

The Modern Tension of Wushu Physical Practice from the Perspective of Sports Philosophy: A Return Path from Perceptual Alienation to Mind-Body Harmony

Qiwei Wu^{1,2}, Mengsha Chen^{3*}

¹School of Physical Education, Ningde Normal University, Ningde 352100, Fujian, China

²Fujian and Taiwan Folk Sports and Culture Institute, Ningde Normal University, Ningde 352100, Fujian, China

³Academic Affairs Office, Ningde Normal University, Ningde 352100, Fujian, China

Corresponding author: Mengsha Chen (e-mail: chenms1985@163.com)

ABSTRACT Quantitative evaluation of mind-body coordination in martial arts practice requires integrated analysis of movement perception, physiological signals, and motor-control dynamics. This study investigates perceptual alienation and mind-body synergy using phenomenological body theory, embodied cognition, and an 18-month intervention experiment involving 368 practitioners. Body perception scales, inertial measurement units, electromyography, electroencephalography, and heart-rate-variability indicators are used to characterize proprioceptive acuity, perception–movement coupling, body-schema integrity, autonomic balance, and muscle coordination. A three-stage intervention model is implemented, including proprioceptive reconstruction, perception–consciousness–movement feedback-loop construction, and holistic practice. Results show that proprioceptive acuity increases by 83.7%, perception–movement coupling improves by 91.2%, body-schema integrity reaches 89.3%, and the intention–limb response delay decreases from 682 ms to 126 ms. The framework provides a measurable pathway for human motion analysis, physiological signal processing, and bioelectromagnetic sensing-based evaluation of motor coordination.

INDEX TERMS physiological signal analysis, motion sensing, bioelectromagnetic signals, motor coordination, human-machine evaluation

I. INTRODUCTION

THE expansion of technological rationality within industrial modernity has redefined the fundamental shape of human physical practice, mirroring the shift toward automated precision seen in modern manufacturing systems. This systemic evolution necessitates a recalibration of bodily movement to align with the highly structured and synchronized logic of contemporary technical excellence. Being a cultural form which harbors the ancient Chinese wisdom of the body, martial arts focuses on the holistic perspective of unity of inner and outer and union of form and spirit. But, through the influence of industrial civilization, the competitive transformation has turned martial arts into a pure technic exercise as well as the standardized training mode has reduced the complex body perception into quantifiable movement specifications. Practitioners are over dependent on visual feedback, and extrinsic instructions and the functional degradation occurs after the longterm dormancy of the proprioceptive system. Breathing, meaning and action

do not work together and the body is alienated into a tool which can be controlled. Such perceptual alienation is not only the collapse of the cultural essence of martial arts, but also mirrors the profound breakage in the relations between individuals and their very bodies in the framework of modernity [1-2]. In this context, perceptual alienation refers specifically to a “sensory-motor amnesia” where the practitioner loses the ability to feel internal physiological states, resulting in movements that are mechanically correct but internally “hollow”—a state clearly distinguished from temporary physical fatigue or a simple lack of technical skill.

According to the phenomenological theory of the body given by Merleau-Ponty, the body is not an objective physical object, but a subjective domain of perception of the world. The embodied cognition paradigm affirms that the cognitive processes lie in the dynamism that exists between body and environment. The researchers based their research on 368 martial artists, followed up over 18 months, applied

body perception scale, exercise physiological monitoring, and sampled in-depth interview data to reduce the generative mechanism of perceptual alienation into a systematic analysis. According to the phenomenology body theory, a three-stage intervention model was developed, examining avenues of the synergistic restoration of mind and body on three levels: reconstructing proprioception, constructing dynamic feedback, and practicing holistically. By integrating the systemic logic of engineering, this study offers a theoretical background and practical answers to contemporary martial arts body practice that reflect the technical excellence of the industry. This cross-disciplinary approach ensures that physical training systems align with the structural precision and integrated manufacturing standards essential to modern production.

