NEURODIVERGENT SOUNDSCAPES: PROFILING MUSICAL STRENGTHS IN ADHD, ADD, AND DYSLEXIA

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This article introduces the concept of the Neuro-Auditory Profile, a multimodal framework for describing musical abilities in neurodivergent populations, with a particular focus on children and adolescents with Attention Deficit Hyperactivity Disorder (ADHD), Attention Deficit Disorder (ADD), and dyslexia. Drawing on a series of studies conducted between 2014 and 2023, the model integrates four dimensions: neuroanatomical structures, functional timing parameters (e.g., magnetoencephalography (MEG) latencies), psychoacoustic and musical performance, and metacognitive self-evaluation. Findings indicate that, despite documented perceptual deficits, adolescents with ADHD and ADD perform on par with control groups in improvisational and expressive musical tasks. This suggests that musical creativity and expressiveness may represent preserved or even enhanced domains of functioning. The results carry both theoretical and profiling implications, encouraging a shift away from deficit-oriented perspectives toward a differentiated understanding of musical potential. For music education, the model highlights new opportunities to support individual strengths in inclusive learning environments. Finally, the article outlines perspectives for the further development of the framework, emphasizing the need for validated instruments and ecologically valid performance tasks to enable more precise characterization of musical creativity in neurodivergent populations.

Keywords: Neuro-Auditory Profile; musical creativity; neurodiversity; ADHD; ADD; dyslexia; auditory processing; MRI; MEG; improvisation and expression; inclusive music education.

1. INTRODUCTION

Over the past decade, systematic musicology has increasingly engaged with questions of individual variability in auditory processing and musical behaviour, driven by advances in auditory neuroscience and developmental psychology. This shift reflects a growing recognition of the complex interplay between neurobiological, cognitive, and experiential factors that shape musical perception and production (Zatorre 2013; Müllensiefen et al. 2014). For example, individual differences in pitch perception, rhythm synchronization, and timbre discrimination have been linked to variations in auditory cortical structures and connectivity (Schneider et al. 2005; Schnupp, Nelken and King 2011; Hyde et al. 2009). At the same time, developmental studies underscore the role of early auditory and musical experiences in shaping neural plasticity and musical behavior across the lifespan (Trainor et al. 2009; Putkinen, Tervaniemi and Huotilainen 2013). Consequently, systematic musicology has begun to incorporate methods and models from differential psychology and cognitive neuroscience to better understand the roots and implications of inter-individual variability in musicality (Mosing et al. 2014; Gingras, Honing and Peretz, 2015).

Building upon this shift in focus toward individual variability in musical behavior and auditory processing, the concept of the Neuro-Auditory Profile has been introduced as a multimodal framework. It integrates neuroanatomical features, neurophysiological timing measures, and behavioural indicators of musicality to account for the complex relationship between auditory processing and musical expression. This research is essential not only for clarifying the mechanisms underlying the beneficial effects of musicality on auditory processing, but also for establishing a conceptual framework to examine the inverse pathway – that is, the development and characteristics of auditory deficits. Over the past decade, empirical research suggests that neurodevelopmental conditions such as Attention Deficit Hyperactivity Disorder (ADHD), Attention Deficit Disorder (ADD), and developmental dyslexia are associated with distinct auditory processing and anatomical patterns, some of which correlate with enhanced musical improvisation and expressive fluency, rather than deficits (Groß et al. 2022; Seither-Preisler et al. 2014; Serrallach et al. 2016).

The Neuro-Auditory Profile is a multimodal construct that integrates (1) neuroanatomical parameters – specifically the volume and ratio of Heschl's gyrus (HG) and the planum temporale (PT), (2) functional timing characteristics derived from auditory-evoked fields (such as hemispheric P1 latency asymmetries measured via MEG), and (3) psychoacoustic and musical performance indicators, including pitch discrimination and rhythm reproduction. It was designed to distinguish auditory phenotypes in children, including those associated with developmental disorders, with the goal of linking these profiles to behavioural capacities in music-making (Groß et al. 2022; Serrallach et al. 2016).

