The Perfect Wrong Note: Vyping and the Keyboard as Musical Interface for Human-LLM Interaction

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Abstract

Human interaction with large language models (LLMs) is commonly framed as information exchange, optimized for efficiency and correctness. This paper proposes a different framing: keyboard-as-instrument, where typing to an LLM becomes a form of musical practice. Drawing on the lineage of keyboard instruments, the action–sound framework, and the aesthetics of failure in jazz improvisation and glitch music, the paper introduces *vyping* (typing without looking) as a technique that treats degraded input as an expressive gesture. When a person vypes, inter-onset intervals and keystroke dynamics carry embodied information that the LLM can integrate, in a process closer to musical comping (responsive accompaniment) than to improvisation proper. Three artifacts (ll00mtube, clix-vibe, and KeyMeter) illustrate this approach, making the temporal and sonic dimensions of typing visible and audible. The paper argues that typos can function as grace notes: productive deviations that open new directions. It proposes *reverence* (nuance, grace, and respect) as a design orientation for human-AI interaction, while acknowledging the discomfort of caring for a tool entangled with extractive labor and concentrated corporate power.

CCS Concepts

• **Human-centered computing → Interaction techniques**; *Text input*; • **Computing methodologies → Sound and music computing**.

Keywords

keyboard interface, human–LLM interaction, improvisation, error aesthetics, action–sound, glitch, keystroke dynamics, embodied interaction

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1 Introduction

The keyboard has a long history as a musical instrument. From the harpsichord's direct, mechanical action to the piano's hammer-and-string coupling, keyboard interfaces have supported embodied musical expression. The computer keyboard inherits aspects of this lineage. Yet in the context of large language model (LLM) interaction, the keyboard is often treated as a purely informational conduit, optimized for efficiency and correctness. The temporal, rhythmic, and gestural dimensions of typing recede into the background.

This paper proposes a different framing: *keyboard-as-instrument*, where human-LLM interaction takes on qualities of musical practice. Prior NIME work has explored the computer keyboard musically; for example, Nash added sensors for velocity control [20], and Waite treated typed text as real-time performance input [24]. Where these projects sought to *add* expressivity to keyboards through augmentation, the present paper argues that expressivity is already present in the temporal and rhythmic dimensions of ordinary typing, and that attending to it can reshape how human–LLM interaction is understood.

The paper introduces *vyping* (typing without looking at the keyboard or screen) as a technique that embraces degraded input. When visual feedback is removed, typos proliferate, rhythm becomes irregular, and the body's presence in the text becomes more legible. These deviations are failures in one sense, but they are also deeply human, reflecting human emotion and expressivity. In music performance, and particularly in improvisatory styles, wrong notes or imperfect timing are inevitable and are often treated as material to be integrated and developed. As such, what could be seen as an error could instead be thought of as *grace notes* that fuel performance creativity.

The contributions of this paper are threefold. First, the computer keyboard is situated within a historical and theoretical framework drawing on action–sound theory [12], improvisation theory [3, 21], and glitch aesthetics [4]. Second, three artifacts that explore the keyboard as an instrument are presented: ll00mtube, clix-vibe, and KeyMeter. Third, the paper proposes *reverence* (nuance, grace, and respect) as a design orientation for human–AI interaction, while acknowledging the difficulty of caring for a tool whose material conditions are troubling.

2 Background

2.1 Keyboard Lineage

The keyboard interface has a rich musical history. The harpsichord (from the 15th century) established the basic layout; the pianoforte (from the 18th century) introduced velocity sensitivity and continuous dynamics. The typewriter (from the 19th century) borrowed the spring-like design and adapted it for text, a design that has continued in the computer keyboard. Recent NIME work has explored this continuity: Hamilton et al. [9] augmented a historical harpsichord replica with haptic feedback, McPherson and Kim [19] augmented an acoustic piano with electromagnetic string actuation; and McPherson's TouchKeys [18] added continuous position sensing to piano keys.