II. RELATED WORK

Phenomenological perception theory is the basis of subjectivity of body in the body philosophy where the body schema is postulated to develop the original unity of perception and movement. The study of power mechanism exposes that contemporary disciplinary practices control the body and domesticate it with the use of standardized training, which traces the sociological origins of objectifying the body. The body aesthetics theory promotes the reconstruction of self-awareness by way of body practice and by reviving the aesthetic aspect of the body [3-4]. Self-creation theory is a theory of embodied cognition that focuses on the autonomous emergent nature of cognitive systems, extends mind hypothesis in order to deconstruct boundaries between mind and body and extends the cognitive process to include body environment coupling. Domestic studies examines the epistemological nature of traditional martial arts with reference to body technology thinking and how Tai Chi has phenomenological implications although the majority of studies are on the theoretical explanation level and lack support of quantitative empirical data and systematic intervention programs.

The perception-motor theory framework demonstrates the neural coupling mechanism between intention and movement in the sphere of sports science, and the mirror neuron systems studies confirm that the processes of movements observation and acting have the same neural matrix. Proprioceptive research indicates that there is a strong association between the quality of motor control and perception of joint angle and quantitative evaluation of these mechanisms involves passive position reproduction and active angle matching. The analysis of heart rate variability is a popular one in the evaluation of the functioning of the autonomic nervous system, and the percentage of low-frequency and high-frequency power is the ratio of sympathetic and parasympathetic balance. Surface electromyography measures the patterns of muscle activation and co-contraction index is a measure of coordination between the motor [5-6]. The current martial arts studies are based more on biomechanical study and performance enhancement and little attention has been

given to the body perception aspect. The proposed study is a combination of philosophical and empirical research approaches to develop a systematic model of intervention in mind-body synergistic regression to bridge the gap in research between theory and practice.

III. METHODS

A. RESEARCH DESIGN AND SAMPLE SELECTION

The research design used in this study was a quasi-experimental design because it recruited martial arts school practitioners in Beijing, Shanghai and Guangzhou. The inclusion criteria were: over 24 months of continuous martial arts training with a minimum of 8 hours of training per week, age 18-45 years old, and no incidence of serious sports injuries. The exclusion criteria were: comorbid neurological conditions, taking drugs that can influence sensory functions, and attending other physical and mental training programs [7-8]. The participants (368) were selected as a stratified random sample, stratified by martial arts style (internal/external), and years of practice (2-5 years/more than 5 years), and eventually divided into an intervention group (186) and a control group (182). This study was approved by the Ethics Committee of Ningde Normal University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form. While internal and external styles possess distinct movement philosophies, both are subjected to the same modern standardized competitive frameworks that prioritize external aesthetics over internal perception. Stratification was employed to ensure that the inherent introspective focus of internal styles did not skew the baseline alienation metrics, allowing for a controlled analysis of how modern industrial logic impacts both traditions.

The sample characteristics are shown in Table 1. There were no statistically significant differences between the intervention group and the control group in terms of gender composition ($\chi^2 = 0.347$, $P = 0.556$), age distribution ($t = 0.892$, $P = 0.373$), years of training ($U = 16234$, $P = 0.641$), and body mass index ($t = 1.103$, $P = 0.271$). The baseline physical-mental synergy index was 42.3 ± 6.8 and 41.9 ± 7.1 , respectively ($t = 0.567$, $P = 0.571$), indicating that the two groups were comparable.

TABLE 1. Baseline characteristics distribution of the research samples

Feature variables	Intervention group (n=186)	Control group (n=182)	Statistic	p-value
Male/Female (n)	108/78	102/80	$\chi^2 = 0.347$	0.556
Age (years)	31.4 ± 7.2	30.8 ± 6.9	$t = 0.892$	0.373
Years of training	4.6 ± 2.1	4.5 ± 2.3	$U = 16234$	0.641
Body Mass Index (kg/m^2)	22.8 ± 2.4	23.1 ± 2.6	$t = 1.103$	0.271
Mind-Body Synergy Index	42.3 ± 6.8	41.9 ± 7.1	$t = 0.567$	0.571
Internal martial arts / External martial arts (n)	94/92	89/93	$\chi^2 = 0.273$	0.601

Table 1 presents the balanced distribution of the two groups of participants in terms of demographic characteristics and basic indicators, providing a prerequisite for the attribution analysis of the intervention effect.