Studies have shown that children with ADHD, for example, often exhibit delayed P1 latencies in the left hemisphere and advanced responses in the right, accompanied by atypical HG/PT ratios and reduced auditory synchronization – especially in the absence of musical training (Seither-Preisler et al. 2014; Serrallach et al. 2016). Despite neurofunctional deviations, adolescents with ADHD and ADD performed on par with controls in rhythmic improvisation and musical expression. These findings challenge purely deficit-oriented perspectives on neurodevelopmental disorders, suggesting that divergent auditory processing does not necessarily impede, and may even coexist with, intact creative and expressive musical abilities (Groß et al. 2022, 12–16).

This shift in perspective calls for an expansion of the musicological framework. Rather than evaluating musicality solely on the basis of accuracy or reproduction (e.g., pitch matching or sight-reading), the Neuro-Auditory Profile proposes a broader view that includes temporal processing, behavioural flexibility, and metacognitive insight as further elements.

The empirical convergence of neurophysiological auditory markers and domain-specific musical strengths – especially in adolescents with ADHD and ADD – demonstrates the heuristic value of the Neuro-Auditory Profile not only for differentiated profiling of musical potential, but also for the theorization of musical potential as a dynamic and context-dependent phenomenon. Through the development of the Musical Performance Assessment Scale (MuPAS), musical behaviour was operationalized along six interrelated dimensions: rhythmic reproduction, rhythmic improvisation, pitch reproduction, pitch improvisation, musical expression, and auditory memory. These behavioural profiles could be statistically correlated with timing parameters, such as P1 latencies and hemispheric synchronization patterns, revealing that shorter latencies and reduced asymmetries in neurodivergent groups often co-occur with elevated improvisational fluency and expressive flexibility (Groß et al. 2022, 13-14).

Taken together, this growing body of research underscores the complexity of individual auditory and musical development. Existing research has provided robust evidence for individual variability in auditory cortical morphology (e.g., HG/PT ratios), neurofunctional timing parameters (e.g., hemispheric P1 latency asymmetries), and auditory perception in both neurotypical and neurodivergent populations (e.g., Seither-Preisler et al. 2014; Serrallach et al. 2016, 2022). However, this body of work has predominantly examined these markers in isolation, with limited integration of functional musical behavior – particularly creative and expressive performance – into the interpretation of auditory processing differences.

Consequently, there is an absence of models that have been iteratively developed across multiple studies and age groups, integrating structural, functional, behavioral, and metacognitive dimensions of auditory–musical processing over an extended research period.

The present manuscript addresses this gap by introducing and synthesizing the Neuro-Auditory Profile. Rather than reporting isolated findings, this article traces the longitudinal development of the model across successive empirical studies and demonstrates its epistemological relevance as a profiling approach.

The aim of this article is twofold: 1) to provide a chronologically structured synthesis of peer-reviewed studies conducted by the author's research group between 2014 and 2023 that contributed to the development and empirical grounding of the Neuro-Auditory Profile; and 2) to analyze the epistemological implications of this framework for systematic musicology, with particular attention to the identification of musical strengths in children and adolescents with ADHD, ADD, and dyslexia. Special emphasis will be placed on how the Neuro-Auditory Profile can inform inclusive practices in music education.

This multidimensional concept is illustrated in Figure 1. The subsequent sections will elaborate on these components in detail, drawing on empirical findings that establish the foundation of the model.

