

# Holistic Hierarchical Predictive-Integration Theory (HHPIT): An Exploration of AI-Empowered Innovation and Empirical Research in Traditional Chinese Medicine Meridian Theory

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**Abstract:** By 2025, research on Traditional Chinese Medicine (TCM) meridians has generated 12–15 macro-level theories and over 20 specific hypotheses, manifesting a highly fragmented research landscape. *Objective:* This paper proposes the “Holistic Hierarchical Predictive-Integration Hypothesis” (HHPIT) to construct a unified theoretical framework that integrates the rational components of existing meridian hypotheses. *Methods:* The HHPIT hypothesis systematically reviews current meridian theories, employs interdisciplinary methodologies, integrates artificial intelligence technology, and establishes a three-tier architecture encompassing structural, functional, and systemic layers. *Results:* HHPIT successfully integrates diverse meridian theories, proposes a computable algorithmic pipeline, and provides specific application protocols for chronic disease treatment, anti-aging, and enhancement of Zang-fu organ functions. *Conclusion:* HHPIT offers a novel, computable, and verifiable research paradigm for meridian studies, promoting the modernization and internationalization of TCM theory.

**Keywords:** Holographic hierarchical prediction integration; Meridian research; Artificial intelligence; Modernization of Traditional Chinese Medicine; Multimodal data fusion

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## 1. Introduction

### 1.1. Current state of meridian research

As of 2025, scholars both domestically and internationally have proposed approximately 12–15 categories of

macroscopic theories, further subdivided into over 20 specific hypotheses to explain meridian phenomena <sup>[1-7]</sup>. These primarily include neural theories, humoral theories, energy/biofield theories, fascia/connective tissue theories, among others.

## 1.2. Research progress in the integration of AI and traditional Chinese medicine

In recent years, multiple research teams have attempted to combine AI technology with traditional Chinese medicine (TCM) theories. For instance, the “Xuanhu Zhiyu” team developed an AI-powered TCM brain intelligent diagnosis and treatment system, capable of generating a comprehensive assessment report covering 64 indicators, including organ function and meridian Qi-blood status, within 2 minutes through pulse diagnosis instruments and tongue diagnosis image analysis.

## 2. Theoretical foundations and construction logic of the HHPIT hypothesis

### 2.1. Theoretical origins and disciplinary foundations

#### 2.1.1. Traditional Chinese medicine

Theory The “Huangdi Neijing”, regarded as the foundational text of TCM theory, provides the core ideological basis for the HHPIT hypothesis. The statement in “Su Wen: Pulse Essentials and Subtle Discrimination” that “the pulse is the residence of blood” clarifies the vascular system as the material foundation for Qi-blood circulation. Meanwhile, “Ling Shu: Meridians” states that “when grain enters the stomach, the meridian pathways become unobstructed, and Qi-blood flows”, indicating that the physiological activities of the organs and viscera serve as the power source for meridian function. These theories provide classical theoretical support for the “holographic information field” concept within the HHPIT hypothesis.

#### 2.1.2. AI and technological theories

Predictive coding theory, originating from modern neuroscience, constitutes one of the core functional mechanisms of the HHPIT hypothesis. This theory posits that the brain understands the world through continuous comparison between predictions and sensory inputs, a mechanism highly congruent with the HHPIT hypothesis’s proposal that the meridian system achieves regulatory functions through the minimization of prediction errors.

### 2.2. Hypothesis construction methodology and process

Initially, semantic network analysis was conducted on over 20 existing meridian hypotheses, categorizing them into three major groups based on their core viewpoints and methodological characteristics. See **Table 1**.

