

Metacognition in Marching Musicians: Self-Monitoring, Error Correction, and Cognitive Regulation During Performance

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ABSTRACT: Metacognition, which is the ability to monitor and regulate one's own thinking, has been examined in depth across academic and athletic settings. However, its role in ensemble music has attracted comparatively little attention. This gap is most apparent in research on marching band, an environment that asks musicians to execute memorized repertoire while navigating choreographed movement, maintaining continuous spatial coordination with dozens of fellow performers, and managing the psychological demands of outdoor competitive performance—all without sheet music or a fixed position on the field.

Metacognitive processes sit at the center of what makes marching performance work, and not at the edges of it. The paper draws on research in music cognition, performance psychology, and self-regulated learning to focus on three interconnected processes: self-monitoring, error correction, and cognitive regulation. In a marching context, self-monitoring isn't a single thing, as it splits into two streams running at once, one turned inward on your own playing and movement, the other tracking where you are in relation to the people around you. Error correction is its own challenge entirely; unlike in a rehearsal room, you can't stop, reset, and try again. Mistakes must be quietly absorbed mid-performance, fixed without anyone noticing, and without throwing off the performers on either side of you. And managing attention and anxiety through twenty-plus minutes of competitive performance turns out to shape outcomes just as much as whether you've technically mastered the show.

To organize these processes and their interactions, this paper introduces the Integrated Metacognitive Regulation Framework (IMRF), a three-layer model comprising sensorimotor monitoring, ensemble coherence monitoring, and cognitive-emotional regulation. These layers operate concurrently and shape one another: a lapse at the sensorimotor level immediately places demand on ensemble coherence, while strong emotional regulation enables cleaner monitoring across both. Beyond its theoretical aims, the framework is offered as a practical tool for music educators working to develop more reflective, adaptable performers. Marching band, often overlooked in the broader cognitive science literature, turns out to be a particularly useful context for studying how people regulate complex, embodied performance under real competitive pressure.

KEYWORDS: metacognition, marching band, self-monitoring, cognitive regulation, music performance, embodied cognition, self-regulated learning

I. INTRODUCTION

Cognition is what lets us make sense of the world and act in it. Metacognition is stranger and more useful: it's the capacity to watch your own thinking from the inside, to notice what you're doing mentally and redirect it. Flavell (1979) called it the awareness and regulation of one's cognitive processes, which sounds dry, but covers something real. It includes what people know about how they think (declarative knowledge) and the active, moment-to-moment control they exert over their strategies during a task (Brown, 1987). When metacognition shows up in learning research, it usually goes by another name: self-regulated learning, meaning the ability to plan, check, and evaluate your own performance without waiting to be told how you're doing (Zimmerman, 2002).

Music researchers have studied this mostly through the lens of individual practice. How does a student set goals? How does she notice a mistake and decide what to do about it? McPherson (2005) has done important work here. But solo practice is a controlled, private situation, as you can stop whenever you want, restart, take your time. Ensemble performance is not that. You're regulating your own playing while staying locked in with other people, while moving your body, while the acoustic environment shifts around you. The cognitive demands aren't just greater; they're structurally different.

Marching band is probably the most extreme version of this. The music is memorized. The drill is memorized. You must hold your position relative to dozens of other moving people, read visual cues, account for wind and uneven turf and crowd noise, and do all of it without ever glancing down at a page or planting your feet somewhere fixed. Most ensemble musicians have a music stand and a chair. Marching musicians have

neither. Whether that makes it more interesting to study than other ensemble contexts are debatable, but it does make the cognitive demands unusually visible.

Three processes matter most to how performers manage all of this: self-monitoring, error correction, and cognitive regulation. The rest of the paper examines each in turn, then brings them together in the Integrated Metacognitive Regulation Framework (IMRF), which treats the three as interdependent layers rather than separate skills.

None of this would surprise a good marching director. The musicians who improve fastest don't just run the show again. They also notice what went wrong, figure out why, and change something (McPherson, 2005). Ericsson et al. (1993) built a career on the argument that this kind of deliberate, self-aware practice is what expert development consists of, not just a habit that accompanies it. Marching band makes that argument concrete. When you're expected to be precise, synchronized, and adaptable all at once, the ability to monitor and regulate your own performance in real time isn't a refinement, it's what the whole thing runs on.