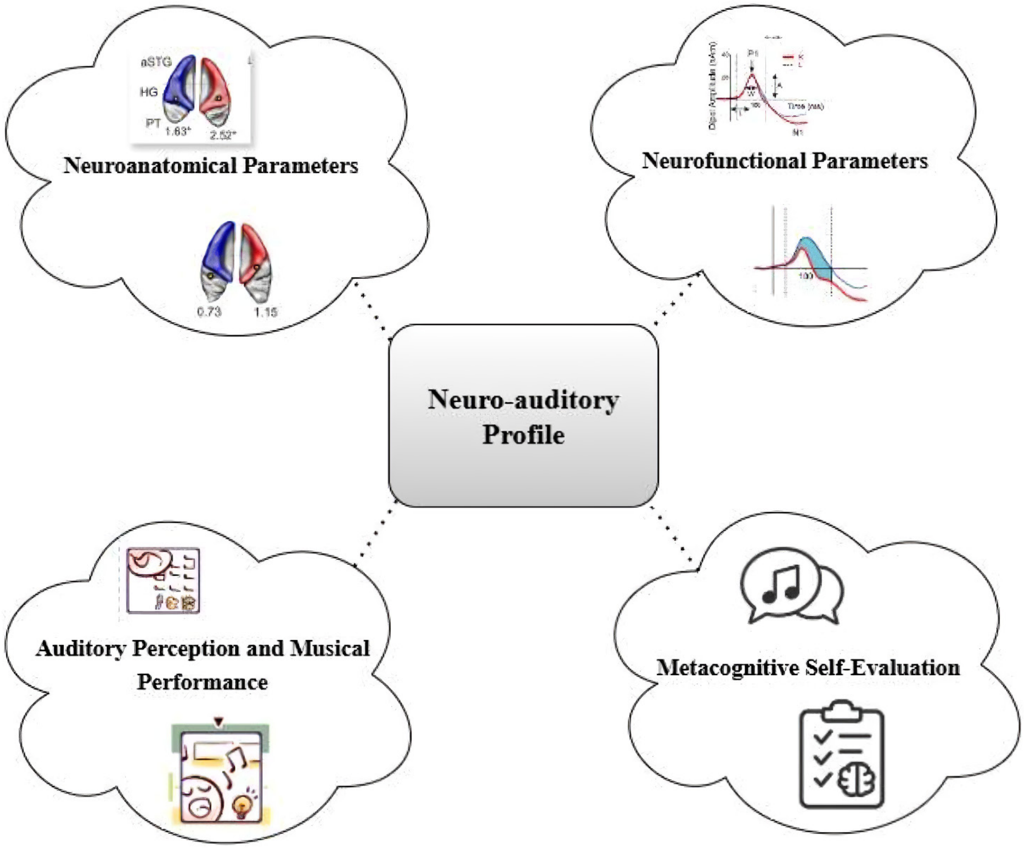

Figure 1. The Neuro-Auditory Profile. The concept of the Neuro-Auditory Profile integrates four dimensions: 1) neuroanatomical parameters (Heschl's gyrus (HG) / planum temporale (PT) ratio), 2) functional timing characteristics (e.g., P1 latency asymmetries), 3) psychoacoustic and musical performance (e.g., Musical Performance Assessment Scale (MuPAS)), and 4) metacognitive self-evaluation in musical and speech-related tasks. Own illustration based on previous research (Seither-Preisler et al. 2014; Serralach et al. 2016, 2022; Groß et al. (2022, 2023).

2. CHRONOLOGICAL OVERVIEW OF CORE RESEARCH

2.1 Chronological synthesis of empirical studies (2014 – 2023)

To enhance transparency regarding the development of the Neuro-Auditory Profile, this subsection provides a chronological synthesis of the empirical studies conducted between 2014 and 2023. The overview highlights how successive studies contributed distinct structural, neurofunctional, behavioural, and metacognitive dimensions to the evolving framework. This synthesis serves as an orientation for the subsequent subsections, which discuss the individual components of the profile in greater detail.

Table 1 Chronological development of the Neuro-Auditory Profile (2014–2023) across successive empirical studies cited in the present manuscript

Period	Study / Reference	Sample (N, age)	Design & Methods	Core contribution to the Neuro-Auditory Profile
2014	Seither-Preisler et al., 2014	N = 132 children (controls and children with AD(H)D), mean age 8.6–8.9 years	Cross-sectional; structural MRI (HG, PT), MEG (P1 latency, hemispheric synchrony), psychoacoustic test battery	Identification of stable neuroanatomical (HG/PT ratios) and neurofunctional timing markers (P1 latency/asynchrony) linked to musical, literacy, and attention skills
2016	Serrallach et al., 2016	N = 147 children, 8–12 years (controls, ADHD, ADD, dyslexia)	Cross-sectional + longitudinal subsample; MRI, MEG, extended auditory perception battery	Differentiation of ADHD, ADD, dyslexia, and controls based on distinct auditory cortical morphologies and latency profiles
2022	Serrallach et al., 2022	N = 82 adults, mean age 35.6-42.6 (controls, ADHD, ADD)	Cross-sectional; MRI, MEG	Differentiation of ADHD, ADD, and controls in adults based on distinct auditory cortical morphologies and latency profiles
2022	Groß et al., 2022	N = 96 adolescents, 12–18 years (controls, ADHD, ADD, dyslexia)	Cross-sectional; MEG, MuPAS (behavioural musical performance), psychoacoustics	Shift from perceptual deficits toward expressive and improvisational musical strengths; introduction of the behavioral dimension
2023	Groß et al., 2023	N = 75 (3×25), 20–21 years (controls, ADHD)	Cross-sectional; complex auditory and musical tasks, self-evaluation measures	Integration of metacognitive self-assessment as an additional dimension, revealing dissociations between perceived and actual performance