The computer keyboard occupies an unusual position in this lineage: it keeps the spatial layout of musical keyboards but trades velocity sensitivity for temporal resolution. Keys are often described as binary (on/off), though in practice, they have travel,

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bounce, and timing characteristics that vary across hardware. Modern keyboards report keystrokes with millisecond precision, enabling measurement of inter-onset-intervals (IOIs), hold times, and flight times, the same parameters used in keystroke dynamics research for biometric authentication [23]. This temporal granularity connects the computer keyboard, perhaps unexpectedly, to the expressive dimensions of its musical ancestors. Magnusson [16] has argued that musical instruments function as epistemic tools, cognitive extensions that shape what the player can think; the computer keyboard, read through this lens, is an epistemic tool whose cognitive affordances remain underexplored [17].

2.2 Action–Sound Framework

The theoretical lens for this connection comes from the action–sound taxonomy developed by Jensenius [12], building on earlier work on musical gestures [13], which provides a framework for understanding music-related body motion. The taxonomy distinguishes between sound-producing and sound-facilitating actions, sound-accompanying and communicative gestures, and further categorizes sound-producing actions as *impulsive* (single strike), *sustained* (continuous), or *iterative* (repeated/rhythmic). Typing is predominantly iterative: a stream of tightly connected impulsive keystrokes with expressive timing.

The action–sound framework also distinguishes *action–sound couplings* (physical/acoustic relationships) from *action–sound mappings* (designed/digital relationships). The keyboard–LLM relationship presented in this work is clearly a mapping. But vyping, as described in Section 3, treats it *as if* it were a coupling, honoring the quasi-physical feel of the relationship between keystroke and response. This "as if" is not confusion; it is a productive fiction, the kind of willful misreading that musical practice often depends on. The action–sound framework, which has also been applied pedagogically [11], enables articulation of what is happening when a typist begins to attend to rhythm, timing, and gestural quality in their keystrokes, and the artifacts described in Section 4 aim to make these dimensions audible and visible.

2.3 Error Aesthetics

Two traditions reframe error as generative material. In jazz improvisation, the "perfect wrong note" is a pedagogical touchstone. As Herbie Hancock recalls from playing a chord that did not fit during a Miles Davis solo, Davis, rather than stopping, "played some notes that made my chord right" [10]. The error became material. Whether a note or a chord is a failure depends on what happens next, on the capacity to absorb and redirect.

A different yet related entry point is Cascone's "aesthetics of failure" [4], which describes post-digital composers who used "glitches, bugs, and system crashes" as raw material. Oval (Markus Popp) scratched CDs to induce skips and loops, composing with the resulting damage. The impulse to treat noise as material has an even longer history: Russolo's futurist manifesto [22] called for an "art of noises," and Attali [1] theorized noise as disruption with generative potential. More recently, Kemper [14] has traced how the post-digital aesthetic of failure continues to shape twenty-first-century media practice. These traditions share an orientation: treating deviation as something to work with, not only to correct. As Section 3 explores, the question is whether this orientation can extend to the relationship between a typist and a language model.

3 Vyping as Musical Practice

3.1 Definition

Vyping is typing without looking at the keyboard or the screen. The term emerged from practice: when typing at thought-speed without visual feedback, "typing" becomes "vyping" through the very errors it describes. The neologism resists stabilization; to vipe, vype, bipe, or nype are equally valid (mis)spellings, reflecting how the practice accommodates diverse relationships to written language.

In vyping, the typist abandons the corrective loop of visual feedback. Instead, typos accumulate. Words blur into approximate shapes. The rhythm, however, tends to become more prominent when freed from the constraint of accuracy. The body's contribution to the text, usually invisible in polished prose, becomes legible.

