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A Study on the Inaccuracy of Keystroke Force in Piano Performance and Its Optimization Strategies

Xiangyu Bai

Zhejiang Conservatory of Music, Hangzhou 310024, Zhejiang, China.

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***Corresponding author:** Xiangyu Bai, Zhejiang Conservatory of Music, Hangzhou 310024, Zhejiang, China.

Abstract

The art of piano performance relies heavily on the meticulous control of touch intensity, where the precision of force not only determines the quality of sound production but also directly shapes the completeness and depth of musical expression. In current performance practice, inaccuracies in force control are widespread, manifesting across dimensions such as tactile dullness, stiffness in dynamic variation, and deficiencies in nuanced dynamic handling, all of which severely constrain overall performance quality. This study systematically examines the characteristics and underlying causes of insufficient precision in touch intensity during piano performance, drawing on research findings related to performance psychology, physiological mechanisms, and pedagogical methodologies. Furthermore, it explores optimization strategies including innovations in fundamental technical training, the construction of contextualized performance experiences, and the integration of technical and artistic approaches in teaching, aiming to provide both theoretical support and practical guidance for the advancement of force control capabilities in piano performance.

Keywords

Piano performance; key-touch force; accuracy; force control

Introduction

Touch force is the most fundamental variable in both the production of sound and the artistic expression of piano performance, permeating every aspect of technical execution and aesthetic interpretation. Insufficient precision in touch control not only degrades sound quality but also undermines the emotional continuity and structural integrity of musical works (Xu, 2025). As the art of performance continues to evolve, the demands for refined control of touch force have become increasingly stringent; reliance solely on mechanical memory or repetitive practice can no longer meet the requirements for nuanced expression. There is an urgent need to reexamine the force training system from multiple dimensions, including tactile cognition, motor coordination, and psychological adjustment, in order to reconstruct a more targeted and responsive teaching framework. Such efforts aim to enhance performers' abilities in perception, regulation, and adaptation of touch force, fundamentally addressing the deficiencies in precision and advancing the overall level of piano performance artistry.

1. Characteristics of Key Touch Force Control in Piano Performance

1.1 The Correlation Between Key Touch Force and Tone Shaping

In piano performance, subtle variations in key touch force directly determine the richness and layering of tone; they not only influence volume levels but also have a significant impact on the roundness of timbre, the granularity of

tone, and the continuity between notes. Fine modulation of force enables the melody to display delicate emotional tension within dynamic fluctuations, promoting an organic unity between the structural layout and internal breathing of the work (Yang, 2025). Inadequate precision in key touch force often results in flat tonal quality and limited emotional conveyance, ultimately impairing the integrity and expressive power of the musical work.

1.2 The Impact of Individual Differences on Force Control

Natural differences in performers' physiological structures, finger muscle control abilities, and neural response speeds constitute a non-negligible individuality in key touch force control (Alghamdi, Morgan, & Walsh, 2025). Some performers, endowed with inherently strong finger strength, are better adapted to styles demanding large dynamic variations, while others excel in delivering subtle and delicate touch expressions. Training methods, accumulated experience, and habitual playing styles further exacerbate this divergence, making the cultivation of force precision highly individualized and necessitating systematic, tailored instructional strategies for improvement and enhancement.

1.3 The Diversity of Key Touch Requirements Across Musical Styles

Different musical styles impose varying demands on the control of key touch force. Classical works emphasize structure and symmetry, requiring performers to achieve finely calibrated force adjustments within a balanced framework; Romantic works seek emotional release and a sense of free breathing, demanding a more natural flow in key touch force variations (Kohler, Czepiel, & Manzano, 2025). Contemporary compositions often challenge traditional norms by requiring extreme dynamic ranges and instantaneous responses. The intertwining of technical and artistic dimensions across styles compels performers to develop flexible adaptation strategies for key touch adjustment and force control according to stylistic contexts.

2. Problems in the Accuracy of Keystroke Force in Piano Performance

2.1 Deficiency or One-sidedness in Fundamental Finger Technique Training

The insufficiency of keystroke force accuracy in piano performance is closely related to the lack of comprehensive learning of finger techniques during the foundational training stage. Some performers focus merely on superficial technical aspects while neglecting the cultivation of keystroke perception, making it difficult to achieve refined control over dynamics when confronted with complex and intricate musical works. Traditional pedagogical systems often emphasize mechanical repetition in the training of finger independence and force distribution, while ignoring the essential role of coordinated movements involving the fingers, wrists, and even upper limbs in assisting dynamic control, resulting in performers facing the dilemma of simplistic force control and limited dynamic range during actual performances. As the complexity of performance repertoire increases, the limitations of early-stage training are increasingly exposed, leading to rigid force control, insufficient layering of sound, and inadequate grasp of emotional nuances, which ultimately restrict the deepening and expansion of musical expressiveness (Thompson, Pan, & Ruiz, 2025).