This chronological synthesis illustrates how the Neuro-Auditory Profile evolved iteratively, with each research phase contributing a distinct dimension to the emerging framework.

Abbreviations: HG = Heschl's gyrus; PT = planum temporale; MRI = magnetic resonance imaging; MEG = magnetoencephalography; MuPAS = Musical Performance Assessment Scale.

2.2 Structural Markers of the Auditory Cortex

As illustrated in Figure 1, structural parameters represent one of the four key dimensions of the Neuro-Auditory Profile, providing the morphological scaffold for subsequent functional and behavioral analyses. The Neuro-Auditory Profile includes structural magnetic resonance imaging (MRI) findings comprising specific volumetric and asymmetry-based markers in auditory cortex regions. Seither-Preisler et al. (2014) demonstrated that children with musical training had enlarged Heschl's gyri (HG) compared to non-musicians, while those with AD(H)D showed reduced volumes of Heschl's gyri and enlarged volumes of the plana temporalia. Morphometric deviations in children diagnosed with AD(H)D and dyslexia were systematically explored in Serrallach et al. (2016), where HG/PT ratios served as indicators differentiating patients with ADHD, ADD, and dyslexia from controls. In this study all three disorder subgroups showed smaller HG and enlarged PT volumes in the left hemisphere, resulting in smaller left HG/PT ratios as compared to controls. In the right hemisphere, HG/PT ratios were generally higher and similar in controls and children with ADD, but clearly decreased in children with ADHD and dyslexia. Extending this research into adulthood, Serrallach et al. (2022) found that these structural differences persist in adults with ADHD and ADD, highlighting enduring reductions in left HG volumes, resulting in diminished left HG/PT ratios and distinct hemispheric patterns, with patients with ADHD showing lower right HG/PT ratios and patients with ADD a similar right HG/PT ratio compared to controls. Together, these structural features form a morpho-anatomical scaffold for the Neuro-Auditory Profile.

2.3 Neurofunctional Timing and MEG Latency Profiles

Across above mentioned studies, magnetoencephalography (MEG) served as a core methodology to assess auditory-evoked fields (AEFs), particularly focusing on the P1 component of the auditory-evoked response (P1 latency). Seither-Preisler et al. (2014) observed that musical training in children enhances bilateral P1 synchronization and accelerates latency, while children with AD(H)D showed delayed left-hemispheric latencies and premature right-hemispheric responses, indicative of inter-hemispheric asynchrony. Serrallach et al. (2016) extended this finding by linking diagnostic subtypes to distinct latency patterns. Controls showed well-balanced bilateral responses, with a mean absolute P1 asynchrony of 3.7 ± 1.6 ms. In disorder subgroups (ADHD, ADD and dyslexia), asynchronies were about fivefold larger and accompanied by distinct source waveform profiles. Dyslexics showed an enlarged P1 peak in the right hemisphere, ADHD children displayed temporally expanded responses in the left and reduced amplitude in the right, and ADD children exhibited bilaterally similar but temporally shifted waveforms. These findings were further supported in adults (Serrallach et al., 2022), where asynchrony patterns partially persisted but were less pronounced, potentially reflecting maturational or compensatory mechanisms.

2.4 Auditory Perception and Musical Performance

The behavioral dimension of the Neuro-Auditory Profile (see Figure 1) captures psychoacoustic and musical performance, which is further specified through measures such as MuPAS. Auditory perception and musical performance have been investigated in neurodivergent populations through increasingly refined methodological frameworks revealing fundamental differences between subgroups (ADHD, ADD, dyslexia) and neurotypical controls in both elementary psychoacoustic skills and complex musical capacities.

