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Functional Assessment of Physiological Changes in Traditional Chinese Medicine

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by

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“Move swift as the Wind and closely-formed as the Wood. Attack like the Fire and be still as the Mountain.”

Sun Tzu

Abstract

Traditional Chinese medicine (TCM) is a systematic healthcare system developed from clinical experience based on a scientific model of regulation. TCM relies on unique theories and practices to treat diseases and enhance health. These practices include Chinese herbal medicine and dietetics, acupuncture and moxibustion, and other non-medication therapies such as Chinese bodywork or manual therapy, known as “Tuina”, and traditional biofeedback exercises, known as “Qigong” and “Taijiquan”.

The integration of TCM in Western health systems and research requires a rational communicable theory, scientific proof of efficacy and safety, and quality control measures. Understanding the structural concepts of the TCM language may enable its translation by terms of Western physiology and the inherent rational use of the reflex therapeutic systems, anti-inflammatory mechanisms, and mental training involved, for example, in acupuncture and “Qigong”. Indeed, clear definitions and diagnosis standardization are critical factors in accurately establishing the patient’s vegetative functional status and, therefore, systematically applying TCM therapeutics such as the stimulation of reflex skin areas known as acupoints. This science-based conceptualization entails using validated methods or developing new systems to parameterize the diagnosis and assess TCM-related effects by objective measurements. Traditionally, tongue and pulse diagnosis and the functional evaluation of action points by pressure sensitivity and physical examination may be regarded as essential diagnostic tools. Parameterizing these techniques is a future key point in the objectification of TCM diagnoses, such as electronic digital image analysis, mechanical pulse diagnostic systems, or the systematic evaluation of acupoints’ electrophysiology.

Because acupoints have bioelectrical properties distinct from common skin, the electrophysiology of these anatomical structures was explored in two studies included in the present thesis. Besides the higher electrical conductance and lower resistance, acupoints show capacitor-like properties, which can be related to their endogenous electrical potential. TCM postulates that meridians, conduits or channels are physiological structures connecting acupoints and working as a conduit for the flow of two essential functional powers known as “qi” and “xue”.

One of the pilot studies mentioned above is presented in Chapter 3. It was focused on evaluating whether the electrical potential of acupoints can be correlated objectively to the functional properties as described by ancient Chinese medical theories, such as the theories of coupled channels of the same phase (“elements”) and the principle of coupled points. Direct needle moxibustion on “Chize” (LU5) and needle dispulsion of “Hegu” (LI4) were performed in 21 subjects. The electrical potential of each acupoint was measured with

a high-resolution data acquisition system taking to reference the acupoint “Sanyinjiao” (SP6) of the Spleen conduit. The results may indicate a functional relationship between the therapeutics and the electrical potential response on the selected acupoints. These effects seem to be explainable considering the specific properties of each acupoint, the relationship between TCM phases, and the dynamics between coupled conduits.

The second pilot study, presented in Chapter 4, aimed to assess the skin electrical potential changes in acupoints from the “Ren Mai” and “Du Mai” conduits and other points of interest during “Qigong” practice. “Qigong” is a therapeutic method of TCM that combines slow, soft movements and postures with breath control and a particular mental state of “awareness”. TCM holds that the practice of “Qigong” promotes the “circulation of qi” in the human body, the “flow” of upwards “yang qi” and downwards “yin qi” to establish “balance”. In Western terms, this may generally be regarded as part of the vegetative homeostasis and the emotionally balanced state induced thereby. Researchers have often attempted to evaluate the functional movements of “qi” using measurements of the skin’s electrical resistance. However, these methodologies have proven challenging to gauge, validate, repeat and interpret. We aimed to overcome these limitations by measuring the skin electrical potential between two points of the same system. While participants performed a specific “Qigong” exercise called “White Ball”, we observed significant changes in the skin electrical potential on “Mìngmén” (GV4), “Shèndáo” (GV11) and “Baihuì” (GV20), from the “Du Mai” conduit, as well as on “Huiyin” (CV1), “Qìhai” (CV6), “Zhongwan” (CV12) and “Dànzhong” (CV17), from “Ren Mai”. These observations follow TCM theory and may help explain the vegetative physiological changes associated with “qi flow” in TCM. Indeed, evaluating the endogenous electrical potential of acupoints and the changes caused by an external stimulus might contribute to understanding TCM concepts, mechanisms, and the effects of associated therapeutics. The observed phenomena encourage the systematic assessment of the functional vegetative status via skin electrophysiology and objective measurements.

TCM holds that “xue” is moved by the “qi” and guided by the mind's intention. Therefore, activating the “qi” flow during “Qigong” practice depends on the practitioner’s particular mental state of awareness, which triggers the manifestation of vegetative physiological changes, such as increasing the microcirculation and changes in the electrical potential of the skin. “Qigong” integrates two main categories known as internal “Qigong”, often used as a self-regulation practice, and external “Qigong”, often used as a hetero-treatment. In both categories, the practitioner’s intention is believed to play an essential role in the process. Because the mechanisms behind intention effects, particularly in external “Qigong” therapy and similar practices, are not clear-cut, a controlled trial and a follow-up

study were carried out on this subject. Those studies are shown in Chapters 5 and 6, respectively.

Within this field, practices such as “Reiki”, therapeutic touch, healing touch, and external “Qigong” have been regarded as some form of “energy medicine” or “biofield therapy”. The biofield concept has been studied and debated by researchers of distinct areas of expertise. Although the phenomenon was sometimes described as physically related to electromagnetics, other factors such as “subtle energy” and focused intention were described as involved. These nonconventional practices integrate contact and non-contact techniques, and those dealing with so-called distant healing interventions are perhaps the most difficult to understand and accept. Practitioners describe these so-called nonlocal interventions as involving intentional factors and particular states of consciousness. With a spiritual mindset and a particular state of awareness, compassion is said to work out as a catalyst to produce physiological and physical changes through mechanisms that are still unproven. At the physical level, these vegetative changes might be related to developing individual self-perception as part of the body's neurovegetative feedback regulation system. Further mechanisms are difficult to document and measure and might be more accessible to research by using physical signal detectors, chemical dynamics methods, biological materials, living sensors, and detectors using the human body.

As the main component of the human body, water was chosen as a model in the controlled trial on focused intention presented in Chapter 5. Intention experiments were performed over four different days at a scheduled interval, during which 286 trained biofield practitioners from several countries were instructed to meditate to change the molecular vibrational state of water samples selected by a blinded operator. The experimental protocol was randomized, blinded, and controlled; the measured variables included water’s Raman spectra, pH and electrical conductivity, and the magnetic field and UV-VIS radiation near the experimental spot. Although a direct causal relationship cannot be established, some parameters of the water samples and the magnetic field and radiation near the experimental spot changed during the experimental period. The follow-up study presented in Chapter 6 explored the hypothetical effects of intention on conditioning a pH system with continuous data acquisition for real-time measurements. Changes in the physicochemical properties of water samples chosen as a target in the intervention involving focused intention were evaluated in that study. After the main experimental period, real-time pH measurements of water samples were taken with the same equipment and under the same experimental conditions, except for the practitioners’ awareness of those experiments and, consequently, without their focused intention. Real-time pH, electrical conductivity, and the concentration

of cations and anions measured by ion chromatography in the water samples were used to test the hypothesis.

Further continuous measurements showed that the pH variations over time kept a systematic and consistent tendency similar to those observed during the experimental activities involving focused intention. However, after the electrode internal electrolyte replacement, this behavior was no longer verified, and the pH was stable as the initial tests to evaluate the equipment sensitivity. This behavior has led to the theoretical assumption that an eventual intention-mediated conditioning of the pH measurement system may have hypothetically occurred by changes in the electrode internal electrolyte properties.

Keywords: traditional Chinese medicine; Heidelberg model of TCM; acupuncture; “Qigong”; electrophysiology; focused intention.

Resumo

A medicina tradicional chinesa (MTC) é um sistema de prestação de cuidados de saúde sistemático, desenvolvido a partir da experiência clínica, tendo por base um modelo científico de regulação. A MTC baseia-se em teorias e práticas específicas para tratar doenças e melhorar a saúde. Essas práticas incluem a fitoterapia e dietética Chinesa, a acupuntura e moxabustão e outras terapias não medicamentosas, como a massagem tradicional Chinesa ou terapia manual, conhecida como "Tuina", e exercícios tradicionais de *biofeedback*, conhecidos como "Qigong" e "Taijiquan".

A integração da MTC nos sistemas de saúde ocidentais e na investigação requer cumulativamente a existência de uma base teórica racional e objetiva, a existência de evidência científica de eficácia e segurança e medidas de controlo de qualidade. A compreensão dos conceitos estruturais da linguagem da MTC permite a sua tradução por termos da fisiologia ocidental e o uso racional dos sistemas terapêuticos reflexos, mecanismos anti-inflamatórios e treino mental envolvidos, por exemplo, na acupuntura e no “Qigong”. A existência de conceitos bem definidos e a padronização do diagnóstico são fatores críticos para estabelecer com precisão o estado funcional vegetativo do paciente e, desta forma, aplicar de forma sistemática as terapêuticas da MTC, que incluem a estimulação de áreas reflexas da pele conhecidas como pontos de acupuntura. Esta conceptualização baseada na ciência requer o uso de métodos validados ou mesmo o desenvolvimento de novos sistemas para parametrizar o diagnóstico e avaliar os efeitos da MTC por medições objetivas. Tradicionalmente, o diagnóstico da língua, do pulso e a avaliação funcional de pontos específicos recorrendo à sensibilidade e ao exame físico podem ser consideradas ferramentas essenciais de diagnóstico. Parametrizar essas técnicas é essencial para a objetivação do diagnóstico da MTC, como por exemplo, fazendo uso da análise de imagem digital, de sistemas mecânicos de diagnóstico de pulso ou da avaliação sistemática da eletrofisiologia dos pontos de acupuntura.

Dado que os pontos de acupuntura têm propriedades bioelétricas distintas da restante pele, dois dos estudos incluídos na presente tese exploraram alguns aspetos relacionados com a eletrofisiologia dessas estruturas anatómicas. Para além da maior condutância, ou seja, menor resistência elétrica, os pontos de acupuntura apresentam propriedades similares às dos condensadores, com efeitos no potencial elétrico endógeno. A MTC teoriza que os meridianos, condutos ou canais são estruturas fisiológicas que unem pontos de acupuntura e funcionam como um canal para a circulação de duas capacidades funcionais conhecidas como “qi” e “xue”.

