be influenced by indirect or additive factors such as fatigue, stress, or the broader context in which substances are consumed. Although our design captured participants' self-reported experiences, the complexity of these perceptual shifts likely requires more targeted experimental paradigms capable of isolating specific perceptual effects from confounding influences. Future work should disentangle these contributing factors to better understand how and when auditory perception, particularly absolute pitch, is most susceptible to alteration.

Conclusion

This study represents a preliminary but essential step toward understanding how psychoactive substances may affect absolute pitch perception. Findings indicate that alcohol consumption quantity is significantly associated with an increased likelihood of reporting pitch shifts, while nonmedical drug use frequency is not, though subjective reports suggest that both substances may influence pitch perception in unpredictable ways. These results suggest that AP, while generally stable over long-term contexts, may be subject to temporary state-based modulations under certain conditions. By highlighting the potential influence of chemical and environmental factors on pitch perception, the present findings challenge traditional assumptions of AP immutability and contribute to a broader understanding of the nature of auditory expertise.

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