3.2 A Vyping Transcript

The following excerpt, drawn from a documented practice session, illustrates vyped input and its parsed interpretation:

> **Vyped (raw):** `viping and coding is or vipign in generarl extentd sthe trusts that is already manifest in our relationshsip, you nknow, i trust that the palna you propsoe is gonna workm that you wont brick the pusj, and viping addsae another layere of trust in tehre youj know`
> **Parsed:** "Vyping and coding, or vyping in general, extends the trust that is already manifest in our relationship, you know, I trust that the plan you propose is gonna work, that you won't brick the push, and vyping adds another layer of trust in there you know"

The raw text would fail a spell check. A human editor would return it with corrections. Yet the LLM parsed it fluently, identifying the topic (trust in human–LLM collaboration), the emotional register (conversational, reflective), and the core argument (vyping extends trust from operational to interpretive). In the raw text, characteristic patterns emerge: key adjacency errors ("propsoe" for "propose," "extentd" for "extends"), transpositions ("tehre" for "there"), and accumulated extra characters within words ("addsae" for "adds," "relationshsip" for "relationship"). These patterns follow the geometry of the QWERTY layout and the biomechanics of the typist's hands. They are individually distinctive and contextually recoverable, which is why the approach described in Section 2.3 (treating deviations as material rather than error) is relevant here.

3.3 Keystroke as Gesture

Keystroke dynamics research has established that typing patterns are individually distinctive, sufficiently so for biometric authentication [23]. The key parameters include inter-onset-interval (IOI, the time between successive keystrokes), hold time (the duration a key is pressed), and flight time (the time between releasing one key and pressing the next). These parameters vary with cognitive state, emotional arousal, and linguistic content [2]. They exhibit *coarticulation*: each keystroke anticipates the next, as in speech production [26]. Concretely, this means the finger reaching for "t" is already positioned differently depending on whether the next letter is "h" or "r"; the motor plan for a word shapes each keystroke within it, just as a pianist's hand shapes itself in anticipation of the next chord. The keyboard, like a musical instrument, affords gestural phrasing.

In vyping, these temporal signatures become more pronounced. Without visual correction, the typist relies on motor memory and proprioception. Hesitations, bursts, and rhythmic patterns emerge that would be smoothed out in the corrected text. The KeyMeter tool captures these patterns with millisecond timestamps, enabling analysis of typing as embodied performance, a connection that the action–sound framework (Section 2.2) helps to articulate: typing analyzed through the lens of iterative sound-producing action reveals rhythmic structure that is otherwise invisible.

3.4 Integration and Productive Misreading

When vyped text reaches an LLM, the model receives degraded input: typos, omissions, rhythmic artifacts encoded in timing (where interfaces preserve it). The model's response to this degradation is instructive, if imperfect, as an analogy to musical improvisation.

Modern language models are trained on noisy text and can perform robust inference on degraded input. "Teh" becomes "the"; "adn" becomes "and." The model resolves ambiguity, often successfully, sometimes in unexpected directions. Typos can produce what might be called *productive misreadings*: a misspelled word interpreted as a different word, opening semantic paths that the typist had not anticipated. The degraded signal becomes a source of variation, noise, and material at once.

The analogy to improvisation is partial. An improvising musician responds to unexpected material with intention, memory, and aesthetic judgment [15]; an LLM responds with statistical inference. The two processes are not equivalent. A more precise musical term may be *comping*: the practice of accompaniment in jazz, where the rhythm section listens, adapts, and supports the soloist's line without asserting its own melodic agenda. The comp player absorbs what is happening and provides a responsive harmonic and rhythmic bed. The LLM does something structurally similar when it parses vyped input: it absorbs degraded material and provides a coherent response, without the intentionality or aesthetic judgment that characterizes improvisation proper. Comping involves absorption without authorship, responsiveness without initiative, which maps more honestly onto what the model does than "improvisation" would. Fiebrink's work on machine learning in instrument design [7, 8] is relevant here: the question is not whether the model is creative, but what kinds of musical relationships it enables.

Derek Bailey's distinction between *idiomatic* and *non-idiomatic* improvisation [3] remains useful here: vyping is idiomatic (it works within the conventions of language) but the errors introduce non-idiomatic elements that can shift direction. Developing skill in vyping means developing skill in working with these shifts, which is different from preventing them, though prevention remains appropriate in many contexts.

This is also why the LLM is constitutive of the practice rather than incidental. If the typo were the whole interest, a rule-based corrector would suffice. What makes vyping musical is what happens *after* the parse: the LLM's generative response treats the misread word as coherent intent and continues from there, producing a return that the typist can attend to, push back against, or follow into directions they had not planned. The grace note, in jazz terms, requires both player and comp section. Vyping requires both body and receiver. The artifacts described below make these dynamics tangible.