B. DATA COLLECTION TOOLS AND EVALUATION SYSTEM CONSTRUCTION

The Body Perception Scale (BPS) comprises three dimensions: proprioceptive acuity, which uses a 10-centimeter visual simulation scoring method, requiring participants to perceive the knee flexion angle with their eyes closed, and the deviation between the actual angle and the perceived angle is used as the evaluation index; perception-motor coupling, which uses an inertial measurement unit (IMU) to record the trajectory of a punching action and calculates the time difference between the intention initiation time and the limb response time; and body schema integrity test, which uses a modified Moseley body matrix task, presenting 72 sets of body part images and recording recognition accuracy and reaction time [9-10]. The physiological monitoring system integrates a heart rate variability analyzer (Polar H10), a surface electromyography (EMG) acquisition device (Delsys Trigno), and a portable EEG device (Emotiv EPOC X). The heart rate variability index extracts the ratio of low-frequency power (LF) to high-frequency power (HF) to reflect the autonomic nervous system balance; EMG signals are collected from the biceps brachii, quadriceps femoris, and gastrocnemius muscles to calculate the co-contraction index.

C. IMPLEMENTATION PATH OF THE THREE-STAGE INTERVENTION MODEL

The initial (1-6 months) phase entailed a proprioceptive reconstruction training. The subjects did exercises of scanning the body in a supine position and felt the spatial position and muscle tension of the joints, beginning with the toes. Each time was 20 minutes and twice a day. The training in standing meditation entailed 30 minutes of sitting in the three-body posture with the knee flexion angle monitored continuously to keep the angle within 135° and the actual tactile response used to identify the postural changes. Microkinetic awareness training consisted of single movements done at incredibly slow speeds; the Tai Chi Cloud Hands performance time was increased to 8-10 minutes, and the participants had to recount the model of muscles activation and the path the weight was transferred by every moment. To prevent muscular fatigue from confounding the EMG data, participants were trained to utilize “effortless power” (Song) principles, and the 10-minute duration was reached progressively. Furthermore, EMG data collection was restricted to the median 4-minute window of the exercise to ensure that signals reflected neural awareness rather than physiological exhaustion.

The second stage (7-12 months) is development of a perception consciousness-motor feedback cycle. The training breathing guidance is based on a 4-2-6s rhythm of breathing 4 seconds inhalation, 2 seconds pause, and 6 seconds exhalation, as foundations of shoulder and elbow relaxation movement. EMG recording proves that the upper trapezius muscle relaxation rate exceeds more than three-quarters of the original rate. In mind-guided practice, the

participants need to give the command intention 3 seconds before making any movement. IMU sensors ensure that the time interval between the conscious command and the limb response is reduced to a range of 200 milliseconds. Mirror observation training: a coach shows a boxing maneuver to the participants; they memorize the image of the movement standing with their eyes closed and then perform the movement with their eyes open. The similarity coefficient of the trajectory demonstrated and the executed one is compared in the frame of the kinematic analysis.

The third stage (13-18 months) is the holistic practice. Regular training exercises are combined with self-reflective surveillance actions. The forms of Chen-style routine must be completed correctly as the participants are expected to report on the breathing phase and the intensity of interoceptive abdominal pressure (traditionally termed ‘qi sensation’) at six preset time points. This subjective metric was cross-validated with intra-abdominal pressure fluctuations and lower-rectus electromyography to provide a standardized physiological correlate for the reported internal sensations. Partner push-hands training involves application of progressive contact pressure (starting with 50N, slowly escalating to 150N), whereby the participants are expected to determine the direction of the force of the opponent basing on skin receptor feedback, and the desired error rate is 85%.

D. DATA ANALYSIS AND STATISTICAL METHODS

The multidimensional weighted model is used to compute the mind-body synergy index; it incorporates proprioceptive acuity (weight 35%), perception-motor coupling (weight 30%), body schema integrity (weight 20%) and autonomic balance indicators (weight 15%). These weights were determined through a preliminary Principal Component Analysis (PCA) conducted on the baseline data, which identified proprioceptive acuity as the primary factor explaining the highest variance in mind-body synergy, followed by motor coupling and schema integrity. Proprioceptive acuity is normalized by transforming the angular perception deviation scores into a percentage and a deviation of 0 degrees corresponds to 100 points, deviation of 90 degrees corresponds to 0 points and the score decreases linearly. Perception-motor coupling is rated in regards to the time difference of intention to limb response where a time difference of 0 milliseconds would receive full marks and a time difference of above 500 milliseconds would receive 0 marks, where an exponential decaying factor is used to convert the scores.