II. SELF-MONITORING IN MARCHING MUSICIANS

Self-monitoring, in its simplest form, is the ability to observe what you're doing while you're doing it and adjust in real time. For marching musicians, this runs on at least two tracks simultaneously. One is directed inward, with tracking tone, intonation, rhythm, posture, step size, while the other points outward, toward one's spatial and sonic relationship to the surrounding ensemble. This distinction is important because it reveals that self-monitoring in marching contexts is fundamentally relational, and that one cannot evaluate one's own performance in isolation from the group.

Inward monitoring involves tracking tone quality, intonation, rhythmic accuracy, dynamic control, and physical execution including posture, step size, and instrument carriage. Outward monitoring involves evaluating spatial alignment with adjacent performers, matching tempo and articulation to the ensemble, and reading cues from drum majors or section leaders. A performer, strong in one dimension but weak in the other runs into predictable problems, technically clean music paired with visible drift, or precise formation work paired with flat, inattentive playing. Strong marching performance asks for both, running concurrently. Elite marching performance requires the integration of both.

Brennan's (2018) work on collegiate marching bands supports this picture, characterizing marching performance as an embodied, collective activity in which individual monitoring is continuously intertwined with responsiveness to others. In outdoor settings, especially where sound disperses quickly and performers can't rely on acoustic feedback the way they can in a concert hall visual coordination becomes the primary vehicle for ensemble alignment, and distributed awareness a practical necessity. Self-monitoring in this context is not merely an individual cognitive act but a distributed, socially embedded one.

This dual-stream nature of self-monitoring in marching band also illuminates an important tension identified in performance psychology: the relationship between automaticity and deliberate attention. In expert musicians, many technical skills become procedurally automated through extended practice, freeing metacognitive resources for higher-order adjustment (Ericsson et al., 1993). An experienced performer no longer consciously manages breath support or foot placement, those processes become automatic, freeing attention for higher-level concerns like ensemble coherence and musical shaping. A newer performer doesn't have that luxury; basic execution pulls at cognitive resources that can't then go toward watching the ensemble. How self-monitoring develops across experience levels has real implications for how directors structure instruction, especially when working with mixed-experience sections.

III. ERROR CORRECTION AND ADAPTIVE PERFORMANCE

Error correction follows naturally from self-monitoring: you can't fix what you haven't noticed. In marching band, the errors themselves vary a lot: you might be beat off, playing sharp, drifting out of your slot, or suddenly blank on what comes next. Each one calls for something different, and the window for fixing any of them is narrow in a way that doesn't apply to rehearsal. In the practice room you can stop. On the field you cannot.

That constraint changes what correction looks like. A musician who's gotten ahead of the ensemble by a beat can't just pause, as they must stretch something out, delay an attack, bleed back into the group without anyone noticing. A performer who's drifted half a step left must ease back over several counts; a sudden sideways lurch would break the visual form for everyone nearby. These are small, fast decisions made while moving, while playing, while probably a little out of breath. They're not the same cognitive act as sitting in a practice room and deciding to try the passage again from the top.

There's also a slower version of error correction that happens after the fact. Performers, individually or as a section, go back and try to figure out what went wrong and why. Zimmerman (2002) calls this the self-reflection phase of self-regulated learning, and it's where a lot of real improvement happens, especially when the

approach is diagnostic rather than just self-critical. A performer who replays a recurring intonation issue and asks *why it keeps happening* gets more out of that reflection than one who just registers that it was bad. Same goes at the section level, where identifying that a particular transition keeps breaking down is useful; understanding the cause is what fixes it.

Ericsson et al. (1993) made a version of this argument about expert practice generally. The performers who improve aren't the ones who log the most repetitions, they're the ones who practice in ways that target specific problems and use feedback to guide each attempt. In marching band that might mean isolating a difficult eight-count and drilling it separately before putting it back in context or watching video to catch a drift that was invisible from inside the ensemble. The metacognitive skill involved knowing what to work on and how isn't glamorous, but it's probably more responsible for improvement than most people give it credit for.