**Table 1.** Classification of meridian hypotheses and corresponding integration with HHPIT

Hypothesis category	Representative hypotheses	Core elements	HHPIT integration direction
Structural	Neural Theory, Fascia Theory, Interstitial Space Hypothesis	Physical Channels, Network Topology, Low-dimensional Structures	Multimodal Structural Layer (Hardware)
Functional	Energy Field Theory, Cybernetics, Dual Reflex Theory	Information Flow, Feedback Regulation, Dynamic Equilibrium	Predictive Coding Functional Layer (Software)
Systemic	Third Equilibrium, Meridian-Qi Ontology, Holographic Field Theory	Holism, Self-organization, Long-distance Correlation	Holographic Regulation Layer (Wisdom)

### **3. Core connotations and architecture of the HHPIT hypothesis**

#### **3.1. Three-tier architecture and its integration relationships**

##### **3.1.1. Structural layer (Hardware layer)**

The structural layer serves as the material foundation for the realization of meridian functions, corresponding to the physical elements in traditional hypotheses such as neural theories, fascia theories, and humoral theories. The HHPIT hypothesis posits that the structural basis of meridians is not a single tissue but rather a synergistic coupling of multiple anatomical structures:

- (1) Neural network  
Includes peripheral and central nerves, responsible for rapid electrical signal transmission.
- (2) Fascial network  
A continuous 3 dimensional network composed of connective tissue throughout the body, exhibiting semiconductor and piezoelectric effects.
- (3) Humoral network  
Comprises blood, lymph, and interstitial fluid, responsible for chemical signal transmission.
- (4) Vascular network  
Includes arteries, veins, and microvessels, providing energy and material transport.

##### **3.1.2. Functional layer (Software layer)**

Drawing on predictive coding theory, the HHPIT hypothesis proposes that the core functional mechanism of the meridian system is hierarchical predictive integration.

- (1) Prediction generation  
Higher-level structures generate predictions about physiological states based on internal models and prior experiences.
- (2) Error calculation  
Lower-level structures compare real-time physiological signals with predictions to generate prediction errors.
- (3) Bidirectional transmission  
Prediction errors are transmitted bottom-up to update higher-level internal models; optimized predictions are then transmitted top-down to regulate physiological processes.
- (4) Error minimization  
The system maintains homeostasis and health by continuously minimizing prediction errors.

##### **3.1.3. System layer (Wisdom layer)**

The HHPIT hypothesis introduces holographic principles to describe the holistic behavior of the meridian system.

- (1) Holographic mapping  
Any functional unit within the meridian network (e.g., an acupoint) is holographically mapped to other parts of the body and its overall function.
- (2) Phase synchronization  
Local stimuli (e.g., acupuncture) can induce global phase synchronization within the holographic network, enabling remote regulation.
- (3) Adaptive regulation  
The system automatically adjusts its functional state based on real-time physiological data to adapt to

environmental changes.

(4) System emergence

Meridian functions are emergent properties resulting from the high-level coordination of multiple components and cannot be reduced to the functions of individual components.

### **3.2. Holographic mapping mechanism and predictive integration principle**

The predictive integration principle manifests as follows: The meridian system achieves coordination and unity from the microscopic to the macroscopic level through multi-level prediction error minimization<sup>[8-10]</sup>. This includes:

(1) Microscopic predictive integration

Regulation of cellular metabolism and signal transduction.

(2) Mesoscopic predictive integration

Regulation of physiological functions at the tissue and organ levels.

(3) Macroscopic predictive integration

Maintenance of homeostasis at the overall level.

### **3.3. Mathematical expression of the HHPIT hypothesis**

Based on the integration of multiple meridian theories, the HHPIT hypothesis proposes the following mathematical expression:

Including:

(1) Structure-Function

Represents the coupling of structures such as nerves and fascia with functions such as electromagnetic and chemical properties.

(2) Prediction-Integration

Originates from cybernetics and the third equilibrium system.

(3) Holographic mapping

Inherits from the meridian Qi ontology and biofield theories.

## **4. Computational implementation and technical pathway of the HHPI hypothesis**

### **4.1. Multimodal data acquisition and preprocessing**

The validation of the HHPIT hypothesis requires support from multimodal, cross-scale data. Data acquisition primarily encompasses the following aspects:

(1) Neuroimaging data

Utilizing Diffusion Tensor Imaging (DTI) to visualize the orientation of nerve tracts and validate the association between meridians and the nervous system.

(2) Fascial imaging data

Employing high-field MRI elastography and three-dimensional ultrasound elastography to demonstrate the continuity of the fascial layer and its relationship with meridian pathways.

(3) Microstructural data

Applying super-resolution microscopy and Atomic Force Microscopy (AFM) to observe microstructures

such as intercellular spaces, exploring the microscopic foundation of meridians.