Seither-Preisler et al. (2014) found that children who spent more time practicing a musical instrument showed enlarged Heschl's gyri and increased right–left hemispheric synchronization of the primary evoked response (P1) to harmonic complex sounds. These anatomical features were positively correlated with performance in frequency discrimination, reading, and spelling skills.

When examining the auditory profiles of children diagnosed with ADHD, ADD, and dyslexia using a battery of psychoacoustic tasks, including basic sound processing (frequency, intensity, onset ramp, and tone duration discrimination) and complex auditory pattern recognition (meter, rhythm, melody, and pitch perception), distinct group differences emerged (Serrallach et al. 2016). Compared with the neurotypical control group, children with dyslexia performed significantly worse than all other groups on both elementary and complex auditory tasks. Moreover, they showed a relative predominance of spectral/timbral aspects in pitch perception in the Auditory Ambiguity Test (AAT). In contrast, children with ADHD were characterized by lower scores in the rhythmic and melodic subscales of the Intermediate Measures of Music Audiation (IMMA), whereas children with ADD exhibited no auditory deficits. These findings indicate that while dyslexia and ADHD are associated with measurable perceptual limitations, ADD may preserve auditory functions. This pattern supports the hypothesis that ADD may be characterized not by a generalized deficit, but by a neurocognitive style conducive to internal audiation, flexible attention, and creative auditory imagination, factors that may underlie superior performance in improvisational and expressive musical tasks.

In contrast to earlier studies that focused primarily on elementary auditory perception, Groß et al. (2022) introduced the Musical Performance Assessment Scale (MuPAS) for evaluating complex musical behavior in adolescents aged 12 to 18. This instrument comprises six subtests that assess both reproductive and generative dimensions of musical ability: rhythmic reproduction, rhythmic improvisation, pitch reproduction, pitch improvisation, musical expression, and rhythmic and pitch memorization. The MuPAS thus enables a multidimensional evaluation of musical competence, encompassing both accuracy-based performance and creative fluency.

Improvisation and Expression: Adolescents with ADHD and ADD performed on par with controls in rhythmic improvisation and musical expression. This is a novel finding, given that previous research has documented perceptual deficits – particularly in rhythm and melody perception – for ADHD. The results indicate that, despite such perceptual limitations, adolescents with ADHD and ADD can achieve musical performance levels in these creative and expressive domains comparable to those of unaffected peers.

Pitch Reproduction: Both ADHD and ADD groups performed similarly or slightly below controls in pitch reproduction, suggesting that their enhanced performance in improvisational domains is not driven by superior pitch accuracy but rather by expressive, perhaps compensatory, neural mechanisms. Auditory Memory: No significant group differences were found in rhythmic and pitch memorization tasks, possibly due to task constraints and ceiling effects. Rhythmic improvisation was negatively correlated with P1 and N1 latencies, indicating that earlier cortical responses predicted better improvisational performance. This supports the notion that temporal efficiency in auditory processing facilitates creative musical behaviour. This finding suggests that impaired auditory perception does not necessarily constrain creative musical performance. Beyond musical performance, melodic perception in speech has been shown to correlate with both language performance and musical abilities, underscoring that musicality may scaffold broader cognitive domains such as prosodic processing and linguistic competence (Christiner, Groß, Seither-Preisler and Schneider, 2022).

The empirical findings Seither-Preisler et al. (2014), Serrallach et al. (2016), and Groß et al. (2022) demonstrate a multilayered association between the structural morphology of the auditory cortex, neurofunctional timing parameters, and musical behaviour in both neurotypical and neurodivergent individuals (Seither-Presiler at al. 2014; Serralach et al. 2016; Groß et al. 2022). While earlier studies reported associations between these neural characteristics and superior psychoacoustic performance – such as rhythm reproduction and frequency discrimination – in the current dataset (Groß et al. 2022, 12-14) the neurofunctional enhancements, namely reduced P1 latency asynchrony and earlier P1/N1 latencies, were specifically associated with better rhythmic improvisation performance.

