

Common Evidence, Multiple Interpretations: Commentaries on a Multilab Study on Musicians' Short-Term Memory

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Rafael Román-Caballero^{1,2,3,4} , Deniz Başkent^{5,6} , Anne Caclin⁷ ,
Laura Ferreri⁸ , Anna Fiveash^{9,10} , Clément François¹¹ ,
Massimo Grassi¹² , Eleanor E. Harding^{5,6,13}, César F. Lima¹⁴,
Katie Overy^{15,16} , Antoni Rodriguez-Fornells^{17,18,19} ,
M. Paula Roncaglia²⁰, E. Glenn Schellenberg^{14,21} ,
L. Robert Slevc²² , Francesca Talamini²³ , Barbara Tillmann⁹ ,
Laurel J. Trainor^{3,4} , and Ana Zappa^{17,18}

¹Department of Experimental Psychology, University of Granada, Granada, Spain; ²Mind, Brain, and Behavior Research Center, University of Granada, Granada, Spain; ³Department of Psychology, Neuroscience, & Behaviour, McMaster University, Hamilton, Ontario, Canada; ⁴McMaster Institute for Music and the Mind, McMaster University, Hamilton, Ontario, Canada; ⁵Department of Otorhinolaryngology, University Medical Center Groningen, University of Groningen, Groningen, Netherlands; ⁶Research School of Behavioural and Cognitive Neuroscience, University of Groningen, Groningen, Netherlands; ⁷Centre de Recherche en Neurosciences, de Lyon Université, Bron, France; ⁸Department of Brain and Behavioral Sciences, University of Pavia, Pavia, Italy; ⁹CNRS, Université Bourgogne Europe, Dijon, France; ¹⁰The MARCS Institute for Brain, Behaviour, and Development, Western Sydney University, Sydney, Australia; ¹¹CNRS Aix-Marseille University, Aix-en-Provence, France; ¹²Department of General Psychology, University of Padua, Padua, Italy; ¹³Center for Language and Cognition, Faculty of Arts, University of Groningen, Groningen, Netherlands; ¹⁴Centro de Investigação e Intervenção Social, Instituto Universitário de Lisboa, Lisbon, Portugal; ¹⁵Reid School of Music, Edinburgh College of Art, University of Edinburgh, Edinburgh, Scotland; ¹⁶Edinburgh Neuroscience, University of Edinburgh, Edinburgh, Scotland; ¹⁷Department of Cognition, Development, and Educational Psychology, Institute of Neurosciences, University of Barcelona, Barcelona, Spain; ¹⁸Cognition and Brain Plasticity Unit, Neuroscience Program, Institut d'Investigació Biomèdica de Bellvitge, L'Hospitalet de Llobregat, Llobregat, Spain; ¹⁹Catalan Institution for Research and Advanced Studies, Barcelona, Spain; ²⁰Tilburg School of Humanities and Digital Sciences, Department of Computational Cognitive Science, Tilburg, Netherlands; ²¹Department of Psychology, University of Toronto Mississauga, Mississauga, Ontario, Canada; ²²Department of Psychology, University of Maryland, College Park, Maryland; and ²³Department of Psychology, University of Innsbruck, Innsbruck, Austria

Abstract

The multilab registered report by Grassi et al. represents the largest collaborative effort to date to estimate differences in short-term memory between musicians and nonmusicians, testing 1,200 participants across 33 units in 15 countries in an a priori registered design that adhered to open-science practices. Beyond providing precise effect-size estimates, the project exposed substantial diversity in how experts interpret the same data set, particularly regarding the causal status and practical significance of musicians' cognitive advantages. Here, we present six independent commentaries, each authored by a subset of researchers of the original team, that articulate these contrasting perspectives. Lima and Schellenberg argue that cross-sectional advantages are best explained by preexisting differences rather than training.

Corresponding Author:

Rafael Román-Caballero, Department of Experimental Psychology, University of Granada, Granada, Spain.
Email: rrrarroca@ugr.es



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Román-Caballero et al. emphasize small but reliable far-transfer effects of musical training on domain-general cognition. Zappa et al. call for greater caution in policy claims about music as a cognitive intervention, and Roncaglia et al. situate musical training alongside other forms of expertise (e.g., chess, physical exercise, bilingualism) as one of several routes to cognitive enhancement. Slevc highlights how coordinated multilab projects can help generate specific and testable predictions in a field that often lacks them, and Grassi and Talamini reflect on the broader methodological value of multilab initiatives for building a more accountable and replicable cognitive science. Together, these commentaries showcase productive theoretical pluralism and outline key directions for future research on musical training, cognition, and large-scale collaborative methods.

Keywords

cognitive abilities, individual differences, memory, multilab, music, musical training, musicians, short-term memory

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The multilab registered report by Grassi et al. (2025) represents the largest effort to date to estimate differences in short-term memory (STM) between musicians and nonmusicians. With data from 1,200 participants across 33 units in 15 countries and guided by a large-scale, transparently documented collaborative workflow, this study contributes key evidence for a long-standing debate: whether musical training is associated with differences in domain-general cognitive abilities and, more controversially, whether such differences are a consequence of training. The study succeeded in coordinating 110 researchers from around the world, all of whom were committed to using the same experimental design and analysis pipeline. An initial team of authors invested substantial effort in carefully specifying and registering a priori the study design, including the selection and operationalization of tasks and measurement tools (e.g., a digit-span task for short-term verbal memory), the identification and control of key control variables (e.g., education, socioeconomic status [SES], and personality), and the choice of the analytical strategy (e.g., stepwise model selection within multilevel regressions). Nevertheless, as the reporting stages of the project unfolded, it became clear that experts in this area hold a variety of different perspectives on the same data.