4 Attunement Artifacts

Three artifacts have been developed that explore keyboard-as-instrument, each making visible or audible a different dimension of the typing practice described in Section 3. Where prior NIME keyboard work has typically *augmented* the instrument through added sensors or modified hardware (Section 2.1), these artifacts work in the opposite direction: they use software to reveal expressive information already present in unmodified typing, and pair it with a generative receiver (the LLM) capable of integrating that information into a continued exchange. They are best read as *probes*: vehicles for thinking about a practice rather than finished instruments.

4.1 ll00mtube

ll00mtube[1] is a search-and-attunement interface built on phonetic pattern matching. Users type vyped queries (garbled, fast, approximate) and the system resolves them relationally, using an LLM to interpret degraded input and surface relevant results. The name itself is vyped ("loomtube"). Built with vanilla JavaScript and deployed on Cloudflare Pages, the interface foregrounds temporal flow: results appear as the user types, creating a rhythm of call and response. The design rewards fluency alongside accuracy, inviting users to trust approximate input and attend to the timing of their interaction. As a design, ll00mtube embodies the productive misreadings described in Section 3.4: the system's capacity to find "Familiar Feeling" from the vyped query "material feeling" (same syllable count, same stress pattern, different words) demonstrates search operating through rhythm rather than literalism.

4.2 clix-vibe

clix-vibe[2] is a WebAudio-based keystroke sonification tool inspired by Clix by Ge Wang [25]. Each keystroke triggers a sound event, key position maps to pitch, and hold time influences envelope shape. The internal scheduling system enables "hanging" sequences, sounds that sustain and overlap, creating a continuous sonic texture from discrete key events. The tool makes typing audible as organized sound, exposing the rhythmic patterns discussed in Section 3.3, as well as the coarticulation and gestural phrasing that keystroke dynamics research identifies but that are imperceptible in text alone. An experimental variant (SoundVibe[3]) explicitly tracks temporal patterns, falling between sonification and analysis. Where ll00mtube surfaces the semantic effects of vyping, clix-vibe surfaces the temporal and sonic ones.

4.3 KeyMeter

KeyMeter[4] is a keystroke logging and visualization tool that captures timestamps with millisecond precision. Where biometric keystroke systems focus on authentication, KeyMeter is designed for expressive analysis: visualizing IOI distributions, identifying rhythmic patterns, and comparing typing signatures across sessions and individuals. It provides the foundation for analyzing how typing exhibits coarticulation, gestural phrasing, and individually distinctive temporal signatures. It closes the loop between the action–sound framework (Section 2.2) and the embodied practice of vyping (Section 3), offering a means to study what the other artifacts make audible or searchable.

[1] https://ll00mtube.pages.dev
[2] http://arj.no/clix-vibe/
[3] https://github.com/alexarje/web_instruments
[4] https://github.com/alexarje/keymeter

4.4 The Timing Gap

An honest accounting of these artifacts requires noting what they do not do. Standard chat interfaces strip timing information before it reaches the LLM: the model receives text, not keystrokes. IOIs, hold times, and flight times, the parameters that KeyMeter captures and clix-vibe sonifies, are lost in transmission. The expressivity that vyping foregrounds is, at present, expressivity for the typist, not for the model. The LLM receives the *results* of embodied typing (the typos, the phonetic drift, the approximate words) but not the *temporal process* that produced them.

This is a design gap, and it points toward a concrete direction. Timestamp-rich input formats, in which keystroke timing is preserved alongside text and exposed to the model, would allow LLMs to access the rhythmic and gestural dimensions of typing that these artifacts make visible. Such formats do not yet exist in standard LLM interfaces, but neither does any technical obstacle prevent them: a JSONL stream of the kind KeyMeter already produces is a sufficient envelope. The artifacts in this paper are, in part, arguments for that envelope's adoption. They demonstrate that keystroke timing carries information worth preserving, that tools to capture it already exist, and that the relevant move is now interface-level rather than research-level.