Building on previous findings, Groß et al. (2022) shifted the focus from auditory perception to the expressive dimensions of musicality, thereby addressing an often-overlooked facet of neurodivergent musical behaviour.

Crucially, these results emphasize the need to differentiate between at least three functionally distinct domains of musicality:

- Perceptual accuracy, reflected in pitch or frequency discrimination tasks;
- Temporal processing, as measured by latency and synchrony parameters (e.g., MEG P1 latencies);
- Expressive fluency, operationalized through generative tasks like improvisation and emotional expression.

This multidimensional framework supports a more nuanced view of musical ability that accounts for compensatory mechanisms and divergent neurodevelopmental trajectories. In practical terms, it suggests that conventional profiling instruments – focused predominantly on accuracy and reproduction – may overlook key indicators of musical potential in neurodivergent populations, particularly those whose strengths manifest in open-ended, creative contexts.

2.5 Metacognitive Self-Evaluation in Musical and Speech Perception Tasks

This section addresses the metacognitive dimension of the Neuro-Auditory Profile (Figure 1). Building upon the structural, functional, and behavioural dimensions of the Neuro-Auditory Profile, a recent study Groß et al. (2023) investigated the metacognitive aspect of musical and speech perception performance in young adults with ADHD (Groß et al. 2023). While previous research had demonstrated perceptual and timing-related deviations in this group, the question remained whether individuals with ADHD are aware of such differences in performance and how self-assessment processes interact with their rated competence. To address this, the study employed a multi-domain diagnostic battery comprising both musical and language-based listening tasks of varying complexity, alongside standardized assessments of short-term memory and subjective self-evaluation. Three groups participated: musically naïve individuals, participants with formal musical training, and individuals diagnosed with ADHD. The results revealed a consistent pattern across tasks: although participants with ADHD performed significantly worse than the control groups in complex auditory tasks – such as melodic discrimination and foreign language prosody identification, their self-assessments were markedly inflated. In contrast to the musically naïve group, who rated their own abilities more conservatively, the ADHD group judged their competence to be on par with musically trained peers, despite objective evidence to the contrary. This discrepancy was especially evident in open-ended tasks requiring complex auditory integration, rather than in simple perceptual discrimination tasks, where no significant group differences emerged.

Importantly, no short-term memory (STM) impairments were observed in the ADHD group, suggesting that previously reported STM limitations in children may not persist into adulthood or may be compensated by alternative strategies (Schmidt, Hesse, Loo, and Thome, 2020). The most distinctive marker, however, was the dissociation between perceived and actual competence. This aligns with prior findings on the positive illusory bias in ADHD (Hoza et al., 2004), where inflated self-evaluations may function as a psychological coping mechanism in the face of inconsistent performance.

Discriminant analyses supported these observations by revealing two orthogonal components: one reflecting actual performance (musical discrimination, STM, language tasks), which clearly separated ADHD participants from both control groups; and a second component reflecting self-perception variables, which grouped ADHD participants with musically trained individuals. This convergence of self-evaluation profiles – despite divergent actual performance – suggests that individuals with ADHD may internalize high competence beliefs independent of feedback accuracy.

These findings have direct implications for music education and training. Since individuals with ADHD tend to systematically overestimate their own performance, self-report measures alone provide limited insight into actual abilities. Thus, pedagogical interventions should combine objective performance assessments with structured feedback to support realistic self-monitoring. Moreover, targeted metacognitive training may help students with ADHD calibrate their self-assessments, fostering more accurate goal-setting, adaptive learning strategies, and effective feedback integration – all of which are critical for sustained progress in complex auditory learning environments (Groß et al. 2023, 12-13).

3. THEORETICAL AND PROFILING IMPLICATIONS

In the present context, the term profiling refers to the systematic characterization of auditory–musical strengths and processing patterns and does not imply clinical diagnosis in the sense of DSM or ICD classification. The findings presented across the examined studies substantiate a theoretical reframing of musicality in neurodivergent populations. Rather than conceptualizing neurodevelopmental conditions such as ADHD, ADD, or dyslexia primarily as deficit-based, the Neuro-Auditory Profile provides a differentiated and integrative multidimensional model.