Given the breadth and at times, contradictory nature of the perspectives of all 110 authors, the discussion exceeded the space and scope available in the main report (Grassi et al., 2025). Consequently, we present here a series of independent commentaries, each articulating the views of a subset of the original authors. Lima and Schellenberg, in their commentary (*What Musicians' Cognitive Advantages Can [and Cannot] Reveal About Causality*), raise the view that the advantages observed in cross-sectional studies likely reflect factors other than training. In contrast, Román-Caballero et al., in *How Far Does Music Go? Tracking Far-Transfer Effects of Musical Training*, contextualize the observed effects within a broader body of evidence that points to potential causal cognitive benefits of musical training. Zappa et al., in

Rethinking the Cognitive Promises of Music Training, emphasize that despite clear positive effects in training-related domains (i.e., auditory and motor skills), inconsistent evidence for general cognitive benefits should lead to caution among policymakers when considering promoting musical training as a cognitive intervention. In *Musical Training: One of Many Routes to Cognitive Enhancement*, Roncaglia et al. present musical training as one activity among many, such as chess, physical exercise, and bilingualism, that may improve domain-general cognitive abilities. Consequently, they caution against assigning music a privileged status in the context of cognitive enhancement or invoking a rhetoric of “superiority” when referring to musicianship. Finally, the last two sections, *What Do Musicians Need to Remember?* by Slevc and *Multilab Research in Cognitive Science: Toward a Sound, Accountable, and Replicable Science* by Grassi and Talamini, highlight the value of initiatives such as the present one for (a) generating specific, operational, and testable predictions that are lacking in the literature (Slevc) and (b) setting a strong foundation for future empirical research (Grassi and Talamini).

The reader should note that each section of this article was written independently and reflects the perspectives of its contributing authors. The inclusion of these commentaries within a single piece does not imply endorsement or agreement across all authors, and the views expressed in each section should be understood as specific to the subset of authors of that section.

What Musicians' Cognitive Advantages Can (and Cannot) Reveal About Causality

**By César F. Lima and
E. Glenn Schellenberg**

Grassi et al. (2025) reported that musicians outperform nonmusicians in STM, based on data from 1,200 participants tested across 33 laboratories. The advantage was large for melodic STM but much smaller for verbal and

visuospatial STM. Musicians also scored higher on music-perception abilities, broader musicality (musical sophistication and musical reward), general cognitive abilities (nonverbal reasoning, vocabulary, updating), and SES. They additionally differed in personality, with particularly high levels of self-reported open-mindedness.

The study's multilab approach (Grassi et al., 2025) combined with open-science practices (registration *a priori* the study design, open data) represent a methodological advance for the field. These practices address persistent problems in the music-training literature, including small sample sizes, insufficient distinction between planned and exploratory analyses, and limited replicability (Schellenberg & Lima, 2024). The value of these practices was recently demonstrated clearly by Whiteford et al. (2025), who showed no association between music training and early subcortical responses to speech in a large multilab sample ($N = 265$), a result that challenges proposals that music training enhances speech processing (e.g., Patel, 2014).

Although researchers routinely acknowledge that correlation does not imply causation, cross-sectional differences between musicians and nonmusicians are often interpreted as training effects implicitly or explicitly (Schellenberg, 2020). Indeed, the proliferation of music-training studies is spurred by the expectation that training enhances nonmusical abilities. This assumption is problematic because the frequent advantages for musicians in cross-sectional studies contrast sharply with the weak and inconsistent findings from longitudinal designs. Meta-analyses of interventions indicate that causal effects of music training on nonmusical abilities are either nonexistent (Sala & Gobet, 2020) or small (Bigand & Tillmann, 2022; Neves et al., 2022; Román-Caballero et al., 2022), suggesting that cross-sectional advantages reflect factors other than training.

The study from Grassi et al. (2025) helps to clarify this issue by demonstrating, in a well-powered context, that musicians and nonmusicians differ in many ways beyond music training. Musicians' higher SES and distinct personalities, for example, likely reflect factors that influenced their engagement with music in the first place and could account for some or all observed advantages in STM and other cognitive measures. Note that the effect size for open-mindedness exceeded that for any nonmusical cognitive task. Even when studies control statistically for these confounding variables, correlational evidence cannot establish causality because unmeasured factors inevitably remain. Genetics, for instance, can influence musical engagement (Wesseldijk et al., 2023) and even account for associations between music practice and cognitive ability (Mosing et al., 2016).

Correlational evidence can, however, reveal when expected causal effects are absent, and Grassi et al.'s (2025) data are informative in this regard. Although the

large advantage for melodic STM is unsurprising, advantages for nonmusical STM were small despite participants having, on average, more than a decade of musical experience. For verbal STM, the effect was not only small but also better explained by other individual differences. Indeed, a reanalysis of the data set that categorized participants into nonmusicians, amateurs, and professional musicians provided clear evidence for no association between verbal STM and music training after controlling for age, education, and SES (Talamini et al., 2026). For visuospatial STM, causal accounts would predict larger advantages among individuals with greater musical experience and engagement, a pattern that was not evident in the reanalysis. Amateur musicians performed similarly to professionals across cognitive tasks and even better on the fluid-intelligence test, replicating a previous large-sample study (Vincenzi et al., 2024).

Two aspects of Grassi et al.'s (2025) analytic approach merit critical attention. First, it would benefit the field to move away from dichotomous comparisons between musicians and nonmusicians because these categories are inherently difficult to define. When the focus is on music training, treating it as a continuous variable is more faithful to the data. Dichotomizing continuous dimensions into end-point groups can alter effect sizes and obscure meaningful variation (Beltran & Tarwater, 2024; Royston et al., 2006; Young, 2016).