O estudo piloto apresentado no Capítulo 3, teve como objetivo avaliar se o potencial elétrico dos pontos de acupuntura pode ser correlacionado objetivamente com as

propriedades funcionais descritas por teorias da MTC, como a teoria dos canais acoplados da mesma fase ("elementos") e o princípio de pontos acoplados. Para tal, procedeu-se a moxabustão direta na agulha no ponto “Chize” (LU5) e a dispersão da agulha no ponto “Hegu” (IG4) em 21 indivíduos. O potencial elétrico de cada ponto de acupuntura foi medido com um sistema de aquisição de dados de alta resolução tendo como referência o ponto de acupuntura "Sanyinjiao" (SP6) do conduto do Baço. Os resultados sugerem uma relação funcional entre a terapêutica e o potencial elétrico medido nos pontos de acupuntura selecionados. As alterações no potencial elétrico parecem ser explicáveis considerando as propriedades específicas de cada ponto de acupuntura, a relação entre as fases da MTC e a dinâmica entre os canais acoplados.

O segundo estudo piloto apresentado no Capítulo 4, teve como objetivo avaliar as alterações do potencial elétrico da pele em pontos de acupuntura dos condutos “Ren Mai” e “Du Mai”, bem como noutros pontos de interesse durante a prática de “Qigong”. O “Qigong” é um método terapêutico de MTC que combina posturas e movimentos lentos e suaves com o controlo da respiração e um estado particular de “consciência”. A MTC considera que a prática do “Qigong” promove a “circulação do qi” no corpo humano, o “fluxo” ascendente do “qi yang” e descendente do “qi yin” para estabelecer o “equilíbrio”. Em termos ocidentais, isso pode ser considerado parte da homeostasia vegetativa e do estado de equilíbrio emocional associado. Vários investigadores tentaram avaliar as propriedades funcionais do "qi" usando medições da resistência elétrica da pele. No entanto, essas metodologias apresentam limitações ao nível da medição, validação, reprodutibilidade e interpretação. Neste estudo, mediu-se o potencial elétrico da pele entre dois pontos do mesmo sistema para tentar superar essas limitações. Durante a prática de um exercício específico de “Qigong” denominado “White Ball”, observaram-se mudanças significativas no potencial elétrico da pele dos participantes nos pontos “Mìngmén” (GV4), “Shèndáo” (GV11) e “Baihuì” (GV20), do canal “Du Mai”, bem como em “Huiyin” (CV1), “Qìhai” (CV6), “Zhongwan” (CV12) e “Dànzhong” (CV17), do canal “Ren Mai”. Essas observações parecem estar de acordo com aspetos teóricos da MTC e podem ajudar a explicar as mudanças fisiológicas vegetativas associadas ao "fluxo de qi". A avaliação do potencial elétrico endógeno dos pontos de acupuntura e as mudanças causadas por um estímulo externo podem contribuir para a compreensão dos conceitos, mecanismos e efeitos das terapêuticas. Os fenómenos observados encorajam a avaliação sistemática do estado vegetativo funcional recorrendo à eletrofisiologia da pele e a medições objetivas.

A MTC considera que o “xue” é movido pelo “qi” e guiado pela intenção. Desta forma, a ativação do fluxo de "qi" durante a prática de "Qigong" depende do estado particular de consciência do praticante, o qual parece induzir alterações fisiológicas vegetativas, como o aumento da microcirculação e mudanças no potencial elétrico da pele. O “Qigong” integra

duas vertentes conhecidas como “Qigong” interno, frequentemente usado como uma prática de autorregulação, e “Qigong” externo, frequentemente usado como um heterotratamento. Em ambas as categorias, a intenção do praticante parece desempenhar um papel essencial no processo. Dado que os mecanismos associados aos efeitos da intenção, particularmente no “Qigong” externo e práticas similares, não são claros, realizou-se um estudo controlado seguido de um estudo de seguimento para avaliar a mensurabilidade do fenómeno. Esses estudos são apresentados nos Capítulos 5 e 6, respetivamente.

Práticas como o “Reiki”, toque terapêutico, toque de cura e o “Qigong” externo têm sido consideradas como formas de “medicina energética” ou “terapia de biofield”. O conceito de “biofield” tem sido estudado e debatido por investigadores de distintas áreas do conhecimento e, embora o fenómeno seja por vezes descrito como fisicamente relacionado com o eletromagnetismo, outros fatores como “energia subtil” e intenção focada podem estar envolvidos. Essas práticas não convencionais integram técnicas com e sem contato, sendo as que envolvem intervenções à distância, são talvez as mais difíceis de compreender e aceitar. Os profissionais descrevem essas intervenções como que envolvendo fatores intencionais e estados particulares de consciência. Pressupõem-se que, com um *mindset* espiritual associado a um estado particular de consciência, a compaixão funcione como um catalisador para produzir mudanças fisiológicas e físicas por meio de mecanismos ainda desconhecidos. Ao nível físico, essas mudanças vegetativas podem estar relacionadas com o desenvolvimento de autopercepção como parte do sistema de regulação neurovegetativa do corpo. Outros mecanismos são difíceis de documentar e medir, sendo importante em trabalhos de investigação futuros explorar a utilização de detetores de sinais físicos, métodos químicos, detetores usando materiais biológicos, detetores usando sensores vivos e detetores usando o corpo humano.

Sendo a água o principal componente do corpo humano, foi escolhida como modelo no estudo controlado sobre intenção focada apresentado no Capítulo 5. Os ensaios de intenção foram realizados em quatro dias diferentes num intervalo programado, durante o qual 286 praticantes qualificados de “biofield” de vários países foram instruídos a meditar com o objetivo de mudar o estado vibracional molecular de amostras de água selecionadas por um operador cego ao estudo. O protocolo seguiu um desenho experimental aleatório, cego e controlado; as variáveis medidas incluíram espectros Raman da água, pH e condutividade elétrica e o campo magnético e radiação UV-VIS perto do local experimental. Embora não possa ser estabelecida uma relação causal direta, verificaram-se alterações significativas em alguns parâmetros na água, campo magnético e radiação durante o período experimental. O estudo de seguimento apresentado no Capítulo 6 explorou os efeitos hipotéticos da intenção no condicionamento de um sistema de medição de pH em

tempo real com aquisição contínua de dados, através da avaliação das mudanças nas propriedades físico-químicas de amostras de água escolhidas como alvo na intervenção com intenção focada. Após o período experimental principal, mediu-se o pH em tempo real de amostras de água, usando o mesmo equipamento e sob as mesmas condições experimentais, exceto o conhecimento, por parte dos praticantes de “biofield” de que essas experiências estavam a ser realizadas e, consequentemente, sem sua intenção focada. Para testar a hipótese proposta recorreu-se à medição do pH em tempo real, condutividade elétrica e concentração em catiões e aniões por cromatografia iónica nas amostras de água. As medições mostraram que as variações do pH ao longo do tempo mantiveram uma tendência sistemática e consistente semelhante às observadas durante as atividades experimentais envolvendo intenção focada. Porém, após a troca da solução interna do elétrodo, o pH ficou estável como nos testes iniciais de avaliação da sensibilidade do equipamento. Este comportamento levou à hipótese de que um eventual condicionamento do sistema de medição de pH mediado pela intenção pode ter hipoteticamente ocorrido devido a alterações das propriedades da solução interna do elétrodo.

Palavras-chave: medicina tradicional Chinesa; modelo de Heidelberg da MTC; acupuntura; “Qigong”; eletrofisiologia; intenção focada.

List of original publications

The articles front pages are shown in Appendix A.

Chapter 2:

1. Matos LC, Machado JP, Monteiro FJ and Greten HJ. Understanding Traditional Chinese Medicine Therapeutics: An Overview of the Basics and Clinical Applications. *Healthcare.* 2021; 9(3): 257.

2. Matos LC, Machado JP, Monteiro FJ and Greten HJ. Can Traditional Chinese Medicine Diagnosis Be Parameterized and Standardized? A Narrative Review. *Healthcare.* 2021; 9(2): 177.

3. Matos LC, Machado JP, Monteiro FJ and Greten HJ. Perspectives, Measurability, and Effects of Non-Contact Biofield-Based Practices: A Narrative Review of Quantitative Research. *Int. J. Environ. Res. Public Health.* 2021*;* 18(12): 6397.

Chapter 3:

4. Matos LC, Lopes LT, Freire VA, Machado J, Monteiro FJ, Greten HJ. Can the electrical potential of acupoints be used to assess the functional state of meridians and the effects of therapeutics? An exploratory data analysis. *Journal of Bodywork and Movement Therapies*. 2021; 26: 309-317.

Chapter 4:

5. Matos LC, Machado J, Greten HJ, Monteiro FJ. Changes of skin electrical potential in acupoints from Ren Mai and Du Mai conduits during “Qigong” practice: Documentation of a clinical phenomenon. *Journal of Bodywork and Movement Therapies*. 2019; 23(4): 713-20.

Chapter 5:

6. Matos LC, Santos SC, Anderson JG, Machado J, Greten HJ and Monteiro FJ. Instrumental Measurements of Water and the Surrounding Space During a Randomized Blinded Controlled Trial of Focused Intention. *Journal of Evidence-Based Complementary & Alternative Medicine*. 2017; 22: 67586.

Chapter 6:

7. Matos LC, Santos SC, Anderson JG, Machado J, Greten HJ, Monteiro FJ. Can measurements be physically conditioned by thought? Further observations following a focused intention experiment. *Journal of Complementary and Integrative Medicine*. 2020; 17(4): 20170056.

Contents

Figure captions

Table captions

Symbols, abbreviations and nomenclature

Symbols

m	Slope of the function electrical potential vs time	$V \cdot s^{-1}$
φ	Electrical potential	V
t	Time	s

Abbreviations

ACM	Active Contour Model
AD	Anno Domini
ANOVA	Analysis of Variance
ATDS	Automatic Tongue Diagnosis System
ATP	Adenosine Triphosphate
BC	Before Christ
BCEC	Biologically Closed Electric Circuits
BSAA	Brainstem Auricular Acupoint
BSPDI	Bi-Sensing Pulse Diagnosis Instrument
CAM	Complementary and Alternative Medicine
cAMP	Cyclic Adenosine Monophosphate
CCD	Charge-Coupled Device
CD	Control Day
CE	Common Era
DAQ	Data Acquisition
DC	Direct Current
DNA	Deoxyribonucleic Acid
DPN	Diabetic Peripheral Neuropathy
DPPC	Dipalmitoylphosphatidylcholine
EAV	Electroacupuncture According to Voll
ED	Experimental Day
EDS	Electrodermal Sreening
EEG	Electroencephalography
EGF/EGFR	Epidermal Growth Factor/Epidermal Growth Factor Receptor
EMT	Epithelial-Mesenchymal Transition
FACS	Fluorescence-Activated Cell Sorting
fMRI	Functional Magnetic Resonance Imaging