## 4.2. Construction of the meridian network

### 4.2.1. Predictive model construction

A predictive model of the meridian system is constructed based on a hierarchical Bayesian network to simulate the system's predictive integration mechanism. This model includes:

- (1) Prior distribution  
Constructed based on historical data and expert knowledge.
- (2) Likelihood function  
Describes the relationship between observed data and model predictions.
- (3) Posterior distribution  
Obtained through Bayesian updating, reflecting the system's adaptive learning.

### 4.2.2. Intervention optimization strategies

Reinforcement learning algorithms are applied to optimize acupuncture intervention strategies:

- (1) State space  
Defines the state variables of the meridian system.
- (2) Action space  
Define the parameters of acupuncture interventions (acupoint selection, stimulation method, intensity, etc.).
- (3) Reward function  
Designed based on intervention effects to guide the agent in learning optimal strategies.

## 5. Application plan and validation of the HHPIT hypothesis

### 5.1. Clinical application plan

#### 5.1.1. Acupoint selection plan for common chronic diseases

The following is an AI-analyzed acupoint selection plan for common chronic diseases (**Table 2**):

**Table 2.** AI-Recommended acupoint list for common chronic diseases

Disease/condition	Main acupoints	Supplementary acupoints	Hub acupoint (s)	AI selection rationale
Hypertension	LI4 (Hegu), LR3 (Taichong)	ST9 (Renyang), GB20 (Fengchi)	LI4 (Hegu)	Regulates sympathetic-parasympathetic balance, improves cervical vascular tension.
Type 2 diabetes	ST36 (Zusanli), SP6 (Sanyinjiao)	LI11 (Quchi), KI3 (Taixi)	ST36 (Zusanli)	Regulates insulin sensitivity, improves glucose metabolism.
Chronic low back pain	BL23 (Shenshu), GB30 (Huantiao)	DU3 (Yaoyangguan), LI4 (Hegu)	LI4 (Hegu)	Regulates local blood circulation, inhibits pain signal transmission.
Insomnia/anxiety	HT7 (Shenmen), PC6 (Neiguan)	SP6 (Sanyinjiao), GV20 (Baihui)	PC6 (Neiguan)	Regulates autonomic nervous system balance, influences emotional centers.
Chronic gastritis	ST36 (Zusanli), CV12 (Zhongwan)	PC6 (Neiguan), LI4 (Hegu)	ST36 (Zusanli)	Regulates gastrointestinal motility, improves gastric acid secretion.

### 5.1.2. Acupoint selection plan for delaying aging

Based on different constitutional types, the following acupoint plans are recommended:

- (1) Balanced constitution  
ST36 (Zusanli), CV4 (Guanyuan), CV6 (Qihai), LI4 (Hegu)
- (2) Qi deficiency constitution  
ST36 (Zusanli), CV4 (Guanyuan), CV6 (Qihai), RN17 (Shanzhong)
- (3) Yang deficiency constitution  
DU4 (Mingmen), BL23 (Shenshu), ST36 (Zusanli), DU14 (Dazhui)
- (4) Yin deficiency constitution  
KI3 (Taixi), SP6 (Sanyinjiao), KI1 (Yongquan), ST36 (Zusanli)

### 5.1.3. Acupuncture point selection protocol for enhancing the functions of the five Zang and six Fu organs

Based on the HHPI hypothesis, the enhancement of the functions of the Five Zang and Six Fu Organs relies on the holistic optimization of the holographic network. This study proposed the “Shu-Yuan-Shu” (Back-Shu, Yuan-Source, and Network-Hub) point combination method, i.e., the combination of Back-Shu points (information entry points) + Yuan-Source/Luo-Connecting points (primary driving force) + Network Hub points (information transmission enhancement):

- (1) Heart  
BL15 (Xinshu), RN17 (Danzhong), LI4 (Hegu)
- (2) Liver  
BL18 (Ganshu), LV8 (Ququan), ST36 (Zusanli)
- (3) Spleen  
BL20 (Pishu), RN12 (Zhongwan), ST36 (Zusanli)
- (4) Lung  
BL13 (Feishu), RN6 (Qihai), LI4 (Hegu)
- (5) Kidney  
BL23 (Shenshu), KI3 (Taixi), ST36 (Zusanli)

## 5.2. Limitations analysis and future directions

As a newly proposed theoretical framework, the HHPIT hypothesis inevitably has some limitations:

- (1) Data integration challenges  
Technical difficulties persist in the acquisition, registration, and integration of multimodal, cross-scale data.
- (2) Model complexity  
The multi-level, nonlinear characteristics of the meridian system make model construction extremely complex.
- (3) Validation difficulties  
Verifying the holographic mapping and predictive integration mechanisms requires innovative experimental designs.