Second, the analyses did not test full models including all confounding variables that are relevant theoretically or empirically (SES, cognitive abilities, personality; e.g., Corrigall et al., 2013; Corrigall & Schellenberg, 2015). Instead, Grassi et al. (2025) relied on backward stepwise elimination, a data-driven procedure in which variable inclusion is determined by statistical criteria highly sensitive to random variation. Although all stepwise methods identify a parsimonious model that consists solely of significant predictor variables, the research question was not about how best to explain STM. Rather, it asked first whether musicianship predicts STM and then whether any association could be attributed to potential confounding variables. For verbal STM, the point is theoretical because music training was rendered inconsequential when the model included a smaller set of covariates. For visuospatial STM, however, the reader is left wondering whether music training would continue to be a significant predictor if SES and vocabulary were additionally controlled, particularly because musicians and nonmusicians differed substantially on both variables. For melodic STM, an association with musicianship remained evident after adjusting for multiple covariates, but the finding is uninformative in terms of plasticity and transfer.

Grassi et al. (2025) rightly noted that long-term randomized controlled studies are impractical. Our approach has been to conduct large-sample correlational studies that consider multiple potential confounding variables,

musical ability, outcome variables, and music training measured continuously or on an ordinal scale. Recently, when we ventured into randomly assigning children to 2 years of music training or control conditions, the music group showed greater improvement on an STM task but not on other cognitive tests (Neves et al., 2025). The discrepancy between this training effect and the negligible verbal-STM difference in Grassi et al. may reflect several factors: our use of auditory rather than visual presentation of digits, effects that emerge early in training but dissipate over time, or experimenter bias, given that our STM measure was the only task involving one-to-one contact between child and experimenter.

Looking ahead, multilab and open-science approaches could be extended to longitudinal music-training studies. Such studies are often small and susceptible to reproducibility issues (Schellenberg & Lima, 2024), making them ideal candidates for collaborative, well-powered designs. In the meantime, large cross-sectional data sets like Grassi et al.'s (2025) remain informative, particularly when results are null or inconsistent with causal predictions. Collectively, existing evidence suggests that pre-existing factors provide a parsimonious explanation for most observed associations between music training and general cognitive abilities.

How Far Does Music Go? Tracking Far-Transfer Effects of Musical Training

By Rafael Román-Caballero, Anne Caclin, M. Paula Roncaglia, Laura Ferreri, Laurel J. Trainor, Katie Overy, Deniz Başkent, Eleanor E. Harding, Anna Fiveash, and Barbara Tillmann

Over recent decades, there has been considerable debate about whether musical training and musical activities can enhance domain-general cognitive abilities. Early positive findings (e.g., Schellenberg, 2004) inspired the view that musical training provides an excellent framework for studying brain plasticity and is a potential tool for brain stimulation (e.g., Herholz & Zatorre, 2012; Schlaug, 2015). Subsequent critical perspectives have noted that without rigorous experimental designs and appropriate controls, cross-sectional studies risk conflating preexisting differences with the causal effects of musical training (i.e., *selection bias*; Schellenberg, 2020). Using a well-controlled design accounting for confounding variables, our multilab registered report (Grassi et al., 2025) showed higher STM scores associated with musical training in a large sample of 1,200 participants from 15 countries. Here, we discuss the findings of the study in relation to three key points: (a) that the positive

effects observed for both verbal and visuospatial STM tasks show differences in domain-general cognitive skills that are not directly trained through musical practice, suggesting far transfer; (b) the level of control of confounding variables, which was highly conservative, to the extent that it may have shifted the analyses and interpretation toward a different research question (i.e., *test the specific STM benefits of musical training beyond general improvements in cognition*); and (c) the discussion and interpretation of these findings within the broader context of recent literature on near and far transfer in musical training, whether real-world or experimentally implemented training.

First, the 600 musicians included in the registered report (Grassi et al., 2025) yielded higher scores in STM for melodies (their trained domain) than the 600 nonmusicians, with a large effect size. They also showed small but significant advantages in STM tasks involving materials more distant from their trained domain, such as numbers presented visually (verbal STM) and the spatial location of a dot within a matrix (visuospatial STM). The decision to use numbers presented visually for the verbal STM task (as opposed to a more typical verbal task presented auditorily) was made to avoid a potential confound of an auditory-processing advantage for musicians. However, this is a conservative choice because (a) listening to numbers and holding them in STM is not part of musicians' regular training and (b) replacing the auditory presentation with a visual presentation may reduce the likelihood of detecting far-transfer effects in verbal STM. Even if holding sequences of numbers in auditory memory could be considered a near-transfer benefit (Tierney et al., 2008), it is likely that observed far-transfer benefits might arise, at least partly, from a cascade of near-transfer gains that gradually support seemingly less related skills (Assaneo et al., 2024). These potential cascade effects are difficult to isolate, especially in the context of a multimodal and long-term practice as musical training. The extensive evidence linking musical training with diverse cognitive skills warrants further investigation of these pathways to far transfer.

To further illustrate differences in skills that are somewhat closer to training-related demands, we present here in an additional analysis that keyboard players (including pianists), who represented 46% of the musician sample, displayed a larger visuospatial memory advantage over nonmusicians ($d = 0.59$) than did nonkeyboard players ($d = 0.19$), although both effects and the difference between them were statistically significant (for more details, see <https://osf.io/rukgm/>). From a transfer perspective, visuospatial processing can arguably be considered part of keyboard players' instrumental expertise (although keyboard instruments may not be the only instruments for which this applies), but even for these

instrumentalists, the effect on visuospatial STM was considerably smaller than the effect observed on the musical STM task ($d = 1.08$; vs. pianists' visuospatial STM: $d = 0.59$). Although it might be argued that the outcome of this reanalysis might be inflated because of selection bias (i.e., individuals with higher visuospatial STM skills may be more likely to select and persist in piano training), we note that higher visuospatial STM scores were also evident among musicians of other instrumental specialties (compared with nonmusicians). Although causality cannot be inferred, the results of this rigorously controlled multilab study (Grassi et al., 2025) align with the hypothesis that musical training is associated with large advantages in STM for melodies and small but robust benefits for STM in other modalities (verbal and visuospatial). Similar advantages of small effect size were observed in the multilab study for musicians in other domain-general skills, including executive functions (n -back task), fluid intelligence (Raven's matrices), and crystallized intelligence (Vocabulary from the fourth edition of the Weschler Adult Intelligence Scale). Furthermore, our study revealed that differences between musicians and nonmusicians were considerably larger for melodic and pitch-related abilities than for rhythmic or timing skills ($d \approx 1.50$ vs. $d \approx 0.80$) even though melodic and rhythmic skills are both central to musicians' training. This suggests that the picture is more nuanced than a simple distinction between trained and untrained skills. A key question for future studies, therefore, is whether some cognitive abilities might benefit more directly from musical training than others and how cascading effects of training might unfold.