FMS	Fibromyalgia Syndrome
GMT	Greenwich Mean Time
GOD	Glucose Oxidase
HDL	High-Density Lipoprotein
HF	High Frequency
HR	Heart Rate
HRV	Heart Rate Variability
IGF-I	Insulin-like Growth Factor
IMS	Intentional Meditation Source
LBP	Low Back Pain
LDL	Low-Density Lipoprotein
LED	Light-Emitting Diodes
LF	Low Frequency
LOH	Laying On of Hands
MBI	Maslach Burnout Inventory
MEG	Magnetoencephalography
MF	Magnetic Field
MRI	Magnetic Resonance Imaging
NCCIH	National Center for Complementary and Integrative Health
NCS	Nerve Conduction Studies
NCT	Nonconventional Therapeutics
NO	Nitric Oxide
OP1	Operator 1
OP2	Operator 2
PDBSS	Pressure-Displacement Bi-Sensing System
PI3K	Phosphoinositide 3-Kinase
PMS	Premenstrual Syndrome
RAAS	Renin-Angiotensin-Aldosterone System
rACC	Rostral Anterior Cingulate Cortex
RCTs	Randomized Controlled Trials
ROS	Reactive Oxygen Species
RT PCR	Real-Time Polymerase Chain Reaction
SD	Standard Deviation
SPME-GC-MS	Solid-Phase Microextraction Gas Chromatography-Mass Spectrometry
SQUID	Superconducting Quantum Interference Device
TAA	Thumb Auricular Acupoint
TCM	Traditional Chinese Medicine

TLD	Thermoluminescence Dosimeters
TNF	Tumor Necrosis Factor
UV-VIS	Ultraviolet-Visible
WHO	World Health Organization

Molecular Biology Nomenclature

Bcl-xL	B-cell lymphoma-extra large
BEL-7402	Liver cancer cell line
BxPC3	Pancreatic cancer cell line
cyclin D1	Protein that in humans is encoded by the CCND1 gene
Erk1/2	Extracellular signal-regulated kinase 1/2
HT-29	Colon cancer cell line
NF-kB	Nuclear factor-kB
NSCLC A549	Lung cancer cell line
p21(Cip1)	Protein cyclin-dependent kinase inhibitor 1
p27(Kip1)	Protein cyclin-dependent kinase inhibitor 1B
PKB or Akt	Protein kinase B
SMAD2/3	Main signal transducers for receptors of transforming growth factor beta
SPC-A	Lung cancer cell line
TGF-β1	Transforming growth factor beta 1
XIAP	X-linked inhibitor of apoptosis protein

Chapter 1. General Introduction

1.1 Relevance and Motivation

The regulation of the so-called nonconventional therapeutics (NCT), including Traditional Chinese Medicine, had been under the working agenda of Portuguese governmental instances and professionals' representatives. The increasing demand and the primordial need for standards and security guidelines pushed forward for the creation, promulgation and publication of Law 45/2003 of August 22, which established the basic framework of the nonconventional therapeutics, recognizing acupuncture, homeopathy, osteopathy, naturopathy, phytotherapy and chiropractic (TCM was included later), and the technical and deontological autonomy of its professionals.

Number 5 of the 4th article of this law refers to a fundamental principle "The promotion of scientific research in different areas of the nonconventional therapeutics, to achieve higher quality standards, efficacy and effectivity". Therefore, it is crucial to develop proper research to build up the scientific background, which will support the integration of these practices in Western healthcare systems.

A new development viewpoint in TCM has emerged within this process, combining ancient understanding with modern science and technology, supported by clinical and applied structural evidence. Indeed, the integration of TCM in Western health systems and research requires a rationally communicable theory, scientific proof of efficacy and safety, and quality control. Therefore, a science-based conceptualization and the parameterization of the TCM diagnosis are essential in this process, demanding the use of validated technological methods or even developing new systems to assess TCM related effects by objective measurements.

A well-established TCM diagnosis differentiates a successful intervention and, like in Western medicine, leads to the allocation of therapies to symptoms. According to the Heidelberg model of TCM, this diagnosis is understood as a functional vegetative state of the patient, which requires the systematic application of vegetative skin reflexes by stimulating reflex areas of the skin, called acupoints.

The success of acupuncture has sparked many studies on the nature of the conduits system, frequently called meridians or channels and considered the foundation of traditional acupuncture theory. Techniques involving the stimulation of the conduits, such as acupuncture and "Qigong", may activate the self-organizing system of an organism, thus improving its structure and function at a more fundamental level than symptomatic relief. This field of research may have broad implications in medicine and the way the scientific

community regards human regulation and the physiological changes inherent to these practices.

Within this framework, the development of new technological approaches may enable the diagnosis and treatment of a pathologic process at an early signal transduction stage before its progression to stages involving anatomical or morphological changes.

1.2 Objectives and thesis structure

The main initial goals of this thesis were:

1. The development and practical application of biomedical technologies to assess functional vegetative, bioelectrical and possible magnetic field changes during the application of TCM therapies, especially “Qigong” and acupuncture;
2. The assessment of possible correlations between the above-mentioned changes and TCM physiological concepts and patients' clinical status and evolution (syndrome severity and the course of symptoms).

The studies included in this document considered the following primary hypotheses:

1. There are vegetative physiological changes associated with the “qi flow” in Chinese medicine that can be measured and quantified;
2. TCM conduits (channels) include specific pathways associated with the regulation process and can be detected and mapped with technological methods;
3. The vegetative changes in acupoints are related to the functional state and TCM diagnosis according to the Heidelberg model;
4. A biofield-based intervention can influence the physicochemical properties of water.

The present thesis includes seven chapters, mainly covering the general introduction, literature review, experimental work, general conclusions, and future work. Those chapters are organized as follows:

Chapter 1 *General Introduction*

This brief chapter aims to state the relevance, motivation and main objectives of the thesis. It also presents the basic organizational structure of the document.

Chapter 2 *Literature Review*

This chapter is divided into four main subsections, reviewing specific topics of interest in this thesis. The first topic introduces some TCM theoretical concepts and the evidence-

based clinical application of TCM's leading practices. The second topic aims to demonstrate and critically analyze some achievements and limitations in the clinical application of device-assisted TCM diagnosis systems to evaluate functional physiological patterns. The third topic aims to introduce the Heidelberg model of TCM, and the fourth topic aims to partially overview the history, theory and findings of quantitative research strategies exploring non-contact biofield-based practices.

Chapter 3 *Can the electrical potential of acupoints be used to assess the functional state of meridians and the effects of therapeutics? An exploratory data analysis*

This chapter presents a pilot study focused on evaluating whether the electrical potential of acupoints can be correlated objectively to the functional properties described by ancient Chinese medical theories, such as the theories of coupled channels of the same phase ("elements") and the principle of coupled points.

Chapter 4 *Changes of skin electrical potential in acupoints from "Ren Mai" and "Du Mai" conduits during "Qigong" practice: documentation of a clinical phenomenon*

This chapter presents a pilot study that aimed to assess the skin electrical potential changes in acupoints from the "Ren Mai" and "Du Mai" conduits and other points of interest during "Qigong" practice.

Chapter 5 *Instrumental measurements of water and the surrounding space during a randomized, blinded controlled trial of focused intention*

This chapter presents a randomized, blinded controlled trial aimed to access measurable interactions on water and the surrounding experimental space induced by focused intention, frequently used in biofield practices such as Healing Touch, "Reiki", and external "Qigong".

Chapter 6 *Can measurements be physically conditioned by thought? Further observations following a focused intention experiment*

This chapter presents a follow-up study that explored the hypothetical effects of intention on conditioning a pH system with continuous data acquisition for real-time measurements by evaluating the changes in the physicochemical properties of water samples chosen as a target in the intervention involving focused intention.

Chapter 7 *General Conclusions and Future Work*

This chapter aims to overview the whole work's main conclusions and indicate future research directions.

Chapter 2. Literature Review

The contents of this chapter were adapted from the following published reviews:

Matos LC, Machado JP, Monteiro FJ and Greten HJ. Understanding Traditional Chinese Medicine Therapeutics: An Overview of the Basics and Clinical Applications. Healthcare. 2021; 9(3): 257.

Matos LC, Machado JP, Monteiro FJ and Greten HJ. Can Traditional Chinese Medicine Diagnosis Be Parameterized and Standardized? A Narrative Review. Healthcare. 2021; 9(2): 177.

Matos LC, Machado JP, Monteiro FJ and Greten HJ. Perspectives, Measurability, and Effects of Non-Contact Biofield-Based Practices: A Narrative Review of Quantitative Research. Int. J. Environ. Res. Public Health. 2021; 18(12): 6397.

The first review aims to overview some of the TCM theoretical concepts and the evidence-based clinical application of TCM's leading practices to create an easy to consult and condensed source of information available for the healthcare community, facilitating the understanding and communication between conventional health professionals and TCM practitioners and acupuncturists.

The second review aims to demonstrate and critically analyze some achievements and limitations in the clinical application of device-assisted TCM diagnosis systems to evaluate functional physiological patterns. Despite some limitations, tongue, pulse, and electrophysiological diagnosis devices have been reported as valuable tools for establishing a person’s functional status.

The third review aims to provide an easy to consult partial overview of the history, theory and findings of quantitative research strategies exploring non-contact biofield-based practices. This work also aims to stimulate the reader’s mind with the raised hypotheses, catalyzing further research on the subject to confirm or deny the reported outcomes.

This chapter also includes section 2.3, which, although not adapted from any of the previously mentioned reviews, aims to introduce the Heidelberg model of TCM.

2.1 TCM Therapeutics: An Overview of the Basics and Clinical Applications

Although the origin of TCM remains uncertain, some evidence points to more than 5000 years of history. Indeed, some archaeological findings of acupuncture needles and traces of herbal treatments suggest 4000 to 8000 years of existence [1,2]. The “Yijing” (“I Ching” or The Book of Changes) and the “Huangdi Neijing” (The Yellow Emperor’s Classic of Internal Medicine) may represent some of the oldest known written sources of information in TCM theory and clinical application. The “Yijing”, dating back 3000 to 5000 years, describes the course of life systematically based on a mathematical model. It describes its changes and modalities, offering advice on personal emotional lifestyle and guidance [3,4], while the “Huangdi Neijing” may be comparable in importance to the Hippocratic Corpus in Greek medicine [5].

The main TCM theories include the teaching of “yin” and “yang” and the Five Trespasses or Phases (“Elements”). They describe the activity of effects and functional powers involved in body function such as the “qi”, the “blood” or “xue”, as well as the effects of active and resting fluids “jin ye”, and the differential diagnosis of syndromes. At the same time, the primary practices include acupuncture and moxibustion, the use of Chinese herbs and dietetics, and “Tuina”, “Qigong”, and “Taijiquan”, commonly known as Tai Chi. Ancient Chinese physicians postulated that everything is made of the same “substance” (“functional power”), the “qi”. This philosophy stands for oneness and wholeness as part of the same paradigm, considering that all existing things are symbiotically connected through the system of “qi” [6]. One of the main goals of TCM is to balance the effects of the body`s “qi”, known in the West as the “Vital Force”, to live in balance (“harmony”) with the surrounding “qi”. According to ancient Chinese culture, this includes the inherent effects of “Heaven” on man, such as biorhythmic and postulated astrological effects of the sun, moon, planets, and constellations, and the effects of “Earth”, such as the effects of geographical location, the influence of the plants, soil, water, animals, and natural formations [6]. TCM aims to treat not only the secondary manifestations (branches, “biao”), but also the primary causes (roots, “ben”) of several chronic and acute conditions; for example, in internal medicine, gynecology, pediatrics, traumatology, external medicine, dermatology, emergency medicine, and eye, ear, nose and throat treatments.