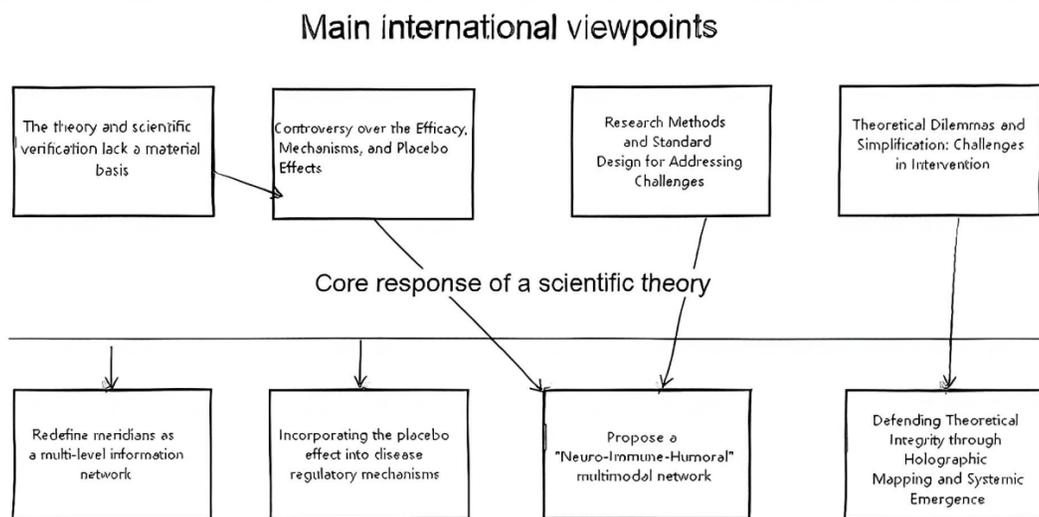
Future research directions include:

- (1) Developing neural network architectures specifically tailored to traditional Chinese medicine theory, incorporating prior knowledge.
- (2) Utilizing interpretable AI techniques to analyze model decision-making processes and enhance the interpretability of results.
- (3) Conducting large-scale, multicenter randomized controlled trials to validate the clinical value of the HHPIT hypothesis.

## 6. Discussion and conclusion

### 6.1. Innovativeness of the HHPIT hypothesis

The HHPIT hypothesis introduces advanced technologies such as artificial intelligence, providing new tools and methods for meridian research. Through technological innovations like multimodal data fusion, graph neural networks, and predictive coding, it enables multi-scale, dynamic, and systematic research on the meridian system. This guides future research to shift from simple comparisons of “real versus fake” to quantifying differences in the integration efficiency of the holographic network induced by different stimuli. See **Figure 1**.



**Figure 1.** Main international viewpoints.

### 6.2. Future research prospects for the HHPIT hypothesis

Future research on HHPIT should focus on the following aspects:

- (1) Innovation in data acquisition technology  
Develop more precise and non-invasive techniques for collecting meridian information.
- (2) Optimization of computational models  
Construct more accurate and efficient computational models of the meridian system.
- (3) Large-scale clinical validation  
Verify the clinical value of the HHPIT hypothesis through multi-center, large-sample clinical trials.
- (4) Interdisciplinary collaboration mechanisms  
Establish more effective interdisciplinary collaboration mechanisms to promote the deep integration of

traditional Chinese medicine with modern science.

Ultimately, the HHPIT hypothesis contributes to the internationalization of traditional Chinese medicine and supports efforts to preserve and pass down Chinese medical heritage.

## Disclosure statement

The authors declare no conflict of interest.

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