Second, the advantages of musicians over nonmusicians in musical and visuospatial STM remained after controlling for a broad set of potential confounders, including intelligence, executive functions, openness to experience, and family SES. We want to reflect here on the extent of statistical control used in our study (Grassi et al., 2025) and its theoretical implications. Some sources of selection bias are clearly not modifiable through musical training. For instance, families of young musicians tend to have higher SES, a difference that can be assumed to be preexisting rather than an outcome of musical practice. In this case, the most plausible causal direction runs from SES to the likelihood of engaging in musical training rather than the reverse. However, for other variables, such as general cognitive abilities or personality, the direction of influence could operate in both directions: The differences observed at the time of study could reflect preexisting differences, which could favor engaging in musical training (i.e., selection bias) and/or the long-term benefits of musical training (e.g., Gustavson et al., 2021). After matching participants for sex, age, and education in our multilab study, we further

chose to control for other factors (e.g., family SES, personality, and intelligence) to provide a highly conservative estimate of the STM effects. Yet doing so may also remove part of the far-transfer variance attributable to musical training and more importantly, shift the very question being asked. A simple model testing the direct effect of musical training (*musical training* $\rightarrow$ *STM*) addresses the general question of *whether far transfer occurs* but does not control for potential selection bias in general cognitive or personality variables, if any. By contrast, a model that includes general cognitive skills as a covariate effectively controls for some of the very abilities (or overlapping processes) through which far transfer might manifest. In the latter case, the research question changes to *whether musical training is specifically associated with enhanced STM beyond general improvements in cognition* (Jakobson et al., 2008). Thus, a smaller (although still significant) effect in the covariate-adjusted model should not be interpreted solely as a more unbiased estimate of the difference between musicians and nonmusicians in STM. Rather, it is a trade-off in which part of the effect of far transfer might have been subtracted out. It may also indicate that improvements in memory constitute an independent component of the broader pattern of enhancements associated with musical training beyond general changes in cognition.

Finally, the beneficial effects of musical training observed in correlational studies are in agreement with cognitive far-transfer effects observed in experimentally implemented short-term musical training programs even though most effect sizes are small (e.g., Bigand & Tillmann, 2022; Jamey et al., 2024; Román-Caballero et al., 2022). Given the impracticality of maintaining randomized interventions over extended periods, establishing the causal benefits of long-term musical training is challenging. Long-term randomized interventions often face poor adherence, and assigning participants to a single activity by chance for decades would raise important ethical concerns (Habibi et al., 2018; Tervaniemi et al., 2018). As in other historical scientific debates, such as whether smoking causes cancer (Pearl & Mackenzie, 2018), evidence from nonexperimental designs has been crucial for addressing phenomena that cannot be ethically or practically tested through laboratory manipulation. For musical training, the findings from short-term randomized interventions provide converging evidence with longitudinal twin studies (Gustavson et al., 2021), population-based (Guhn et al., 2020) and epidemiological research (Verghese et al., 2003), and well-controlled cross-sectional approaches (Román-Caballero et al., 2021), all suggesting a small yet reliable far-transfer effect of long-term musical practice on domain-general cognitive abilities. Our registered report (Grassi et al., 2025) adds to this growing body of evidence, suggesting

that musical training is associated with measurable advantages extending beyond the musical domain, including STM across modalities and materials. Rather than framing the investigation as a dichotomy about whether far transfer exists (e.g., Sala & Gobet, 2019), focusing on the magnitude and practical significance of the observed effects makes this research line constructive and informative about the brain's capacity for neural plasticity. The presence of small but consistent domain-general benefits, such as in STM, is theoretically important for investigating the malleability of the brain and the strengths and limits of cognitive plasticity. Although modest in size, the far-transfer effects observed in our multilab study and the various converging evidence from other studies and approaches are far from negligible: They reflect measurable neurocognitive differences that may be especially relevant for developing brains, aging populations, and individuals from disadvantaged socioeconomic backgrounds. Future progress in confirming and extending these findings will rely on large-scale collaborations, such as Grassi et al. (2025), complemented by longitudinal and controlled experimental approaches.

Rethinking the Cognitive Promises of Music Training

By Ana Zappa, Clément François, and Antoni Rodríguez-Fornells

The idea that musical practice can bring cognitive enhancements in areas outside of music processing has long appealed to researchers, educators, and policymakers. Intuitively, it follows that music training might transfer to and potentially boost cognitive domains (e.g., memory, attention, or executive control) and that these benefits potentially extend into academic performance. Indeed, music training has been promoted for decades as a tool for intellectual development (Schellenberg, 2004). Studies have linked music training to enhanced auditory processing, attention, and working memory (Besson et al., 2011). However, much of this literature relies on cross-sectional comparisons (sometimes from studies with small sample sizes) or brief interventions, which cannot distinguish between correlation and causation (and even longitudinal approaches provide only partial control over potential confounding influences). Furthermore, children who demonstrate better musical aptitude and pursue music for several years tend to come from families of higher SES (Swaminathan & Schellenberg, 2018), who value education and provide academic support, which may explain their higher cognitive performance. Evidence for *near transfer*, such as improved auditory discrimination or phonological processing (e.g., the overlap, precision, emotion, repetition, and attention

hypothesis; Patel, 2011), is more consistent than that for *far transfer* (e.g., improvements in general cognitive abilities or executive control), which remains controversial (Bruin et al., 2021).