The mathematical analysis of the “Yijing” performed by the mathematician, Gottfried Leibniz in 1697 [4], allows for understanding TCM as a logical model of systems biology with a structural mathematical language. The analogy to the binary system, considering 0 as “yin” and 1 as “yang”, leads to a technical understanding of monograms, bigrams, and

trigrams, which are related to the Phases and the circular regulatory processes seen, for example, in rhythmical seasonal changes, daytime processes and human regulation and behavior (Figure 2.1a,b) [7,8]. These circular processes are expressed as sinusoidal functions, which integrate the concepts of “yin”, “yang”, and the Phases as cybernetic elements and vegetative functional tendencies in human physiological regulation.

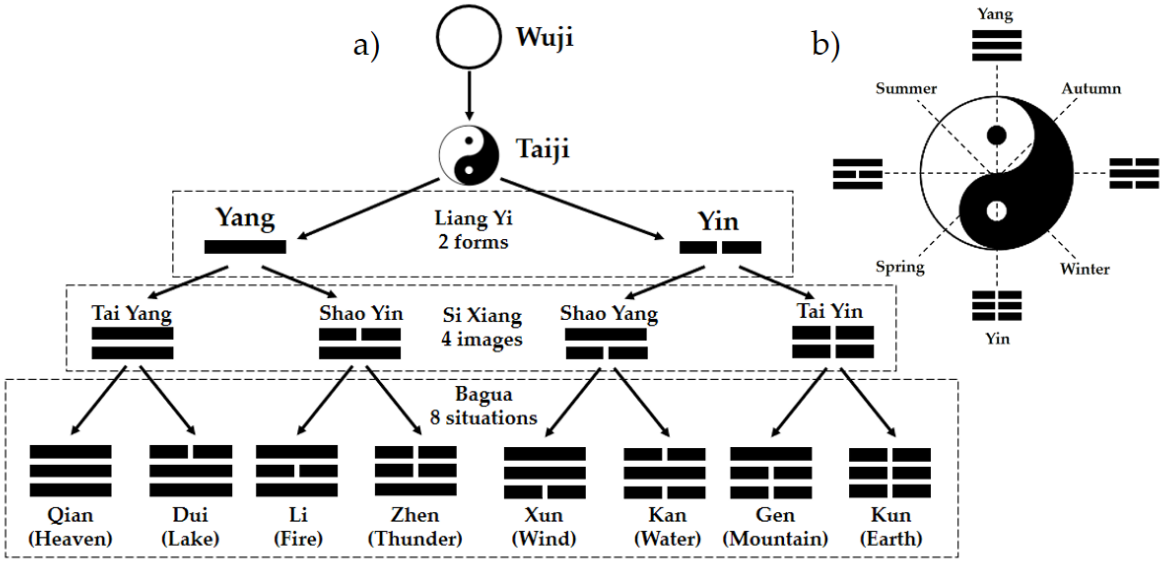

Figure 2.1. The creation of “yin yang” and “Bagua” (a); the “Taiji” symbol (b) (adapted from [8]).

The “yin yang” concept is central in TCM philosophy. in Chinese culture and language and has a broad list of possible metaphorical meanings. Common examples related to “yin” are cold, female, earth, water, weak, dark, night, winter, passive, and interior, while those related to “yang” are hot, male, heaven, fire, strong, light, day, summer, active and exterior [9]. Within the regulatory (cybernetic) context, “yin” and “yang” may enclose the meanings shown in Table 2.1.

Table 2.1. Meanings of “yin yang” within the medical context (adapted from [10]).

“Yin”	“Yang”
Less vivid, less “qi” (depletion)	More vivid, more “qi” (repletion)
Colder, “algor”	Warmer, “calor”
Inside, interior, “intima”	Outside, exterior, “extima”
Structure	Function

Traditionally, the Five Phases influence each other both physiologically (“sheng” and “ke” cycle) and pathologically (“cheng”, “wu” and, to some extent, the “sheng” cycle). If the balance of the Five Phases is disturbed, pathological syndromes are more likely to manifest. [11].

In the Compass Rose cycle, the Earth Phase is considered the center, the baseline or target value, around which upregulation (Wood and Fire) and downregulation (Metal and Water) processes are established (Figure 2.2a). The Compass Rose dynamics can be represented as a circular function of vegetative regulation, with “yin” and “yang” components, wherein the abscissa axis represents the Earth Phase (Figure 2.2b).

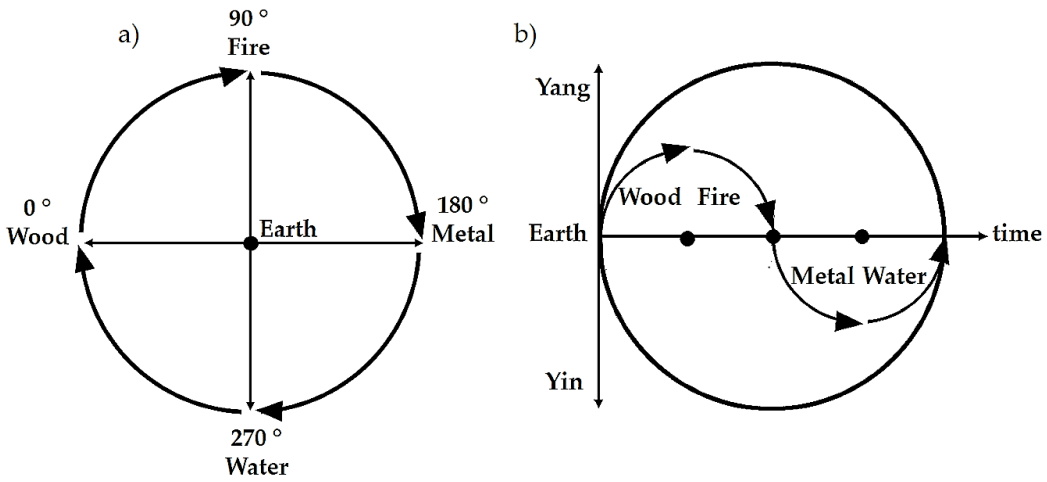

Figure 2.2. Compass Rose (a) and circular function of vegetative regulation (b) with the “yang” (upregulation) and “yin” (downregulation) components and respective Phases (adapted from [7, 10]).

The functional activity related to each Phase can be metaphorically described as follows: Wood is the creation of potential; Fire is the transformation of potential into function; Metal shows a relative lack of energy, as well as the rhythmical distribution of energy; Water is regeneration; Earth stimulates transformation and evolution. These main actions are related to the overall vegetative activity, ruled by transmitters and neuronal pathways, whereby sympathetic functions are more active in “yang” phases, and in the “yin” phases, parasympathetic (vagal) activity is relatively more present [3].

The vegetative system integrates the sympathetic, parasympathetic, and enteric nervous systems involved in the regulation cycle. For example, in stressful situations, the enteric nervous system is less active; otherwise, defecation would be dysfunctional. On the other hand, in the downregulation phases or even in Fire and Metal, the enteric nervous system is more active in restoring the energy levels. This system of functional regulation can also integrate muscle tonus and motion patterns by hypertonic, hyperdynamic, hypotonic, and hypodynamic functional patterns, or the RAAS (renin-angiotensin-aldosterone system), which is more active in the “yang” phases, above the target value, and less active below, in the “yin” phases domain [3,7,10,12,13].

In TCM, physiological functions, pathological changes, and the relationship of an organ with the “qi”, “xue”, “jin ye”, other organs, and other parts of the body are more

important than its anatomical structure. In Western medicine, anatomical structure plays an essential role in “judging the exterior from the interior”. TCM chooses the pattern of “judging the interior from the exterior” by observing the body’s outward appearance, body language and functional changes, considering that physiological changes occurring inside the body’s cavities may manifest on the body’s surface and appearances, thus referring to a system of clinical signs and symptoms [14].

In Western medicine, symptom-perception historically had gradually developed to disease-perception, which means a deeper understanding of its nature, pathophysiology and etiology. In TCM, the manifestation and differentiation of syndromes (via signs and symptoms) rather than diseases are essential to allocate the appropriate therapeutic intervention. Syndromes, also known as “zheng”, are symptoms of disturbances of visceral function and “yin yang” balance evoked by pathogenic factors. These originate signs that can be detected, for example, in tongue and pulse diagnosis. Many Western medicine diseases may be similar to some “syndromes” in TCM, while some “syndromes” may include certain Western medicine diseases [14]. For example, the kidney’s essence, also known as “jing”, is an essential concept related to the process of aging. According to TCM, each person is born with a finite amount of “jing” stored in the kidneys and gradually uses it through life. Some authors consider “kidney deficiency syndrome” equivalent to aging in Western medicine. Similarly, “heart qi deficiency” is associated with cardiac insufficiency [15].

The term “zang-fu” in Chinese refers not only to the anatomical entities of the internal organs but also to a generalization of the human body’s function. TCM divides the internal organs into two groups, typically coupled in “yin yang” pairs per Phase: “zang”, or solid organs, which are considered “yin” organs (heart and pericardium, liver, spleen, lung, and kidney), and “fu” or hollow organs, which are considered “yang” organs (small intestine and triple burner, gall bladder, stomach, large intestine, and bladder) [16]. TCM channels or conduits and collaterals within the interstitial connective tissue constitute a network called “jing luo”. These conduits, believed to serve as channels for the flow of “qi” and “xue”, are connections between acupoints with effects on specific orbs’ clinical signs. There are 12 primary channels, 6 “yin” and six “yang”, classified as the 3 “yang” channels of the hand, the 3 “yang” channels of the foot, 3 “yin” channels of the hand, and 3 “yin” channels of the foot. The “yin” channels pertain to the “zang” organs and the “yang” channels to the “fu” organs. In this way, “qi” and “xue” flow through them and reach every part of the body in a cyclical circulation [17,18].

2.1.1 Chinese Herbal Medicine and Dietetics

Although the written history of Chinese materia medica dates back to the Eastern Han dynasty (AD 25–220), with the “Shen Nong Ben Cao Jing” (Divine Husbandman’s Classic of Materia Medica), also known as The Canon of Materia Medica, or Shennong’s Herbal Classic [19], Chinese knowledge of botanic medicine dates back to the discovery of “Ma Huang” (herba ephedrae), around 3000 BC. This herb was initially used as a stimulant but was also used for respiratory disorders and other diseases. The active ingredient in herba ephedrae is ephedrine, an effective bronchodilator, making “Ma Huang” central in asthma treatment [20].