IV. COGNITIVE REGULATION IN PERFORMANCE ENVIRONMENTS

Cognitive regulation covers a cluster of related skills such as directing attention, managing emotional responses, and distributing mental effort across the competing demands of performance. Marching band is an environment where places sustained demands on all three. Performers contend with physical exertion from continuous movement, performance anxiety generated by competition or audience presence, and external distractors including crowd noise, weather, and the visual complexity of an outdoor performance field. The ability to regulate cognition in this environment is not a peripheral performance skill, but a core one.

Attentional regulation in marching musicians involves actively directing focus toward performance-relevant cues (ensemble alignment, musical pulse, physical form) while suppressing attention to irrelevant stimuli. This selective attention is itself a metacognitive act: performers must not only attend to the right things but know what the right things are and monitor whether their attention has drifted. In high-stakes competitive contexts, this can be especially challenging, as the salience of the crowd or the awareness of judges can redirect attention in ways that degrade performance.

Beilock and Carr (2001) document one of the more counterintuitive threats to performance under pressure: "choking," in which a performer begins consciously attending to movements that have become automatic, and in doing so destabilizes them. A marching musician who has fully internalized a drill sequence can, under competitive pressure, start monitoring each individual step and that shift in attention is often enough to break the fluency of a passage that ran cleanly in rehearsal (Beilock & Carr, 2001). Metacognitive regulation guards against this by helping performers recognize when attention has become counterproductively self-focused and redirect it outward toward ensemble coordination or musical expression. This is not a passive process; it requires active meta-awareness of one's own attentional state.

Emotional regulation is equally important. Performance anxiety in marching band has a particular texture. It runs longer than in most concert settings, unfolds during sustained physical exertion that heightens physiological arousal, and plays out in full view of other ensemble members, meaning that one performer's visible distress can ripple through a section. Performers who learn to recognize early signs of anxiety, question their significance, and redirect attention toward something actionable tend to hold up better under competition pressure. This is a trainable skill, not a fixed trait, and one that music education has historically underemphasized relative to technical preparation.

V. AN INTEGRATED METACOGNITIVE REGULATION FRAMEWORK FOR MARCHING MUSICIANS

The three processes above don't operate independently and treating them as separate phenomena only goes so far. In practice, they bleed into each other constantly. This paper proposes the Integrated Metacognitive Regulation Framework (IMRF) as a way of accounting for how self-monitoring, error correction, and cognitive regulation function together in marching musicians not as discrete mechanisms but as a single, mutually dependent system.

The IMRF identifies three layers of metacognitive activity. The first, Sensorimotor Monitoring, deals with how performers track their own execution; intonation, rhythm, body position, much of which becomes automatic through sustained practice. That automaticity isn't incidental; it's what makes the rest of the framework possible, because it frees attention for demands that can't be automated. The second layer, Ensemble Coherence, is what makes marching performance categorically different from practicing alone: performers must simultaneously monitor their sonic and spatial relationship with everyone around them and correct for drift in real time. The third, Cognitive-Emotional Regulation, is harder to localize, it's less a distinct layer than a condition that runs through the other two, determining how well form of monitoring holds up when performance pressure spikes.

What the framework tries to capture is how quickly a problem in one layer becomes a problem everywhere. A single memory lapse doesn't just disrupt individual execution; it creates a resynchronization

demand for the ensemble and, often, an anxiety response that narrows attention at exactly the wrong moment. Strong emotional regulation works the same way in reverse: it keeps sensorimotor monitoring from collapsing under pressure. These aren't parallel processes that occasionally interact. They're tangled up in each other, and the IMRF is an attempt to describe that entanglement systematically.

Table 1.