Moreover, comparisons across studies are often uneven: Longitudinal interventions typically involve limited practice (e.g., about 1 hr per week for 1 to 2 years; Habibi et al., 2018), whereas cross-sectional studies examine professional musicians with thousands of hours of accumulated experience. Such disparities in training intensity, duration, frequency, and experimental design make it difficult to estimate consistent effect sizes or draw firm conclusions about the causal impact of music training. Finally, meta-analyses suggest that there is insufficient or inconsistent evidence of cognitive benefits from music training (Román-Caballero et al., 2022; Sala & Gobet, 2017). In line with our results (Grassi et al., 2025), which show only small or very small effects outside of the music domain—a very small effect for verbal STM (Hedges's $g = 0.16$) and a small effect for visuospatial memory (Hedges's $g = 0.28$)—improvements tend to be confined to closely related perceptual and motor domains rather than general cognitive abilities. Even neuroimaging findings showing structural brain plasticity following music training do not imply that such changes translate into transferable cognitive gains (Habibi et al., 2018). Taken together, the literature calls for a more nuanced interpretation: Music training shapes the brain in a meaningful yet rather domain-specific way.

The crucial issue, then, is not whether musical practice changes the brain—it clearly does—but whether the magnitude and scope of these changes justify the policy and social narratives currently built around them. Despite the small size of the effects, public discourse often celebrates music as a cognitive “booster,” which can influence educational strategies, a view echoed in policy frameworks linking music education to creativity and cognitive development (e.g., European Music Cities Policy Handbook, <https://aec-music.eu>; Steering Committee for the Harmonisation of European Music Education, <https://www.europeanmusicpolicyexchange.eu>). Importantly, the time children spend on music is not spent on other pursuits, such as reading books, playing games, resting, experiencing boredom, or engaging in unstructured exploration. For some, a daily requirement to practice music may help them to develop self-discipline; for others, it may result in frustration or conflict with caregivers. The obligation to practice music can put teachers and caregivers under unnecessary pressure and even dampen the intrinsic pleasure that can be generated by playing music.

Whereas intrinsic pleasure drives many amateur musicians to continue playing throughout their lives, children and adolescents who undergo rigorous musical pedagogy

often abandon music, even after several years of practice (Ruth & Müllensiefen, 2021). Recent evidence suggests that musical aptitudes and musical enjoyment may follow partly dissociable neurobiological and even genetic pathways (Bignardi et al., 2025), indicating that music aptitude and the capacity to derive pleasure from music-related activities may have evolved along different trajectories. This dissociation is usually observed after brain damage in which music anhedonia (the loss of pleasure for music listening) and amusia (loss of music perceptual abilities) are sometimes dissociated (Mas-Herrero et al., 2014; Satoh et al., 2011). This dissociation could explain why strong musical aptitudes do not necessarily predict greater sensitivity to musical reward (although we observed a small correlation; see Grassi et al., 2025, Fig. 4) and why music's educational value may lie less in cognitive transfer than in cultivating and fostering emotional connection through shared musical experiences.

When small or unreliable effects become the basis for educational priorities, one risks overlooking bigger costs or consequences. Policymakers should be cautious about promoting music training as a cognitive intervention when its measurable benefits beyond musical ability remain uncertain, particularly given that evidence of brain or behavioral change does not necessarily equate to meaningful improvements in learning or cognition (see also critiques from the *neuroskepticism* perspective; Raz & Thibault, 2019). Rather than striving to eliminate or control every confounding variable, future research may benefit from embracing the complexity of real-world music learning, acknowledging that factors such as motivation, social context, and access are almost impossible to control for yet integral to understanding its effects. Furthermore, music training should be recognized for what it truly offers: perseverance, collaboration, social bonding, and emotional awareness (Hallam, 2010). Rather than relying on questionable claims of cognitive enhancement, music training should be advocated for its cultural and emotional value. Like other artistic pursuits (i.e., fine arts, dance), music practice is in itself an essential means of human development and communication, which is far more important than possible spillover effects on mathematical or language abilities. Attempts to isolate the purely cognitive benefits of music overlook its emotional, embodied, and social nature. A similar issue arises with music-based interventions, in which efforts to quantify cognitive outcomes often miss powerful motivational and affective mechanisms behind the impact of this rehabilitation approach (Rodríguez-Fornells et al., 2025).

The enduring appeal of music training as a pathway to general cognitive enhancement may reflect not only empirical findings but also a broader positive and at times, elitist bias toward ideas that are intuitively

appealing and socially prestigious. Much like the debate on the “bilingual advantage,” this enthusiasm might simply reflect the desire to believe that enriching cultural experiences—such as learning music or another language—sharpen the mind. Yet current evidence does not justify large-scale educational policies based on such speculative transfer effects. Beyond asking whether music makes people smarter, a more pertinent line of questioning might be whether it makes people more curious, motivated, and socially connected. Although there is still relatively little research on these broader outcomes, shared musical activities have been associated with prosocial behavior in children (Buren et al., 2021; Kirschner & Tomasello, 2010) and increased social bonding in adults (Pearce et al., 2016). The value of music may therefore lie in its broader social and emotional effects, which likely depend on the form of musical education—especially the balance between formal and more inclusive, participatory approaches.