Together, these three artifacts span input (vyping), sonification (clix-vibe), and analysis (KeyMeter), with ll00mtube demonstrating how an LLM can participate in the loop by integrating degraded input relationally (Figure 1).

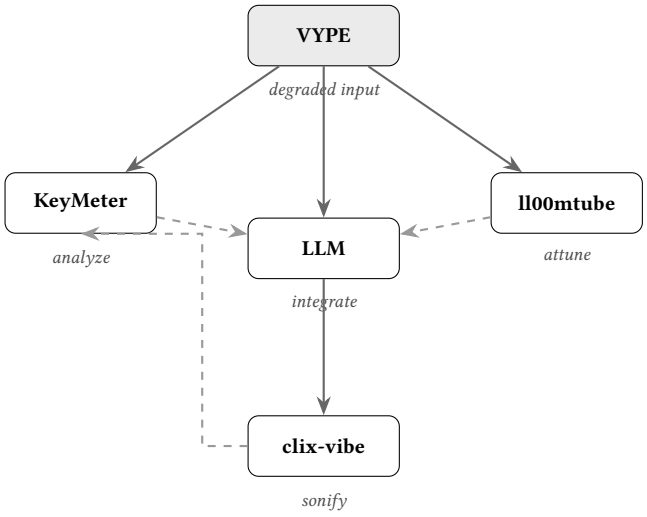

Figure 1: The keyboard-as-instrument framework. Vyped input flows (solid arrows) to three artifacts and the LLM. Dashed arrows indicate feedback: KeyMeter analysis informs the LLM; clix-vibe sonification feeds back to analysis; ll00mtube search results return through the LLM. The timing gap (Section 4.4) sits between the artifacts and the LLM: keystroke timing is currently available to the typist, not the model.

5 Discussion: Reverence and Its Difficulties

The artifacts and practice described above suggest a design orientation that this paper calls *reverence*. This is not a clean position. It sits uncomfortably between several tensions that are worth articulating. This section attempts to define the term, distinguish it from adjacent concepts, and sit with those tensions.

5.1 Reverence as Design Orientation

Reverence, as used here, names a specific orientation toward a tool: the disposition to attend to its temporal, material, and gestural dimensions with the kind of care a musician brings to an instrument. It has three components. *Nuance*: sensitivity to the fine-grained qualities of interaction (timing, rhythm, the micro-structure of keystrokes). *Grace*: a willingness to work with what arrives, including error, rather than demanding that input conform to expectation. *Respect*: an acknowledgment that the tool has properties and behaviors worth understanding on their own terms, even when those terms are troubling.

Reverence is not care, though it overlaps. Care, in its HCI and design usage, centers the wellbeing of persons and communities. Reverence can include care, but its primary object is the quality of the relationship between practitioner and instrument: how attentively the interaction is conducted, how much of the tool's character is allowed to surface. It is also not attunement, though the paper has used the word. Attunement describes a state (being attuned); reverence describes a practice (the ongoing work of paying attention, including on days when attunement fails). The distinction matters because reverence is effortful. It does not arrive naturally. It is maintained against the pull of efficiency, habit, and the perfectly reasonable desire to get things done.

Concretely, reverence in the context of keyboard-as-instrument means: preserving temporal information that could be discarded (Section 4.3, KeyMeter); making audible the sonic qualities of keystroke patterns that could remain silent (Section 4.2, clix-vibe); and designing search interfaces that work with phonetic drift rather than correcting it (Section 4.1, ll00mtube). The artifacts are modest instantiations of the orientation. Whether the orientation itself can survive contact with the material conditions of LLM production is addressed below.

5.2 From Correction to Attention

The keyboard-as-instrument framing, supported by the action-sound taxonomy (Section 2.2), suggests that temporal information in typing is worth preserving, not only correcting. The artifacts in Section 4 demonstrate three ways of doing this: clix-vibe sonifies keystroke timing, making rhythmic patterns audible; KeyMeter captures and visualizes the same patterns for analysis; ll00mtube shows that an LLM can search relationally through degraded input, treating phonetic drift as signal. Each artifact responds to a different dimension of what vyping (Section 3) foregrounds: the body's contribution to text, usually erased in polished prose.