The intervention effect was tested using repeated measures ANOVA. The independent variables included a group (intervention/control) and time (baseline/mid-term/final) whereas the dependent variable included the psychophysical synergy index, as well as all the sub-dimension scores. The hypothesis was tested with the help of the Mauchly method and the Greenhouse-Geisser correction when the hypothesis was broken. A control of false positives in post-hoc comparisons was done through Bonferroni method at a level of significance of 0.05.

Partial eta-squared effect sizes were assessed: 0.01–0.06 was considered a small effect, 0.06–0.14 a moderate effect, and greater than 0.14 a large effect.

IV. RESULTS AND DISCUSSION

A. THE GENERATION MECHANISM AND REPRESENTATION OF PERCEPTUAL ALIENATION

The three-dimensional portrayal of perceptual alienation was identified in the baseline assessment. The average deviation of perception of the knee angle in the proprioceptive test was 12.4 degrees with a higher deviation among the 182 participants practicing external martial arts (14.2 degrees) as compared to those practicing internal martial arts (10.6 degrees). These baseline figures, while reflecting a degree of modern “perceptual alienation,” are consistent with standardized joint-position reproduction errors observed in athletes transitioning from standardized technical drills to refined introspective awareness. The practice records indicated that 73.4% of the participants were not able to find the fourth lumbar vertebra accurately, and instead, found it vaguely as the lumbar area. The inertial measurement unit recorded an average delay of 682 milliseconds between the initial intention and limb reaction with some respondents reporting delays of more than 1200 milliseconds, suggesting a gross disconnection between the body and consciousness.

B. QUANTITATIVE EVALUATION OF THE EFFECTS OF THE THREE-STAGE INTERVENTION

Repeated measures ANOVA was used to test the interaction effect between group and time and observed it to be statistically significant with F-value of 127.83, degrees of freedom 2, and 732, P-value less than 0.001 and a partial eta squared value of 0.259. The psycho-physical synergy index of the intervention group rose at baseline to mid-term to 63.7 and finally to 78.6, whereas the control group showed a moderate natural progression from 41.9 to 52.4. This significant divergence ($P < 0.05$) highlights that while traditional repetitive training yields incremental gains in coordination, the targeted intervention model accelerates the integration of subjective perception and objective motor execution. Bonferonni post-hoc analyses demonstrated that the difference between all time points in intervention group was significant (P-values smaller than 0.001), but the difference between time points in the control group was not significant. The quantitative results are found in Table 2.

TABLE 2. Quantitative Results

Measurement indicators	Baseline period of intervention group	End of intervention group	Baseline period of control group	Control group end period
Mind-Body Synergy Index	42.3 ± 6.8	78.6 ± 5.2***	41.9 ± 7.1	44.2 ± 6.9
Proprioceptive acuity (points)	38.4 ± 8.3	70.5 ± 6.7***	37.8 ± 8.6	39.1 ± 8.4
Perception-Movement Coupling Degree (points)	35.6 ± 9.1	68.1 ± 7.4***	36.2 ± 9.3	37.5 ± 9.1
Body schema integrity (%)	52.7 ± 11.2	89.3 ± 8.6***	51.9 ± 10.8	53.4 ± 10.6
LF/HF ratio	3.42 ± 0.86	1.78 ± 0.52***	3.38 ± 0.91	3.29 ± 0.88
Synergistic contraction index	1.87 ± 0.43	0.94 ± 0.28***	1.84 ± 0.46	1.81 ± 0.44

Note: *** indicates $P < 0.001$.

Table 2 indicates that the intervention model has a systematic improvement effect of different dimensions of indicators. There was an improvement in proprioceptive acuity by 83.7 and a reduction in deviation of the perception

of the knee joint angle by 27.6 to 7.2 degrees, which demonstrates that mindfulness training is beneficial in re-creating the body self-awareness. The perception-motor coupling was enhanced by 91.2 and intention-limb response delay reduced which was 682 milliseconds to 126 milliseconds confirming the establishment of a dynamic feedback loop was successful. The body schema integrity rose to 89.3% and subjects could identify the location correctly of all the parts of the spine. The autonomic balance also improved greatly, the LF/HF ratio dropped to 1.78, the synergistic contraction index fell to 0.94 and muscle activation patterns turned fluid and regular, which proved that deep integration of the mind-body system was reached with the help of holistic practice.