The Integrated Metacognitive Regulation Framework (IMRF) for Marching Musicians

Layer	Core Function	Illustrative Example
Sensorimotor Monitoring	Tracking own musical and physical execution; leveraging automaticity to free attentional resources	Monitoring intonation and step size without consciously attending to each breath or footfall
Ensemble Coherence	Outward monitoring of spatial and sonic alignment with the group; real-time error correction	Detecting a half-step drift from formation and gradually correcting over several counts without disrupting neighbors
Cognitive-Emotional Regulation	Managing attention, arousal, and anxiety to sustain performance quality across the other two layers	Recognizing attention has shifted to audience response and redirecting focus to ensemble pulse and alignment

This framework contributes to literature in several ways. Conceptually, it situates marching band within the broader literature on embodied cognition by demonstrating that metacognitive regulation in this context is not purely intrapsychic but is distributed across the performer-body-environment-ensemble system. Practically, it provides a vocabulary for educators and performers to identify and develop specific metacognitive capacities, rather than treating metacognition as a unitary, undifferentiated skill. Empirically, it offers a testable structure for future research investigating how the three layers develop across experience levels, how they interact under varying performance conditions, and whether targeted pedagogical interventions can strengthen specific layers independently.

VI. IMPLICATIONS FOR MUSIC EDUCATION

The IMRF has practical consequences for how directors teach, and the most important one is also the most uncomfortable: current marching band pedagogy largely ignores one of the three layers. Technical execution and positional precision get rehearsed obsessively. The cognitive-emotional side, meaning how performers manage attention and anxiety when it counts, gets almost no deliberate instruction. That's a gap worth closing.

The most straightforward place to start is diagnosis. Most ensembles run on a feedback loop where the director spots errors and performers correct them. That works, but it also means performers never develop the habit of finding problems themselves. Recording and reviewing one's own performances, with enough structure that performers are annotating what went wrong and why, builds that habit (McPherson, 2005). The key is to do it early, well before competition season, so it's automatic by the time the pressure arrives.

Ensemble monitoring is harder to train deliberately, but it can be done. Pulling auditory feedback out of rehearsal, in-ear metronomes only and no drum corps, forces performers to navigate by visual cues instead of sonic ones. That's a different skill, and one that usually goes undeveloped. Intentional error drills work similarly: have a section drift on purpose, then recover. It sounds almost too simple, but it rehearses exactly what live performance demands, in a context where the mistake doesn't cost anything.

The anxiety piece is where most rehearsal culture has the furthest to go. Beilock and Carr's (2001) research on choking points to something directors rarely address head-on: the problem usually isn't that performers forget how to play under pressure, it's that they start monitoring their own execution too consciously and the automaticity falls apart. Teaching performers to notice when that's happening, and to have a strategy for it, is a legitimate pedagogical goal, not a psychological indulgence.

Zimmerman (2002) would frame all this as developing self-regulated learners, which is accurate but also somewhat bloodless. The more direct version is that directors who teach performers to diagnose their own errors, monitor the ensemble without sonic anchors, and manage their attention under pressure are building something that outlasts any competitive season. Those capacities don't stay in the activity.

VII. CONCLUSION

Metacognition isn't incidental to marching band performance. Given what the activity demands, coordinating movement and music from memory in front of thousands of people while staying spatially locked to fifty other performers, it's closer to the core of what makes performance possible at all. This paper argued that metacognitive regulation in this context is as consequential as technical skill, and proposed the IMRF as a way of describing how it works: three layers, sensorimotor monitoring, ensemble coherence, and cognitive-emotional regulation, operating simultaneously and shaping each other continuously rather than firing in sequence.

The argument has implications beyond rehearsal design. Marching band is, somewhat unexpectedly, a rich environment for studying embodied metacognition under real pressure. That combination is hard to manufacture in a lab, which is part of why this domain has received less research attention than it deserves. There are genuine empirical questions here worth pursuing: how the three layers develop as performers move from novice to expert, whether targeted training on one-layer transfers to the others, how ensemble-level metacognitive norms form and shift across a competitive season. These aren't niche questions. They sit at the intersection of music cognition, performance psychology, and educational neuroscience, and the answers would matter beyond the marching context.

What draws all this together is a basic observation: performing well under pressure is a skill, and like other skills it can be taught, practiced, and studied. Marching band, for all the ways it gets treated as extracurricular, turns out to be a serious site for understanding how that skill works.

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