Chinese herbal medicine and dietetics, also known as Chinese materia medica, follow the same diagnostic principles as acupuncture, “Tuina”, and “Qigong”. This branch of TCM is focused on the beneficial effects of herbs and foods on the body. Those are classified according to the thermal nature, flavor or “sapor”, organ network, and functional effect direction. The thermal nature has a cooling or warming effect on the body by acting on microcirculation. The “sapor” relates to the Five Phases and regulates a particular organ network [21].

Regarding the thermal nature, “hot” herbs and foods such as pepper, chili, and garlic have heating, warming effects on the body, increasing “yang”, speeding up the “qi”, activating, dispersing, and moving upward and outward, warming the bowels and viscera (“zang-fu”), eliminating external and internal cold, and mobilizing defense energy. Oppositely, “Cold” foods, such as tomatoes and bananas, cool the body, cool internal heat, and have a calming effect on the spirit (“shen”). Warm and cool herbs and foods have a milder effect on the body, strengthening “yang” and “qi” and supplementing body fluids (“jin ye”) and “xue”, respectively [22].

According to the Heidelberg model of TCM, the flavors or “sapors” are considered therapeutic vectors within the system described in Figure 2.2 [21]. Flavors can be classified according to their “yin” or “yang” quality, and each one belongs to one of the Five Phases:

- Sweet belongs to Phase Earth (spleen and stomach). According to the Heidelberg model of TCM, sweet relates to the stomach, and neutral relates to the spleen. Sweet has a warming, strengthening, harmonizing, relaxing, and moistening effects. It has the most potent supplementing effect on the body;
- Acrid or pungent belongs to the Phase Metal (lung and large intestine). It moves the “qi”, invigorates energy circulation, loosens stagnation, disperses, opens pores, frees the surface of exogenous disease factors, and produces perspiration;
- Salty belongs to the Phase Water (kidney and bladder). It cools, moistens, produces a downward bearing, softens, and loosens;

- Sour belongs to the Phase Wood (liver and gallbladder). It has an astringent effect and gathers and preserves fluids;
- Bitter belongs to the Phase Fire (heart-pericardium and small intestine). It has a drying, hardening, and downward-bearing effect.

Along with their general effects, each “sapor” directly affects a specific “orb” within each Phase and indirectly affects the Phases network. As mentioned in the “Huangdi Neijing”, “Sourness enters the liver, bitterness enters the heart, sweetness enters the spleen, acridity enters the lungs, and saltiness enters the kidneys.” Thus, “Sourness enters the sinews, bitterness enters the blood, acridity enters the qi, sweetness enters the flesh, and saltiness enters the bones”.

Herbs and foods can also be classified according to the effective therapeutic direction. Therefore, they can act on the surface or “extima”, or affect the depth, the “intima”, or the “yin” itself [21]. Some of the selected plants used in TCM are shown in Figure 2.3.

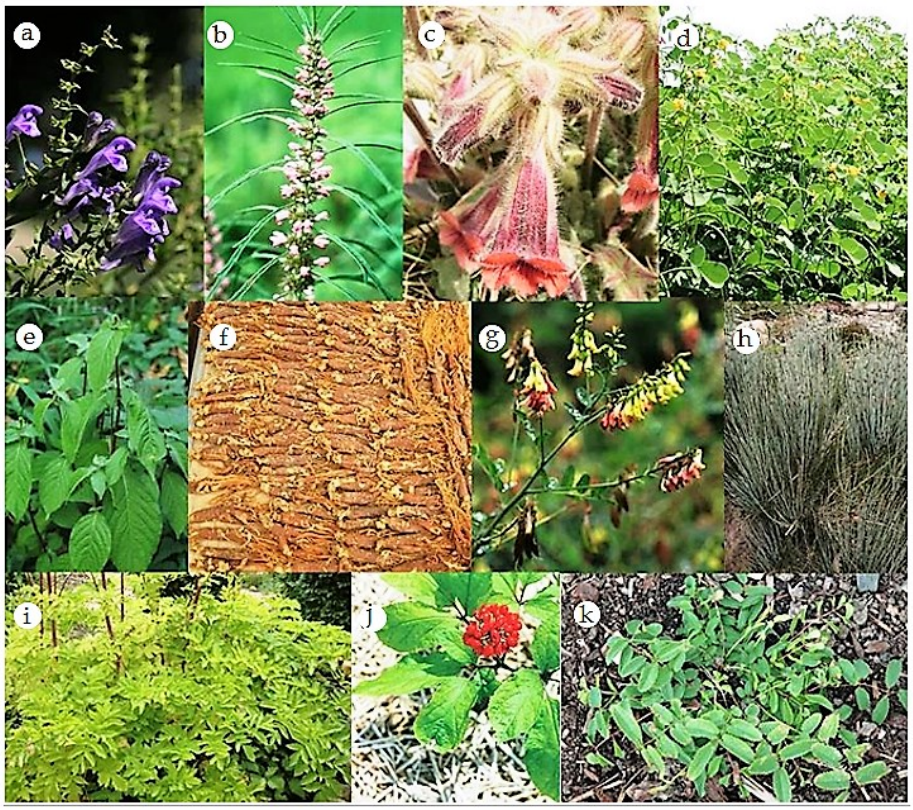

Figure 2.3. Examples of herbs used in Chinese herbal medicine: (a) Scutellaria; (b) Leonurus artemisia; (c) Rehmannia; (d) Cassia obtusifolia; (e) Achyranthis bidentata; (f) Panax ginseng root; (g) Astragalus membranaceus; (h) Ephedra intermedia; (i) Angelica sinensis; (j) Panax ginseng plant; (k) Sanguisorba officinalis. Reprinted with permission from ref. [23].

The plants listed in Figure 2.3, as an example, are frequently used in the form of infusions, mixed with others in predefined proportions, giving rise to specific formulas or

decoctions directed to the treatment of certain diseases and conditions. The roots are the most commonly used part; however, the leaves and stems are also used in some formulas. The preparation of decoctions is an art, and its application's success is intimately related to an accurate diagnosis.

2.1.1.1 Chinese Herbal Medicine Tendencies in Research and Clinical Applications

Herbal treatment is among the most commonly used complementary and alternative medicine (CAM) therapies, and some of the used herbs originate from TCM. The popularity of and interest in CAM has increased in Western societies. Socioeconomic, demographic, and health indicators seem to be related to the prevalence of CAM in each country [24]. In 2002, 2007, and 2012, the percentages of American adults who used any CAM approach in the past 12 months were 32.3 %, 35.5 %, and 33.2 %, respectively [25]. The variability of CAM's prevalence in different countries is significant. In France and Germany, two European countries with a higher prevalence, those values reached 49 % and 46 %, respectively [24], while in Australia, it was about 52 % [26], and in Singapore, nearly 76 % [27]. Although the statistics correspond to different years, the relative global analysis remains accurate, showing a significant variability.

Several herbs used in Chinese herbal medicine have been used in Western medicine. For example, the ginseng decoction used to invigorate "qi" and prevent prostration may be used in hemorrhagic or cardiogenic shock [15]. Artemisia annua, also known as sweet wormwood, became popular in the West after Tu Youyou was awarded the 2015 Nobel Prize in Physiology or Medicine for her discoveries concerning a novel therapy against Malaria. Tu Youyou, a pharmacologist trained in TCM, started working in the Institute of Chinese Materia Medica of the Academy of Traditional Chinese Medicine (Beijing, China) in 1955. In 1969, she started leading a research group focused on searching for antimalarial drugs among traditional Chinese medicines. After reviewing the traditional Chinese medical literature and folk recipes, and interviewing experienced TCM practitioners, a reference to sweet wormwood ("Qinghao"), which had been used in China around 400 AD to treat "intermittent fevers" (a symptom of malaria), came to her attention. The first clinical trial was carried in October 1972, after multiple extraction studies. The trial was successful, and the team started working in the isolation and purification of what came to be known as artemisinin. Later, the team discovered dihydroartemisinin, a derivate of artemisinin that is ten times more potent clinically, demonstrating a high efficacy, rapid action, and low toxicity [28].

Studying Chinese herbs' pharmacology and action mechanisms is crucial for consensus regarding TCM integration into Western healthcare systems and research. In the last few decades, the number of articles on Chinese herbs published in international scientific journals has increased exponentially [29]; likewise, the trend in published articles on TCM, in general, has also increased [30]. Indeed, with a simple analysis using PubMed, the previous observation can be quickly confirmed. Therefore, twenty commonly used Chinese herbs were chosen, and their names were searched in PubMed using the titles of articles in general. Figure 2.4 shows the retrieved number of publications per herb (data accessed on 10 February 2021).

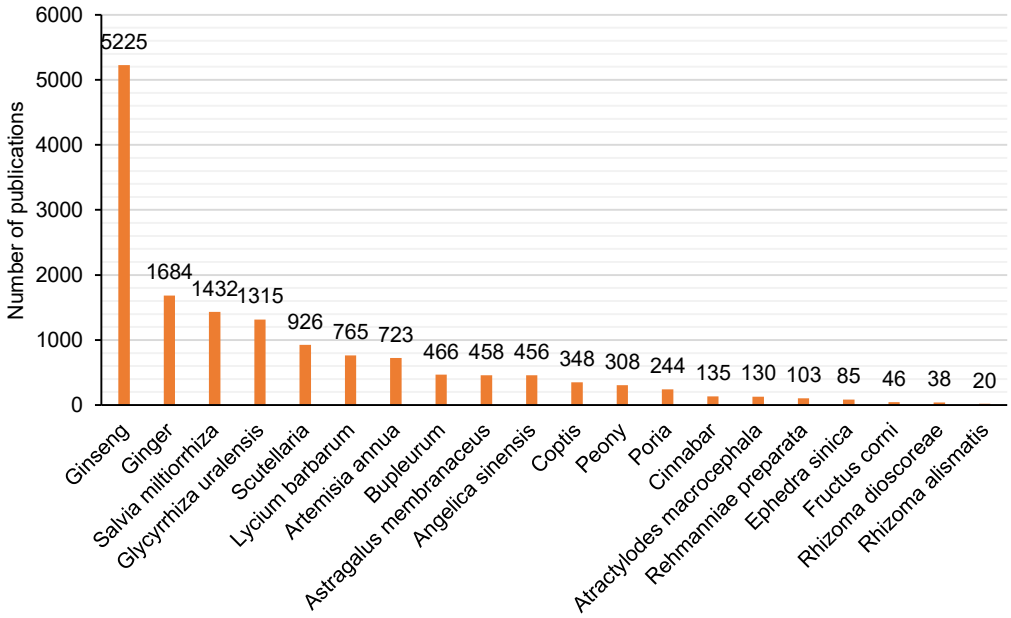

Figure 2.4. Total number of publications per herb in PubMed, using the article's title as the searching criteria.