Especially in individuals with ADD and ADHD, distinctive strengths in improvisation and expressive performance have been observed, capacities that are not well predicted by traditional measures of musical aptitude such as pitch reproduction or STM. These creative strengths correlate with shortened latencies in MEG-based auditory evoked fields (P1, N1) and, as shown in Section 2.5, with elevated self-confidence in auditory performance, even in the absence of objective superiority.

Crucially, the findings underscore the importance of distinguishing between at least three functionally distinct domains of musicality: perceptual accuracy, temporal processing, and expressive fluency. Perceptual accuracy refers to abilities such as pitch and frequency discrimination, while temporal processing encompasses parameters like auditory-evoked latencies and hemispheric synchrony (e.g., P1 latencies measured via MEG). Expressive fluency, by contrast, is reflected in generative musical behaviors such as improvisation and emotional expressiveness. This multidimensional conceptualization offers a more differentiated understanding of musical ability, one that takes into account compensatory mechanisms and divergent neurodevelopmental trajectories. From a practical perspective, it highlights the limitations of conventional profiling tools, which often prioritize accuracy and reproduction, and may therefore fail to identify crucial indicators of musical potential – especially in neurodivergent individuals whose strengths emerge most clearly in open-ended, creative contexts.

4. PERSPECTIVES FOR SYSTEMATIC MUSICOLOGY

The Neuro-Auditory Profile offers systematic musicology a novel epistemological lens through which musical ability is reconceptualized as a dynamic interplay of brain-based timing, perceptual precision, expressive fluency, and metacognitive reflection. Through the combined analysis of morphological (HG/PT ratios), functional (MEG latencies), behavioural (MuPAS subscales), and metacognitive (self-assessment) data, musicality can be understood not as a fixed trait but as a multifactorial, developmentally sensitive process.

This reconceptualization carries significant implications for music education. In inclusive pedagogical environments, diagnostic profiles that highlight individual creative strengths – such as improvisational fluency or expressive modulation – can inform personalized instructional design. For example, learners with ADHD who struggle with pitch accuracy may thrive in generative, less structured musical settings, where their auditory-motor integration capacities are better utilized.

Methodologically, the Neuro-Auditory Profile challenges musicology to expand its scope to include neurophysiological measurement techniques (e.g., EEG/MEG), realworld performance assessments (e.g., ratings of a familiarsong singing task and brief improvisations recorded under typical classroom/clinic conditions), and psychometrically grounded coding frameworks such as MuPAS. Incorporating metacognitive measures (selfestimates alongside objective performance) adds a profiling and educational layer consistent with current research on neurodiversity and learning.

5. CONCLUSIONS AND FUTURE DIRECTIONS

5.1 Main findings and current state of the Neuro-Auditory Profile

The present manuscript synthesized a series of empirical studies conducted between 2014 and 2023 to document the development of the Neuro-Auditory Profile as an integrative framework for understanding auditory–musical processing in neurodivergent populations.

Structural and neurofunctional markers of the auditory cortex-hemispheric asymmetries and timing-related parameters-were reliably associated with individual differences in musical, literacy-related, and attentional skills in children with ADHD, ADD, and dyslexia. Notably, these auditory processing characteristics were linked not only to perceptual performance but also to expressive and improvisational musical strengths, highlighting the functional significance of efficient internal auditory timing.

Findings from adolescent and young adult samples further demonstrated systematic dissociations between objective auditory-musical performance and subjective self-evaluation, indicating a distinct metacognitive dimension that complements neurophysiological and behavioural indicators. Taken together, the available evidence supports the Neuro-Auditory Profile as a multimodal, strength-oriented profiling framework that captures heterogeneous auditory–musical processing patterns across developmental stages, rather than reducing neurodivergence to deficit-based classifications.

5.2 Implications and future research directions

While the Neuro-Auditory Profile is empirically grounded in several peer-reviewed studies, future research is required to further refine and extend the framework. This includes the systematic validation of profiling dimensions across larger and more diverse samples, as well as the examination of their developmental stability using longitudinal designs.

Future work integrating neurophysiological, behavioural, and self-report measures within ecologically valid research paradigms may further elucidate how differentiated auditory–musical profiles can inform inclusive approaches in music education and related applied contexts, provided that the strength-oriented character of the framework is preserved

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