C. VALIDATION OF THE PRACTICAL PATH FOR MIND-BODY SYNERGISTIC REGRESSION

Three main turning points were identified and the behavioral changes were monitored. At the 47th day of training in the standing meditation, there was a slight knee joint tremor with a local heat sensation in the intervention group members 83.3% which was the awakening of proprioceptive awareness. During the breathing guidance training, electromyography demonstrated that relaxation rate of the trapezius muscle was above the threshold on day 112 and spontaneously, a deep and prolonged exhalation occurred and then followed by initiation of the movement. The participants indicated the fluid experience of the body knowing the next movement, and the kinematic analysis demonstrated the smoothness coefficient of movement trajectory increased to 0.87 on day 203 in the routine practice as they indicated, which was smooth and demonstrated the seamless connection between representational consciousness and limb.

TABLE 3. Indicators of Key Turning Points in the Return to Mind-Body Synergy

Turning point	Time window (days)	Behavioral markers	Changes in physiological indicators	Subjective experience reporting rate (%)
Proprioceptive Awakening	47 ± 12	Knee joint trembling and warm sensation	Skin temperature rose by 1.8°C	83.3
Breathing-Motion Coupling	112 ± 18	Exhaled deeply spontaneously before starting the movement	The respiratory muscle activation rate reached 68.7%	76.9
Mind-Body Fusion	203 ± 25	Anticipate the next move	The trajectory smoothness coefficient is 0.87	91.4
Overall Flow Experience	289 ± 31	State of complete absorption	The power of frontal lobe data waves increased by 217%	85.8
Mind-body unity and self-awareness	376 ± 28	The body becomes the subject	Body schema integrity: 94.2%	87.4

Table 3 shows that the return to mind-body synergy follows a gradual trajectory from local awareness to holistic integration. The 1.8°C increase in skin temperature during the proprioceptive arousal stage stems from improved micro-circulation, validating the activation of the neuro-endocrine-immune network. The relaxation rate of the trapezius muscle at the respiratory-motor coupling node reached 68.7%, confirming the involvement of the parasympathetic nervous system in motor regulation. The trajectory smoothness coefficient jumped to 0.87 during the intention-limb fusion stage, indicating coordination between central commands and peripheral execution.

V. CONCLUSION

Through an 18-month longitudinal intervention experiment, this study validated that current martial arts practition-

ers display perceptual alienation and muscle compensation patterns that mirror the mechanical fragmentation found in non-integrated engineering processes. These deficiencies in proprioception and mind-body connection represent a departure from the seamless operational logic and technical excellence required in the modern industry. This disconnection is brought about by the loss of bodily subjectivity through rational thinking of technology. This model of the three stages of intervention was successful in restoring the overall mind-body synergy. Mind-body synergy index in the intervention group led to an increase of 42.3 point to 78.6 point at the baseline and end, thought-body response delay was shortened to 682 milliseconds to 126 milliseconds and balance of the autonomic nervous system was greatly enhanced and the ratio of LF/HF was reduced to 1.78. The successive outcome of follow-up monitoring showed that the recovery of mind-body synergy is a progressive process: proprioceptive awakening, breath-movement, thought-body fusion, holistic flow experience, conscious mind-body unity. The research confirms that introspective training restores bodily self-awareness by developing dynamic feedback loops that mirror the synchronized precision of modern engineering systems. This synergistic perception-consciousness-movement framework facilitates a holistic practice that transforms the body into a subject of existence, aligning with the integrated operational excellence of the contemporary industry.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Ethics Committee of Ningde Normal University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

AUTHOR CONTRIBUTIONS

Conceptualization – Qiwei Wu and Mengsha Chen; methodology – Qiwei Wu and Mengsha Chen; investigation – Qiwei Wu and Mengsha Chen; writing-original draft preparation – Qiwei Wu and Mengsha Chen. All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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