Musical Training: One of Many Routes to Cognitive Enhancement

By M. Paula Roncaglia, Deniz Başkent, and Eleanor E. Harding

Although some studies have reported little or no cognitive benefit to musical training (e.g., Ilari & Habibi, 2023; Sala & Gobet, 2017; see *Rethinking the Cognitive Promises of Music Training* above), other correlational and intervention studies have reported such benefits from musical training as yielding higher scores on cognitive tasks such as spatial reasoning (Rauscher et al., 1993), STM for music, visuospatial stimuli (Grassi et al., 2025), verbal memory (Brandler & Rammsayer, 2003), and full IQ-scale (Moreno et al., 2009; Schellenberg, 2004). When considering these latter studies, musical expertise emerges as a potential tool for enhancing overall cognitive skills. However, musical training is not the only expertise suggested to improve domain-general cognitive abilities. Correlational studies investigating chess players suggest that chess is linked to adults' higher scores on fluid-intelligence tasks (Burgoyne et al., 2016) and older adults' higher indices of cognitive reserve (Lillo-Crespo et al., 2019). Moreover, a recent meta-analysis observed higher scores on measures of cognitive flexibility in young and older-adult elite athletes compared with nonathletes (Logan et al., 2023). Evidence of cognitive benefits of expertise has also been greatly reported by the bilingualism/multilingualism literature (e.g., Adesope et al., 2010; Bialystok, 2009), including training studies (Brouwer et al., 2025). Similarly to what has been reported for these areas of trained expertise, musicianship serves as a boost for cognitive

development in childhood and adolescence (Degé et al., 2011; Moreno et al., 2009; Schellenberg, 2004), presenting a more contained and domain-specific cognitive enhancement during adulthood (Bialystok & DePape, 2009; Brandler & Rammsayer, 2003; Grassi et al., 2025), and works as a protective mechanism against normal cognitive decline later in life (Biasutti & Mangiacotti, 2018; Brouwer et al., 2024; Nijmeijer et al., 2023) and among patients with Alzheimer's (Wolff et al., 2023).

Thus, music should not hold any special status in cognitive enhancement, at least not higher than any other cognitive expertise with comparable effects. However, many studies seem to perpetuate the notion of a cognitively higher status among individuals with musical training in terms of their cognitive benefits by failing to acknowledge their similarity with other trained expertise. In this sense, there seems to be a rhetoric of “superiority” when referring to musicianship. When research is moving to become more interdisciplinary and collaborative (Dalton et al., 2021), this is not desirable; it is rather limiting, and it could even be counterproductive to the music-research field. Using words that connote superiority when referring to musical practice while failing to acknowledge similar enhancements promoted by other trained forms of expertise might, on the one hand, trigger readers to resist positive conclusions, such as the one in Grassi et al. (2025), and on the other hand, implicitly overlook common patterns of effects from expertise in cognition. In this sense, we argue that the benefits of musical training should not present any special status reflected by a superior rhetoric. Rather, the field could benefit from studies discussing musical training in the context of being among other forms of expertise enhancing cognition such that reporting reflects the complex interaction of trained expertise with cognition throughout the life span. This could help to disseminate findings beyond the scope of music cognition to a broader and interdisciplinary audience.

What Do Musicians Need to Remember?

By L. Robert Slevc

Why do musicians outperform nonmusicians on STM tasks? An STM advantage for musical material is unsurprising given other evidence for expertise-specific memory benefits. However, these expertise effects are typically domain-specific (Sala & Gobet, 2017), so it is less obvious why musicians would have an advantage on nonmusical auditory or visuospatial STM tasks.

As noted by the (many) authors of Grassi et al. (2025), this musician/STM relationship might reflect some kind of transfer from musical experience such that the memory demands imposed by extensive musical training and

engagement lead to collateral memory benefits. Alternatively, this relationship may exist because individuals who can better manage the memory demands of musical training are more likely to pursue and succeed in such training.¹ Both of these accounts rest on the same underlying assumption: that something about being a musician is particularly and perhaps uniquely demanding on multiple types of STM.

Unfortunately, this underlying assumption is not typically made very precisely. For example, the target article (Grassi et al., 2025) suggests that STM benefits might emerge because music training involves fine motor actions, fine auditory skills, and multisensory integration. But reliance on fine motor actions, auditory skills, and multisensory integration is hardly unique to musicians; consider athletes, dancers, magicians, or sign-language interpreters. Most real-world skills are complex, rely on multiple perceptual and cognitive abilities, and involve integration across sensory modalities. (In fact, multisensory integration is so ubiquitous that it can be observed in single neurons; Stein & Stanford, 2008.) So what exactly is it about musicianship that is so uniquely demanding on (multiple types of) STM?

As far as I know, there have been no formal analyses of the relative memory (or other cognitive) demands of learning music compared with learning various other things that nonmusicians learn. One might take this lack of theoretical specificity as another example of psychology's “theory crisis” (e.g., Eronen & Bringmann, 2021); however, it is important to remember that formal detailed theories develop within the constraints of relevant reliable data. I suggest that large-scale studies such as Grassi et al. (2025) offer an opportunity to develop and improve hypotheses and theories. That is, these data offer a valuable opportunity for hypothesis *generation* (not just for hypothesis testing; cf. Lavelle, 2024). More specifically, Grassi et al. pointed out that different subgroups of musicians can have very different experiences (e.g., singers vs. instrumentalists vs. conductors, players of fixed- vs. variable-pitch instrumentalists, improvisational vs. nonimprovisational, conservatory vs. street training, *inter alia*). Such group differences can motivate better and more specific theories.

For example, if researchers observe larger advantages in visuospatial STM for sight-reading instrumentalists compared with, say, vocalists who do not typically sight-read, that might inspire hypotheses about key memory demands of short-term integration of the spatial organization of musical notation into the appropriate motor actions to produce the intended sounds. One might then expand this idea to consider how musicians' tendencies to rely on more expansive versus more technical approaches to learning/performing musical scores (Reid, 2001) might impose different demands on (and thus lead

to different relationships with) aspects of STM. Or if researchers observe that visuospatial STM advantages are especially pronounced for musicians who train/perform in group settings and who focus on multipart music, that could inspire hypotheses about the demands of representing and coordinating one's role among multiple auditory streams. Or researchers might even notice particularly strong visuospatial STM advantages among musicians who specialize in different playing techniques, which could motivate hypotheses about the translation of visuospatial timbral metaphors (e.g., brightness) into the nuances of production.