Ginseng is the herb that has gathered the most research attention, followed by ginger, Salvia miltiorrhiza, Glycyrrhiza uralensis, Scutellaria, Lycium barbarum, and Artemisia annua. Considering these seven herbs, Figure 2.5 shows the total number of publications per year (the histograms) and the cumulative number of publications (the continuous lines) since 1950.

Nowadays, ginseng is an active ingredient in modern medicine, and is often used as a tonic for invigoration and fortification in fatigue, debility, or declining sexual capacity, improving concentration, helping convalescence, and enhancing the immune system. Although clinical trials support these indications, ginseng's properties had already been described in Chinese herbal medicine classics.

The pharmacological properties of ginseng were firstly described in Shennong's Herbal Classic. In this classic of materia medica, ginseng is described as being capable of nourishing or strengthening the five vital organs of the body (the spleen, lung, heart, kidney, and liver), having sedative properties, being used for palpitations to restore a regular pulse, for dispelling pathogenic factors, for improving visual acuity and mental activity, and for enhancing longevity with long-term intake. Later on, in the Mingyi Bielu written by Hongjing Tao (AD 456–536), additional properties can be found, including curing internal coldness, pain in the chest or abdomen, sensations of fullness in the chest, vomiting, and diarrhea, relieving thirst, and feelings of solidness, enhancing cognitive function and improving blood circulation. The Bencao Gangmu written by Shizhen Li (1518–1593) describes ginseng as capable of treating general weakness, spontaneous sweating, and fever, vertigo and headache, regurgitation and vomiting, alternating fever and chills, chronic diarrhea, increased urination or strangury, fatigue, externally contracted wind or hot attacks, cramps, vomiting blood (hematemesis), bleeding from the rectum, bloody urinary leakage, abnormal uterine bleeding, and discomfort before or after parturition [31].

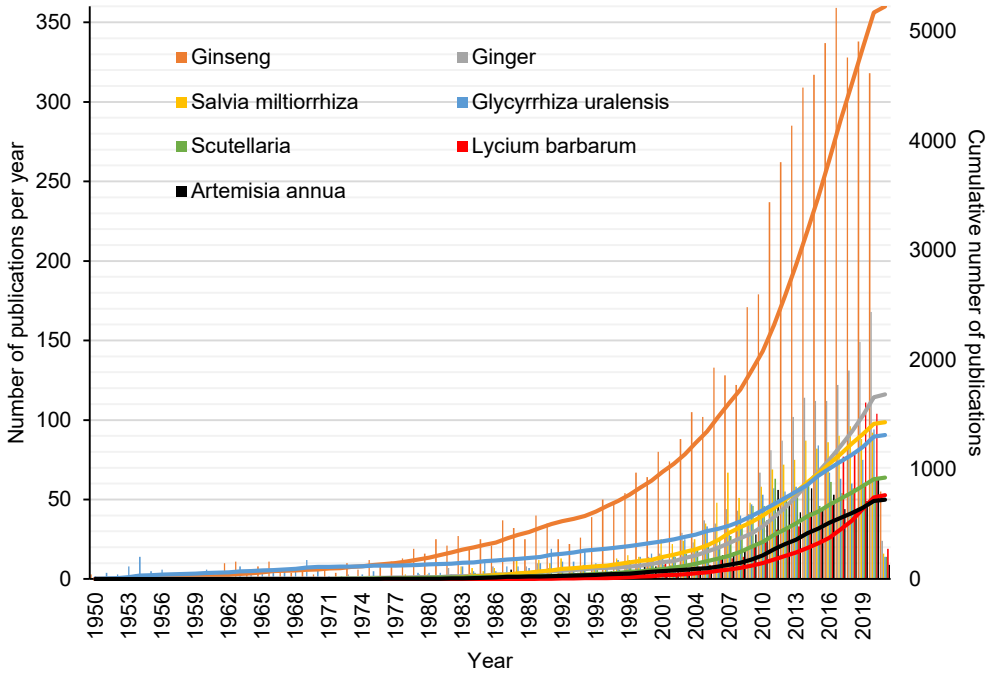

Figure 2.5. Total number of publications per year (the histograms) and the cumulative number of publications (the continuous lines) since 1950.

Chinese herbal medicine is a complicated and vast field of study. While Western medicine seeks to isolate a single active ingredient, herbal medicine relies on the synergistic action of the constituents of an herb or decoction. These combinations may yield a wide

variety of effects, such as anti-inflammatory, antioxidative, antipyretic, antidepressant, antimicrobial activity, relaxation of blood vessel walls, skeletal muscle relaxation, and anticonvulsant activity, among many others [32].

Chinese herbal medicine's clinical effects must be tested in well-controlled conditions using well-designed randomized controlled trials (RCTs). These should be published under a rigorous peer-reviewed process and scrutinized to minimize the effects of methodological flaws and to create clear evidence of security and efficiency. The highest form of evidence comes from systematic reviews and meta-analyses. Therefore, to understand the degree of clinical evidence available for Chinese herbal medicine, a simple analysis was performed on 20 February 2021, using the PubMed/MEDLINE database. The searching criteria were based on using the combination of terms (Chinese herbal medicine (Title)) AND (systematic review and meta-analysis (Title)) NOT (protocol (Title)) in the titles of the articles, and considering a publication period set between 1 January 2019 and 20 February 2021. Twenty-six articles were obtained using this strategy. Three articles were excluded because one was a commentary, the other was a protocol, and the last used an animal model. The diversity of pathologies covered by the remaining articles is considerable, with three articles related to cancer (involving 54, 14 and 18 RCTs) [33–35], three related to hypertension (involving 30, 17 and 39 RCTs) [36–38], three related to COVID-19 (involving 19, 7 and 18 RCTs) [39–41], two related to depression (involving 40 and 16 RCTs) [42,43], two related to headache (involving 31 and 30 RCTs) [44,45], and the others related to allergic rhinitis (involving 17 RCTs) [46], spinal cord injury (involving 26 RCTs) [47], breast pain (involving 17 RCTs) [48], primary Raynaud's phenomenon (involving 8 RCTs) [49], insomnia (involving 13 RCTs) [50], erectile dysfunction (involving 11 RCTs) [51], poststroke spasticity (involving 35 RCTs) [52], irritable bowel syndrome with diarrhea (involving 21 RCTs) [53], diabetic kidney disease (involving 20 RCTs) [54], and Wilson's disease (involving 18 RCTs) [55]. All articles reported the beneficial effects of Chinese herbal medicine when used as a primary treatment or adjunct therapy to Western medicine. Nevertheless, almost all meta-analyses reported the low quality of the included RCTs, identifying problems in randomization, concealment of allocation, blinding, dropouts, heterogeneity, and sample size.

From the above, the meta-analysis conducted by Wang et al. (2019) included RCTs whose methodological quality was classified as moderate, providing evidence to a certain extent for Chinese herbal medicine's routine use for depression [42]. In addition, in the study conducted by Shi et al. (2019), despite the clinical heterogeneity, the authors found that when comparing Chinese herbal medicine with a placebo, the overall quality of evidence according to the primary outcome measures was moderate or high, and the overall quality

of evidence in Chinese herbal medicine relative to Western medicine was low or moderate. These results support Chinese herbal medicine's efficiency for headaches, at least to some extent [45].

The previous results must be evaluated with caution, as the searching criteria of the analysis mentioned above, using a combination of terms that might have been restrictive, might therefore have excluded systematic reviews and meta-analyses presenting a higher level of evidence. For example, by using a different conjugation of terms, (Chinese herbs (Title/Abstract)) OR (Chinese herbal medicine (Title/Abstract)) OR (Decoction (Title/Abstract)) AND (systematic review and meta-analysis (Title)) NOT (protocol (Title)), in the same period, 64 articles were retrieved. Those articles covered near 30 different pathologies, among which cancer-related conditions were the most frequent, followed by chronic obstructive pulmonary disease, COVID-19, and hypertension.

According to the World Health Organization (WHO, Geneva, Switzerland), trachea, bronchus, and lung cancers are among the top 10 causes of death globally, plus stomach, colon, and rectum cancers in upper-middle and high-income countries. Unfortunately, cancer remains a scourge, and despite some advances, often the treatments continue to be, in some cases, painful, damaging, expensive, and ineffective. Surgery, radiotherapy, and chemotherapy are still the primary treatment methods, often causing unpleasant side effects, varying from person to person. Here, Chinese herbal medicine can be a good ally in an integrative strategy based on evidence.

Wang et al. (2019) conducted a systematic review and meta-analysis of high-quality RCTs using Chinese formulas, including "Danshen" for cancer treatment. These authors found that the "Danshen" formulae combined with chemotherapy for cancer treatment were better than a conventional drug treatment plan alone [56]. Indeed, radix Salviae Miltiorrhizae ("Danshen") has been used for over 2000 years in clinical practice. This herb enhances blood circulation and clears blood stasis, two crucial qualities in cancer treatment.

In 2019, an overview of RCTs of TCM in cancer care published in Chinese was published in the high-ranked journal The Lancet. The authors found that from the 5834 RCTs (involving 477147 participants), only 62 publications were indexed in MEDLINE. The main three cancers treated with TCM, either combined with conventional treatment or for the treatment of symptoms and side-effects, were lung cancer, stomach cancer, and breast cancer, and the primary outcomes were clinical symptom improvement (3712 RCTs; 63.6 %) followed by quality of life (2725 RCTs; 46.7 %) and biomarker indices (2384 RCTs; 40.9 %). Although further comprehensive evaluations of the beneficial effects and safety of these TCM modalities are needed, the authors concluded that in comparison with conventional treatment, TCM alone or combined with conventional treatment had a better

effect in cancer care [57]. However, validated standards for this kind of treatment are still lacking, which causes problems regarding oncologists' acceptance [58].

Despite the increasing demand and positive therapeutic effects, rigorous research on botanicals and Chinese herbal preparations are crucial for their acceptance into mainstream science. These include evaluating toxicological issues, including dose-response curves, the standardization of extract analysis, and a better understanding of neurochemical mechanisms. Unfortunately, much of these studies are lacking [19,20].

2.1.2 Acupuncture, Moxibustion, and Cupping

Acu-moxa therapy ("zhen jiu") is a general term covering several techniques designed to stimulate acupoints located on the body along the circulation tracts or conduits. These practices either alleviate local symptoms, affect orbs' functions, or treat the underlying imbalance causing the symptoms. Although TCM involves many other techniques, acupuncture and moxibustion are the most popular [59].

2.1.2.1 Acupuncture

Acupuncture ("zhen") is based on the proper insertion and manipulation of needles of various gauges and lengths into the skin at specific acupoints. Acupuncture can be traced back to the Stone Age in ancient China when people used pointed stone implements and pressure to alleviate illness. With the advancement of technology, the stone-needle was replaced with bamboo, and later, metals. Acupuncture treatment is offered in several distinct styles, including Japanese styles, Korean hand acupuncture, Leamington Five-Elements acupuncture, French energetic acupuncture, and Chinese TCM style. There are also specialized approaches, known as microsystems, such as hand-foot acupuncture and auricular and scalp acupuncture. Although the use of metal needles and moxibustion continues to be the most common technical approach, today, both electricity [60,61] and lasers [60,62,63] are used to replace handheld needles in certain circumstances [64].