The design orientation here is not to replace correction with acceptance. Autocorrect is useful. Spellcheck catches errors. The suggestion is that these tools, when they are the *only* response to the gap between intention and execution, erase information that could be productive. The improvisation and glitch traditions described in Section 2.3 offer precedent: in both, the capacity to work with deviation, rather than only against it, is a practiced skill. The artifacts presented here are modest attempts to create conditions where that skill can develop in the context of human-LLM interaction.

5.3 The Instrument and Its Conditions

Proposing attunement toward an LLM requires honesty about what the instrument is. It is a technology entangled with extractive labor practices, high environmental cost, and concentrated corporate power. The companies that train these models operate

at a scale and with a political economy that many in the NIME community find troubling. Proposing reverence toward such a tool is a provocation, and may also be naïve. The authors are not certain that it is not.

Musicians have maintained complicated relationships with their instruments and the industries that produce them. The live coding community built a practice around corporate laptops running proprietary operating systems, and transformed that practice into a site of collective experimentation and critical discourse [5]. Diapoulis et al. [6] have shown that continuous interactions in live coding can be analyzed to predict programming behaviours, suggesting that keystroke-level attention to process is already productive in that tradition. The question in that tradition was how to play with integrity, not whether to play. A similar question arises here, though the scale and opacity of LLM infrastructure make it harder to answer.

What does it mean to practice attunement toward a tool whose existence one feels ambivalent about? Can reverence coexist with critique? These questions do not have stable answers. The practice described in this paper (vyping, sonifying, analyzing) is offered as a starting point, with the awareness that starting points can also be dead ends, and that the ethical tensions raised here may require structural responses that design alone cannot provide.

5.4 Limitations

This work is exploratory and practice-based. No formal user studies have been conducted; the artifacts are research prototypes tested primarily by the authors. The vyping transcript in Section 3.2 is drawn from a single practitioner's documented sessions. Future work should investigate whether the patterns described here generalize across typists, languages, and keyboard layouts, and whether the ethical tensions raised can be addressed through design or only acknowledged.

6 Conclusion

The computer keyboard has a longer musical lineage than its current use as an LLM input device suggests. This paper introduced vyping (typing without looking) as a technique that treats typos as grace notes, and presented three artifacts that make the temporal and sonic dimensions of typing visible and audible.

The deeper contribution may be the question. Reverence does not require innocence; it requires attention. An LLM, like an improvising musician, can sometimes make the wrong note right. Whether that capacity is worth cultivating, given the costs, is something that each practitioner answers differently, and answers again.

7 Ethical Standards

This research did not involve human subjects and therefore did not require ethics approval. The artifacts described are research prototypes that have not been deployed publicly. The use of LLM-based tools (Claude) in both the research practice described and in the preparation of this manuscript is disclosed; the keyboard-as-instrument framing means the tool is simultaneously subject and instrument of inquiry. The authors have no conflicts of interest to declare.