These examples are underdeveloped and perhaps even a bit silly. However, rich data sets like that in Grassi et al. (2025) combined with insights from work on musical education and expertise (see e.g., Hallam & Bautista, 2018) give valuable tools to develop formal hypotheses about the *specific* STM (and other) demands involved in developing musical expertise. More specific theories will also allow the field to move beyond course groupings of “musicians” and “nonmusicians” (especially because it is unclear exactly what it means to be a “nonmusician”; Ilari & Habibi, 2023) and instead leverage the wide variety in individuals' musical experiences both within and across musical traditions.

Of course, none of this addresses the question of whether musician advantages in STM *result from* musical training, but I believe that understanding the underlying (unique?) demands of musical training not only will lead to a better understanding of music training and musical expertise but also is a prerequisite for good experimental studies of potential transfer. The Grassi et al. (2025) study offers an opportunity to make real progress: It is a rich data set that can help generate more precise hypotheses and constrain theories of exactly how, when, and why musical training relies on nonmusical cognitive abilities, such as STM.

Multilab Research in Cognitive Science: Toward a Sound, Accountable, and Replicable Science

***By Massimo Grassi and Francesca
Talamini***

It has been a long time that research in psychology and neuroscience has been trying to understand whether excelling in certain domains may reverberate beneficial effects in other domains. The so-called far transfer postulates this: that constantly practicing a particular activity (e.g., music) may reverberate positive and beneficial effects in distant abilities, such as general cognitive abilities. We anticipate here that this large effort (Grassi et al., 2025) that we had the honor and the privilege to coordinate

unfortunately will not provide a final answer to this debate. Nonetheless, we take this chance to comment on the article and discuss what we think is a “no way back” in the literature: a new standard that, we hope, will be able to give better answers to this and similar important questions of psychology and neuroscience.

It is now more than a century that psychology and neuroscience have investigated the possible effects of music training on cognition via classic, individual, single-laboratory experiments. Like in many subfields of psychology and neuroscience, the debate seems now stuck, with scientists debating different (and often contrasting) results. When results contrast, researchers often blame the differences in methods and protocols, which may hold the origin of the inconsistencies. In psychology and neuroscience of music (but more generally, in laboratory experiments with human participants), there is yet another issue that undermines the accountability of individual studies: small samples. Expert musicians are difficult to find. It is difficult to find people who have played a musical instrument for years; who have practiced that same instrument regularly; who have received proper, formal training in music; and so on. The net result is that scientists are trying to tackle subtle and nuanced phenomena with research protocols that often have no shared consensus and experiments that are often too small to capture such nuanced effects. Heterogeneity in research protocols, small samples, and the addition of a lack of a proper, operational theory and/or hypothesis (Guest & Martin, 2021) have driven the literature into a quicksand stop, from which even meta-analyses on the very same data have not been able to pull it out (e.g., Sala & Gobet, 2020; Bigand and Tillmann, 2022).

The Music Ensemble project (this is the collective name that we adopted when developing this multilab) emerged as the first attempt to respond to this long-standing fragmentation. Multilab collaborations have become increasingly important in psychology and neuroscience. Multilabs address several structural weaknesses of traditional single-lab studies. They offer the statistical power needed to detect small and subtle phenomena. When comparing musicians and nonmusicians in nonmusical tasks, adequate power is essential not only for detecting effects but also for producing precise estimates of their magnitude and providing a picture of the multifactorial complexity behind the phenomenon. For example, large samples provide a clearer representation of the population from which they are drawn. In addition, multilabs enforce a shared protocol. In Grassi et al. (2025), like in similar projects, laboratories adopted the same procedures, identical behavioral tasks, a common set of explicit inclusion and exclusion criteria for selecting the participants, and so on. Although adopted

methods and protocols are far from being perfect (and perhaps do not fully satisfy many of the scientists working in the field, including many of the authors of the article), they force authors to sign (together) a lowest common denominator: It may not be the best protocol, but it is definitely a point to start from and from which researchers can build on.

Beyond its empirical results, the project offers a concrete illustration that science is a social enterprise. The consortium was built through successive steps, integrating at various stages scientists and data-collection units, including two additional units from New York and Buenos Aires that joined the collaboration later and contributed to the second publication related to this project (see Talamini et al., 2026). We were surprised by the number of expressions of interest we received when we contacted colleagues to set the protocol and later, when we contacted further colleagues to collect the data and work together on the discussion of the results. Many contributed along the way by providing help and feedback during the whole process, quality feedback that simply cannot exist in single-lab studies. One among many is the Minnesota listener who noticed the error in Block 2 of the melody span test, an error that developers could never spot after the ear-anesthetizing effect of hours and hours of listening and testing. Errors are common even in the most rigorous scientific practice, and most of these go undetected. Having multiple researchers go through the same protocol and test the materials has the further benefit of minimizing the risk of errors.

A central strength of multilab research lies in its commitment to shared procedures. All participating sites used the same preregistered protocol. This standardization produced a data set that is unusually coherent for the field: Procedures were transparent, materials were openly shared, and the resulting measurements could be compared directly across laboratories. Adopting a shared standard limits flexibility and makes results less dependent on idiosyncratic methodological choices, a substantial improvement over the traditional landscape of heterogeneous, individual studies.

At the same time, standardization has inherent limits and reveals weaknesses. The shared definitions of “musician” and “nonmusician,” although carefully discussed, remain an approximation that should be possibly reconsidered by the literature. Something that emerged clearly from the results of our multilab (Grassi et al., 2025) is that musical expertise is a multidimensional construct. Similar concerns apply to constructs such as working memory, executive function, or intelligence, which were investigated independently and found partially overlapping, although perhaps this is something researchers have been walking around for more than a century (Spearman, 1961).