Auricular acupuncture (ear acupuncture, auricular therapy) treats pain and certain diseases by placing needles on the external ear's specific points. The auricular points are distributed in the pattern of an upside-down fetus. The ear lobe is related to the head and face region, upper extremities are in the scapha region, the lower extremities are in the superior antihelix crus region, and the internal organs are located in the cavum and cymba concha areas (Figure 2.6).

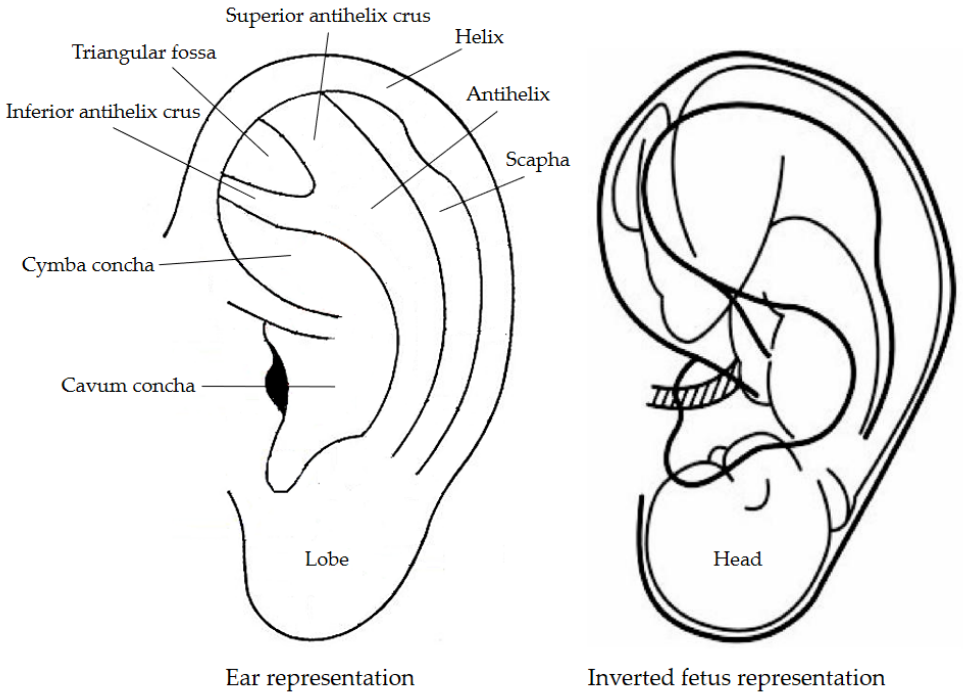

Figure 2.6. Representation of some regions considered in ear acupuncture and the relation to the inverted fetus representation. Reprinted from ref. [65,66].

Pathology, whether on a specific organ or within a body system, is reflected in the auricle, which can exhibit external changes such as discoloration, tenderness and decreased electrical resistance in the corresponding channel pathway within the ear, and even mild morphological changes (scarring) over time [67]. Although there is still some criticism about the clinical specificity of auricular points/areas representing organs or structures of the body, some researchers have reported scientific evidence of the human body's somatotopic representation on the outer ear. Romoli et al. (2014) have shown that stimulation of the thumb auricular acupoint (TAA) selectively activates the secondary somatosensory area bilaterally and that the stimulation of the brainstem auricular acupoint (BSAA) mainly activates the cortical and limbic regions that are part of the pain matrix. This pilot study shows that the specificity of auricular acupoints can be assessed by functional magnetic resonance imaging (fMRI) and that the brain responses of the two tested acupoints might be linked to their respective therapeutic indications [68,69].

Auriculotherapy has been shown effective in reducing chronic musculoskeletal pain [70], stress, anxiety, and depression [71], as well as in managing nausea and vomiting in pregnancy [72]. In addition, auriculotherapy has positive effects associated with the conventional treatments of insomnia and chronic and acute pain. However, further well-

designed studies are required to evaluate this technique's effectiveness in treating other health conditions [69].

2.1.2.1.1 Acupoints Main Characteristics

Acupuncture points are often characterized as a composite including blood and lymph vessels and nerves of various types, located within a sheet of loose connective tissue (mesenchyme) perforating the superficial fascia separating subcutaneous tissue from muscle (Figure 2.7) [73–75]. A higher density of gap junctions has been found at the sites coincident with acupuncture points. These gap junctions are hexagonal protein complexes that form channels between adjacent cells, facilitating intercellular communication and increasing electric conductivity [76]. Deep connective tissue structures in locations corresponding to acupoints have been characterized by a higher concentration of Ca, P, K, Fe, Zn, and Mn [75]. It is well known that both Ca^{2+} and K^{+} are critical signal mediators playing an essential role in various physiological activities [77].

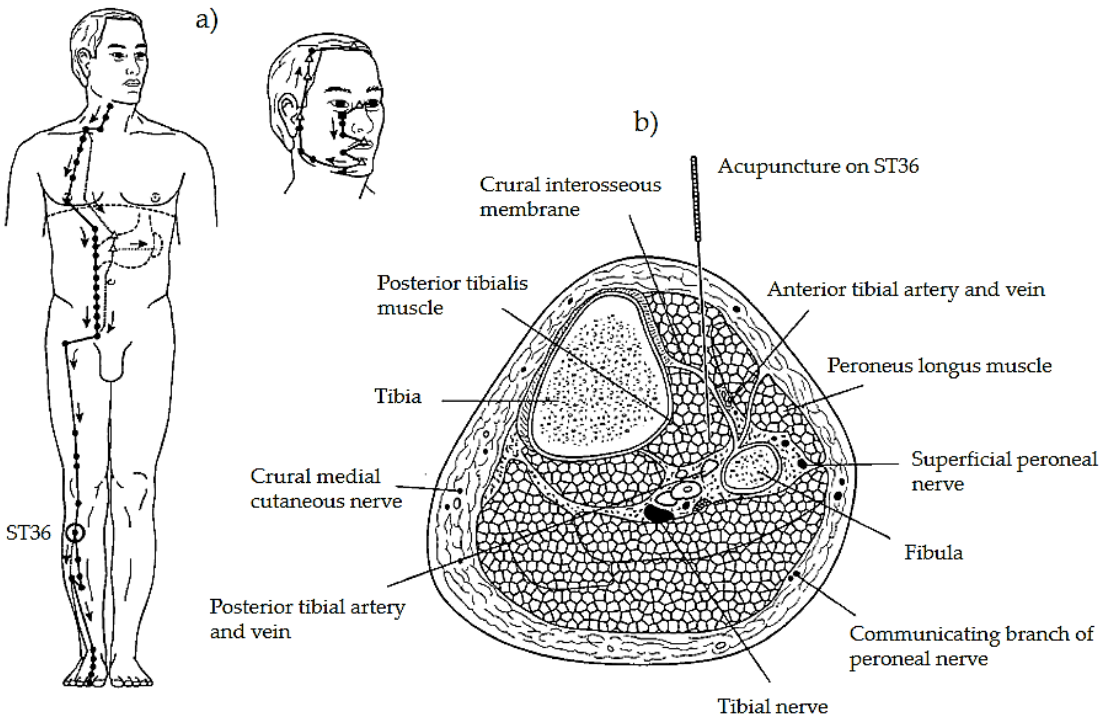

Figure 2.7. Representation of the stomach channel and the location of ST36 (a). Cross-section of the lower limb at ST36, showing the anatomical structures and a needle puncturing the acupoint (b). Reprinted with permission from ref. [64].

For many years, researchers have claimed that acupuncture points are unique locations in the body's surface, at which the skin's electrical conductance is higher than in

the neighboring tissue [78–82]. It is also claimed that the conductivity between two points along the same channel (or conduit) is greater than between points not sharing this relationship, leading to the commonly held opinion that acupuncture structures are special conduits for electric signals [80]. These findings have led to the theory that the channels reflect the pathways of least electric resistance throughout the body. Structurally, these may represent fascial cleavage planes, where extracellular ionic fluids can spread electric potentials over great distances without overcoming the resistance of cellular membranes [83]. It is even conceivable that these low-resistance extracellular fluid pathways might have branches connecting them to the internal organs, thus providing some concrete, albeit hypothetical, basis for the traditional organ–channel associations [64]. These low-resistance fluid channels, where chemical and physical transports occur, are known as low hydraulic resistance channels [84]. The conduit network has also been related to the controversial existence of a primo vascular system known as Bonghan corpuscles and ducts. These thread-like vessels are thought to be similar to blood and lymph capillaries but are distinct in structure, and some are located inside blood and lymph vessels. Thus, tendinomuscular structures, primo-vessels (Bonghan ducts), and regions of increased temperature and low skin resistance have been suggested as features of the channel network or used as identification methods [73].

The analysis of gross anatomic sections of the human arm revealed that about 80 % ($p < 0.001$) of acupuncture sites are located in intermuscular or intramuscular connective tissue [85]. Some studies suggest a relationship between the anatomical direction of collagen fibers along the conduits and acupoints and these structures' functions [75,86]. Collagen is the main structural protein in the connective tissue, forming a fibrillary matrix containing an interspersed and ordered network of hydrogen-bonded water molecules that supports protons' rapid conduction, thus acting as a semiconductor [74].

2.1.2.1.2 Physiological Effects and Mechanisms of Acupuncture According to Western Medicine

The pain relief process through acupuncture is not clear-cut, but many science-based theories do exist. The neurophysiological mechanisms by which acupuncture exerts its effects are complex and still debated. From a Western perspective, acupuncture can be characterized by its effects on the central and peripheral nervous systems. The first one integrates complex somatosensory and cognitive stimuli. When acupuncture acts on the autonomous or vegetative nervous system, it enhances parasympathetic (or reduced sympathetic) activity, decreasing stress responses and promoting immunological homeostasis through the altered brainstem and hypothalamic–neuroendocrine function.

Increased vagal stimulation by acupuncture may also initiate the fast “neural” and slow “diffusible” components of the cholinergic anti-inflammatory pathway. In general, the cholinergic anti-inflammatory pathway is driven by the brainstem and hypothalamic activity, which may downregulate macrophage activation and suppress the synthesis of tumor necrosis factor (TNF) and other peripheral pro-inflammatory cytokines. Although more research remains to be done, this pathway may play a role in acupuncture efficacy [19].

Following a physiological explanation, the neural hypothesis could be summarized: Acupuncture stimulates small-diameter nerves in muscles, which send impulses to the spinal cord. Then, three neural centers (spinal cord, midbrain, and pituitary) are activated to release specific chemicals (endorphins and monoamines), which act as transmitters blocking “pain” messages (Figure 2.8).