2.2 Overreliance on Mechanical Memory During Performance

Although mechanical memory plays a certain supportive role in the smoothness of technical execution in piano performance, excessive dependence on mechanical repetition at the expense of active auditory perception and fine adjustment inevitably leads to diminished keystroke force accuracy. The unconscious nature of mechanical memory renders performance actions increasingly programmatic, weakening the performer's ability to perceive and adapt to changes in force instantaneously; as a result, performers often find it difficult to adjust their touch in response to varying acoustic demands, leading to stiffness in volume control and a flattening of sonic layers. When musical interpretation demands subtle dynamic shifts, reliance on mechanical memory causes delayed responses, surface-level rendering, and rigidity in expression, severely impeding the integration of technical and artistic dimensions (Hirano, Kimoto, & Shiotani, 2025).

2.3 Interference of Psychological and Physiological Factors with Force Stability

Psychological tension, emotional fluctuations, and physiological fatigue during live performance exert a significant

influence on the stability of keystroke force. From a psychological perspective, heightened nervousness often unconsciously causes muscle contraction, disrupting the balance of keystroke strength and altering the normal range of motion, thereby undermining the performer's ability to execute fine dynamic control; physiologically, prolonged high-intensity playing leads to muscle fatigue, which not only diminishes finger flexibility and endurance but also reduces the precision of keystroke control, further aggravating instability in dynamic regulation. The interaction between psychological and physiological factors forms a latent obstacle in performance, rendering even those performers who demonstrate adequate dynamic control during routine practice susceptible to frequent force drift and weakened control under actual performance conditions, thus impairing the consistency of performance outcomes and the integrity of musical expressiveness (Li, Xu, & Wang, 2024).

3. Optimization Strategies for Enhancing the Precision of Piano Key Touch Dynamics

3.1 Innovation in Scientific and Systematic Basic Skills Training Methods

Given the evident deficiency in the precision of key touch dynamics, there is an urgent need to reconstruct the systematic and scientific framework of fundamental training. The training content should focus on three core dimensions: fingertip tactile perception, movement coordination, and muscle memory, establishing progressive and differentiated training modules that emphasize micro-level perception and fine adjustment of dynamic variations. In structuring the training rhythm, monotonous repetition must be abandoned, adopting variable tempo patterns and dynamic adjustment techniques to reinforce the internal mastery of dynamic regularities (Johnson, 2024). In the design of evaluation mechanisms, a dual-criteria system integrating quantitative analysis and subjective perception should be introduced, forming a closed-loop training model that fundamentally enhances the stability and delicacy of dynamic control.

3.2 Establishing Contextualized Performance Experiences to Enhance Tactile Sensitivity

The precision of key touch dynamics relies not only on the accumulation of foundational skills but also on the performer's ability to respond instantaneously to complex situational stimuli. Constructing contextualized performance experiences thus becomes a crucial approach to strengthening tactile sensitivity. It is necessary to design diverse performance scenarios that encompass various emotional atmospheres, tempo fluctuations, and dynamic control requirements, compelling performers to maintain heightened attention and agile adjustment under uncertain conditions. Psychological intervention techniques should be integrated to reinforce self-awareness during performance, enabling dynamic control to become internally coherent and less susceptible to external disruptions. Through continuous experiential calibration, performers can gradually achieve substantial improvements in the precision of key touch dynamics (Xu, Yang, & Li, 2024).

3.3 An Integrated Teaching Model of Technical and Artistic Development

The enhancement of precision in key touch dynamics should not be confined to isolated technical training but must be deeply embedded within the entire teaching framework that integrates both technical and artistic development. Training in dynamic control should proceed in parallel with training in musical expressivity, allowing performers to develop a perceptual sensitivity to changes in melody, rhythm, and harmony, and to naturally refine key touch control, forming a unified logic between internal perception and external execution (Yasuda, Sato, & Nakajima, 2024). Teaching methodologies should advocate for individualized instruction, formulating personalized training strategies based on performers' physical conditions, emotional characteristics, and musical understanding, thereby overcoming the traditional separation between technique and artistry and achieving a positive cycle of mutual reinforcement between dynamic precision and expressive capacity.

4. Conclusion

The issue of touch force precision in piano performance manifests in performers' insufficient understanding of the interrelationship among motor control, auditory perception, and emotional expression; its causes involve multiple intertwined dimensions, including physiological coordination, psychological states, and pedagogical approaches. Given such complexity, it is essential to deepen tactile awareness through fundamental technique training, to strengthen situational adaptability through enriched performance experiences, and to achieve an organic integration of technical and artistic dimensions within the educational framework; only through such comprehensive strategies

can the precision of touch control be fundamentally enhanced, thereby further enriching the nuances and depth of musical expression and fully unleashing the unique sonic charm and expressive power inherent in the art of piano performance.

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