Recognizing these limitations is essential. Multilabs can reduce researcher degrees of freedom and increase the reliability of measurements, but they cannot, on their own, resolve issues of construct validity or theoretical vagueness. The “same protocol” does not guarantee that researchers are measuring the “same construct” in all its complexity. Rather, multilabs highlight the need for more precise theoretical models capable of generating specific, operational, testable predictions.

In this sense, one of the most striking outcomes of the Music Ensemble project is that even when researchers examine the same data set, they often arrive at different interpretations. This divergence is not a failure of the multilab model; rather, it reflects long-standing tensions in the field and a lack of robust theories. Researchers bring their own theoretical commitments and, inevitably, their own opinions. Some interpret cognitive differences between musicians and nonmusicians as evidence of training-induced plasticity, whereas others emphasize preexisting individual differences, self-selection, or sociocultural factors. The same empirical patterns can therefore be read as supporting different causal narratives.

The field continues to lack robust theoretical frameworks capable of explaining the correlates and effects of expertise in cognitive science and neuroscience. Predictions are often broad and rarely operationalize how and to what extent musical training may interact with perceptual and cognitive processes. Without precise predictions, even high-quality evidence remains theoretically underconstrained: Small effect sizes can be interpreted as meaningful or negligible, and null results can be framed as informative or inconclusive (e.g., Anvari & Lakens, 2021). Multilab studies make this situation visible. By producing precise effect-size estimates, they limit interpretative flexibility but cannot eliminate it. Instead, they reveal areas in which theory is insufficiently articulated to guide the interpretation of robust data.

Although multilabs are often celebrated for their methodological rigor, their broader value extends well beyond statistical power and standardization. One advantage is the efficient use of resources. The Music Ensemble project was sustained through many small local contributions, each supporting modest but coordinated data collection. This distributed model lowers financial barriers and makes ambitious studies feasible without substantial central funding. Multilabs also promote inclusion. They create opportunities for small or underresourced laboratories to participate in high-impact research and offer meaningful roles to early career researchers, from experimenters to data managers. Transparency is another built-in feature. Shared repositories, experimenter manuals, openly posted protocols, and the public release of data make the entire research process visible, inspectable, and immediately reproducible. This openness supports

replication and enhances trust: Participants, institutions, and the public can see how data were collected, processed, and interpreted. For these reasons, multilabs contribute to a science that is not only robust but also socially accountable.

To conclude, the Music Ensemble project not only provides robust and unprecedented data but also demonstrates how open science and large-scale collaboration can serve as a model for future scientific practice. The project was able to provide a rich, multisite data set that offers a strong foundation for future empirical investigations and the development of more solid theoretical frameworks. At the same time, it makes clear that collaboration across laboratories, although invaluable, cannot by itself resolve underlying theoretical limitations in a field. From a practical standpoint, multilab studies do not come without challenges: They demand years of sustained collective effort; teamwork; continuous problem-solving, often in response to unforeseen challenges; and a careful balance between methodological rigor and flexibility in managing individual laboratories' issues, needs, and requests. Despite these challenges, we believe that for many domains that rely on laboratory-based research, such collaborative, open-science initiatives represent a necessary and forward-looking model for the future of science. Last but not least, we do hope this will be the first of many similar collaborations in the field.

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Action Editor: Katie Corker

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Author Contributions

Rafael Román-Caballero: Conceptualization; Writing – original draft; Writing – review & editing.

Deniz Başkent: Writing – original draft; Writing – review & editing.

Anne Caclin: Writing – review & editing.

Laura Ferreri: Writing – review & editing.

Anna Fiveash: Writing – review & editing.

Clément François: Writing – original draft; Writing – review & editing.

Massimo Grassi: Conceptualization; Writing – original draft; Writing – review & editing.

Eleanor E. Harding: Writing – review & editing.

César F. Lima: Writing – original draft; Writing – review & editing.

Katie Overy: Writing – review & editing.

Antoni Rodríguez-Fornells: Writing – original draft; Writing – review & editing.

M. Paula Roncaglia: Writing – original draft; Writing – review & editing.

E. Glenn Schellenberg: Writing – original draft; Writing – review & editing.

L. Robert Slevc: Writing – original draft; Writing – review & editing.

Francesca Talamini: Conceptualization; Writing – original draft; Writing – review & editing.

Barbara Tillmann: Conceptualization; Writing – review & editing.

Laurel J. Trainor: Conceptualization; Writing – review & editing.

Ana Zappa: Writing – original draft; Writing – review & editing.

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ORCID iDs

Rafael Román-Caballero  <https://orcid.org/0000-0003-0943-6217>

Deniz Başkent  <https://orcid.org/0000-0002-6560-1451>

Anne Caclin  <https://orcid.org/0000-0003-1367-5923>

Laura Ferreri  <https://orcid.org/0000-0002-6143-1467>

Anna Fiveash  <https://orcid.org/0000-0002-5760-7490>

Clément François  <https://orcid.org/0000-0003-2271-6942>

Massimo Grassi  <https://orcid.org/0000-0002-3784-2784>

Katie Overy  <https://orcid.org/0000-0002-7271-8439>

Antoni Rodríguez-Fornells  <https://orcid.org/0000-0002-3249-6931>

E. Glenn Schellenberg  <https://orcid.org/0000-0003-3681-6020>

L. Robert Slevc  <https://orcid.org/0000-0002-5183-6786>

Francesca Talamini  <https://orcid.org/0000-0001-6083-0282>

Barbara Tillmann  <https://orcid.org/0000-0001-9676-5822>

Laurel J. Trainor  <https://orcid.org/0000-0003-3397-2079>

Note

1. Grassi et al. (2025) also noted another possibility: that these relationships reflect an underlying third factor, such as fluid intelligence, executive functioning, or amount of formal education. For my current purposes, I will assume the relationship does, in fact, involve STM itself.

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