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References

[1] Jacques Attali. 1985. *Noise: The Political Economy of Music.* University of Minnesota Press, Minneapolis.
[2] Various Authors. 2015. The Sensory-Motor Theory of Rhythm and Beat Induction 20 Years On: A New Synthesis and Future Perspectives. *Frontiers in Human Neuroscience* (2015).
[3] Derek Bailey. 1992. *Improvisation: Its Nature and Practice in Music.* Da Capo Press, New York.
[4] Kim Cascone. 2000. The Aesthetics of Failure: "Post-Digital" Tendencies in Contemporary Computer Music. *Computer Music Journal* 24, 4 (2000), 12–18.
[5] Nick Collins, Alex McLean, Julian Rohrhuber, and Adrian Ward. 2003. Live Coding in Laptop Performance. *Organised Sound* 8, 3 (2003), 321–330.
[6] Georgios Diapoulis, Iannis Zannos, Kıvanç Tatar, and Palle Dahlstedt. 2022. Bottom-up Live Coding Analysis of Continuous Interactions: Towards Predicting Programming Behaviours. In *Proceedings of the International Conference on New Interfaces for Musical Expression.*
[7] Rebecca Fiebrink. 2020. Reflections on Eight Years of Instrument Creation with Machine Learning. In *Proceedings of the International Conference on New Interfaces for Musical Expression.*
[8] Rebecca Fiebrink, Dan Trueman, and Perry R. Cook. 2009. A Meta-Instrument for Interactive, On-the-Fly Machine Learning. In *Proceedings of the International Conference on New Interfaces for Musical Expression.*
[9] Matthew Hamilton, Michele Ducceschi, Roberto Livi, Catalina Vicens, and Andrew McPherson. 2025. Augmentation of a Historical Harpsichord Keyboard Replica for Haptic-Enabled Interaction in Museum Exhibitions. In *Proceedings of the International Conference on New Interfaces for Musical Expression.*
[10] Herbie Hancock. 2014. *Possibilities.* Viking, New York. Autobiography recounting the Miles Davis wrong chord story, pp. 74–75.
[11] Alexander Refsum Jensenius. 2013. An Action-Sound Approach to Teaching Interactive Music. *Organised Sound* 18, 2 (2013), 178–189.
[12] Alexander Refsum Jensenius. 2022. *Sound Actions: Conceptualizing Musical Instruments.* MIT Press, Cambridge, MA. Open Access.
[13] Alexander Refsum Jensenius, Marcelo M. Wanderley, Rolf Inge Godoy, and Marc Leman. 2010. Musical Gestures: Concepts and Methods in Research. In *Musical Gestures: Sound, Movement, and Meaning*, Rolf Inge Godoy and Marc Leman (Eds.). Routledge, 12–35.
[14] Jakko Kemper. 2023. Glitch, the Post-digital Aesthetic of Failure and Twenty-First-Century Media. *Convergence* (2023).
[15] Charles J. Limb and Allen R. Braun. 2008. Neural Substrates of Spontaneous Musical Performance: An fMRI Study of Jazz Improvisation. *PLoS ONE* 3, 2 (2008).
[16] Thor Magnusson. 2009. Of Epistemic Tools: Musical Instruments as Cognitive Extensions. *Organised Sound* 14, 2 (2009), 168–176.
[17] Thor Magnusson. 2010. An Epistemic Dimension Space for Musical Devices. In *Proceedings of the International Conference on New Interfaces for Musical Expression.* Sydney, Australia.
[18] Andrew McPherson. 2012. TouchKeys: Capacitive Multi-Touch Sensing on a Physical Keyboard. In *Proceedings of the International Conference on New Interfaces for Musical Expression.* Ann Arbor, MI.
[19] Andrew McPherson and Youngmoo Kim. 2010. Augmenting the Acoustic Piano with Electromagnetic String Actuation and Continuous Key Position Sensing. In *Proceedings of the International Conference on New Interfaces for Musical Expression.* Sydney, Australia, 217–222.
[20] Chris Nash. 2016. The E in QWERTY: Musical Expression with Old Computer Interfaces. In *Proceedings of the International Conference on New Interfaces for Musical Expression.* Brisbane, Australia.
[21] Jeff Pressing. 1984. Cognitive Processes in Improvisation. *Cognitive Processes in the Perception of Art* (1984), 345–363.
[22] Luigi Russolo. 1913. *The Art of Noises.* Futurist manifesto.
[23] Rashik Shadman, Ahmed Anu Wahab, Michael Manno, Matthew Lukaszewski, Daqing Hou, and Faraz Hussain. 2025. Keystroke Dynamics: Concepts, Techniques, and Applications. *Comput. Surveys* 57, 11 (2025). https://doi.org/10.1145/3733103
[24] Si Waite. 2016. Reimagining the Computer Keyboard as a Musical Interface. In *Proceedings of the International Conference on New Interfaces for Musical Expression.*
[25] Ge Wang. 2008. *The ChucK Audio Programming Language: An Strongly-timed and On-the-fly Environ/Mentality.* Ph. D. Dissertation. Princeton University.
[26] Sara A. Winges, Shinichi Furuya, Nathaniel J. Faber, and Martha Flanders. 2013. Patterns of Muscle Activity for Digital Coarticulation. *Journal of Neurophysiology* 110, 1 (2013), 230–242.