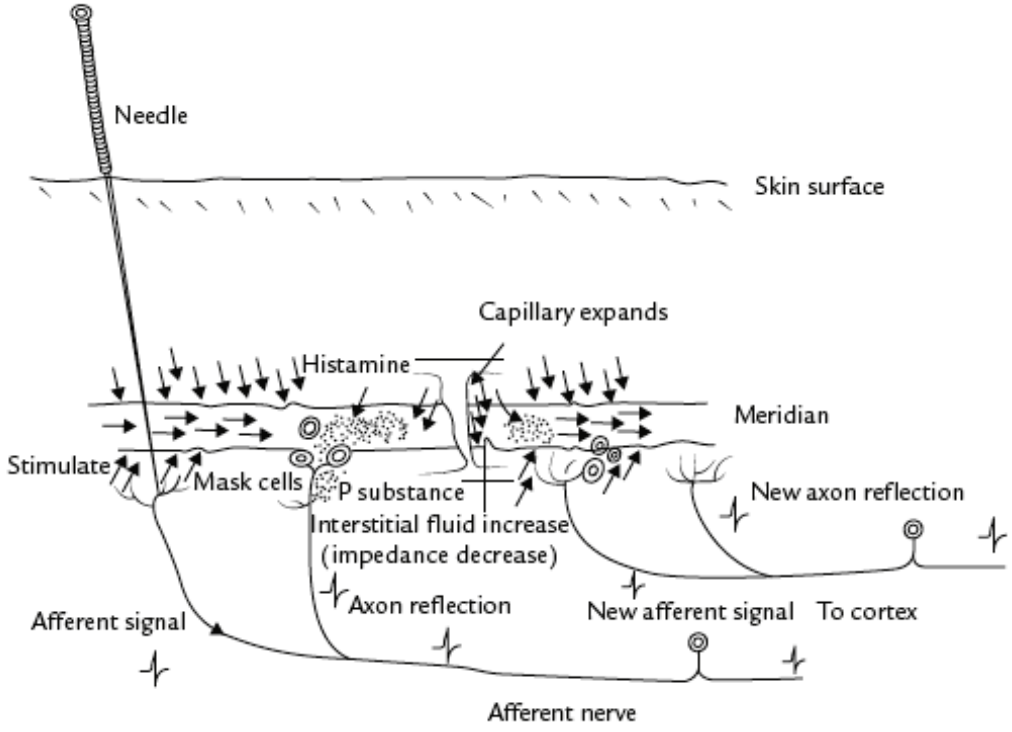

Figure 2.8. Proposed mechanism for the effect of acupuncture along channels. Reprinted with permission from ref. [86].

2.1.2.1.3 Effectiveness of Acupuncture

How could a needle inserted in hand possibly relieve a toothache? Because such phenomena do not conform to accepted physiological concepts, scientists were puzzled and skeptical. Many explained it by the well-known placebo effect, which works through suggestion, distraction, or even hypnosis. However, how does one explain the use of acupuncture analgesia in veterinary medicine if most animals are not suggestible? Over the

last few decades, researchers have been performing controlled experiments to rule out placebo effects and spontaneous remissions. These experiments have been carried out in clinical practice on patients with chronic pain and studying acute laboratory-induced pain in humans and animals. From these studies, it can be concluded that acupuncture is more effective than a placebo [87].

The positive effects of acupuncture have been reported in treating various conditions [60,63,88–112]. Indeed, the World Health Organization (WHO) published in 2002 a detailed review and analysis of randomized controlled trials formally published throughout 1998 (and early 1999) in which acupuncture was proven to be an effective treatment [113]. In 2017, John McDonald and Stephen Janz authored an extensive revision focused on systematic reviews and meta-analyses (the highest form of evidence available) of acupuncture. These authors used “The Australian Department of Veterans’ Affairs 2010 Alternative Therapies Review” and the “United States Department of Veterans Affairs Acupuncture Evidence Map 2014” as a starting point. They updated them in a single document known as “The Acupuncture Evidence Project: A Comparative Literature Review”, reviewing the effectiveness of acupuncture for 122 treatments over 14 clinical areas. The authors found evidence for acupuncture’s effectiveness in 117 conditions, with more robust evidence for some conditions than others. Stronger evidence of the positive effects of acupuncture was found for migraine prophylaxis, headache, chronic low back pain, allergic rhinitis, knee osteoarthritis, chemotherapy-induced nausea and vomiting, postoperative nausea and vomiting, and postoperative pain [114].

Acupuncture is best recognized for its use in treating bodily pain. Vickers et al. (2012) conducted a systematic review to identify randomized controlled trials of acupuncture for chronic pain and found that acupuncture was superior to both sham and non-acupuncture control for each pain condition ($p < 0.001$ for all comparisons). Supported by the significant differences between true and sham acupuncture, these authors concluded that acupuncture has positive effects on chronic pain and that this therapy must be more than a placebo [96].

Neuropathic pain comes from damage or disease in the somatosensory system. Patients suffering from neuropathic conditions such as trigeminal neuralgia, carpal tunnel syndrome, and ulnar tunnel syndrome often report decreased life quality. Carpal tunnel syndrome is a painful and disabling condition affecting the hands when the median nerve, which runs from the forearm into the hand, becomes compressed or inflamed at the wrist. If, on the one hand, the literature exploring the effects of acupuncture in the treatment of symptoms associated with carpal tunnel syndrome points to beneficial effects similar to, or sometimes better than, conventional treatment [115,116], on the other hand, some authors point to little or no effect compared to controls [117,118]. More studies are needed to clarify

the ambiguities. Nerve conduction studies (NCS) could be an excellent strategy to assess nerves' measurable changes after acupuncture. As shown by Chan et al. (2018), while evaluating the effects of acupuncture and moxibustion on the electrophysiological properties of the ulnar nerve, the stimulation of HT4 increased the electrical sensitivity and decreased the stimulus intensity to achieve the maximum amplitude. It also avoided a significant increase in latency and a decrease in reaction velocity in two consecutive electrical stimulations [119]. Using the same assessment strategy on diabetic peripheral neuropathy (DPN) in type 2 diabetes patients, Meyer et al. (2020) found that classical needle acupuncture had significant effects on DPN and that improvements in NCS values presumably indicate structural neuroregeneration following acupuncture [120].

Fibromyalgia syndrome (FMS) is a rheumatic disorder characterized by chronic, generalized, and diffuse musculoskeletal pain. This disease is more frequent in women than men, and the treatment interventions aim to provide the individual with some pain relief and restore functionality. Acupuncture has shown positive effects in this condition, significantly reducing pain threshold and sensitivity, improving anxiety, depression, and quality of life [89,92,121,122].

Low back pain and shoulder pain are two musculoskeletal conditions commonly treated in daily clinical practice. Low back pain (LBP) is one of the most frequently reported complaints. Several studies point to acupuncture's effectiveness in treating chronic spinal pain, which, besides low back pain, includes cervical and sciatic pain [95,123,124]. In this field, Molsberger et al. (2002) performed a large, methodologically rigorous double-blinded trial to assess two questions: Can acupuncture contribute as adjunctive therapy to the conservative management of LBP? Is real acupuncture superior to sham acupuncture? These authors found a pain reduction of 50 % or more at three months after treatment. The rates of achievement of the primary outcome, by group, based on intention-to-treat analysis, were as follows: real acupuncture 76.6 %, sham acupuncture 29.3 %, and conservative orthopedic therapy 13.9 % [93].

Additionally, for low back pain patients with pain persisting over more than five years, the relative probability of experiencing 50 % or more significant pain reduction was ten times higher in real acupuncture than in sham [93]. In 2010, the same authors conducted a randomized pragmatic, controlled, patient-blinded, multi-center trial to study the effects of acupuncture on chronic shoulder pain. They found significant differences between verum and sham and between verum and conventional orthopedic treatment ($p < 0.01$). Moreover, the descriptive statistics showed a more significant improvement of shoulder mobility (abduction and arm-above-head test) for the verum group versus the control group immediately after treatment and after three months, indicating that Chinese acupuncture is

an effective alternative to conventional orthopedic treatment [94]. These results agree with other studies regarding frozen shoulder [125].

Depression, anxiety, and mania are psychopathologic conditions sharing disturbance in mood as a hallmark. These conditions are related to the affection of “shen” and a breakdown of the “yin” and “yang” balance. A patient with depression would be in a state of excessive “yin”, whereas a patient with mania would have excessive “yang”. The reestablishment of a “yin” and “yang” balance might lead to recovery from illness [20]. In this field, acupuncture has shown beneficial results as the primary therapy for reducing the severity of depression [101–103,126,127]. Chan et al. (2015) concluded that combined acupuncture and antidepressant treatment is more effective than antidepressants alone in the first six weeks of treatment. Acupuncture can be an effective, safe, and well-tolerated therapy in the early onset of depression and may reduce antidepressants’ side effects [100].

In the gynecological field, acupuncture helps treat dysmenorrhea, female infertility, and menopausal hot flashes [87,128–130]. Often, these conditions induce nausea and vomiting. The stimulation of the acupoints PC6 and ST36 to reduce nausea and vomiting is well documented and has strong efficacy evidence [131,132]. The proposed action mechanisms stand on the neural response at the insula, hypothalamus, and cerebellum responsible for the autonomic regulation of vestibular function and the somatoparasympathetic reflex, which improves gastric emptying through increased vagal activity [133].

It is noteworthy that significant effects of acupuncture have now also been confirmed by prospective randomized and even double-blinded clinical trials [120, 134–137].

2.1.2.2 Moxibustion

Moxibustion (“jiu” or “ai”) is based on burning tinder made of Chinese mugwort (Artemisia argyi or Artemisia vulgaris) next to a locus or on it [59]. Artemisia tinder has become known in the West as moxa, a Japanese derivation word (“mogusa”, herb for burning). The classical method of performing moxibustion is to make the tinder into a cone and apply it to the skin at points identical to those used for acupuncture. It could be used as a counter-irritant by blistering and scaring the skin or as a milder form of heat treatment by applying it to the skin with a layer of vegetable material or salt interposed between the skin and the cone. Another method is to combine moxibustion with acupuncture by placing a piece of moxa on top of a needle inserted into the body and igniting it. Thus, the moxa’s heat is conducted down the needle to the surrounding tissues [138].

The physiological changes produced by moxibustion are often associated with the combined action of temperature, radiation, and the pharmacological effects of burning

Artemisia and its combustion products [139,140]. The warm temperature of moxibustion induces antipyretic and thermolytic effects by stimulating polymodal receptors in the skin at zones corresponding to acupoints. Vasoconstriction in the treated point and vasodilatation around it are often experienced with increased peripheral blood flow and microvascular permeability. In addition, heat shock proteins naturally synthesized in cells in response to hyperthermia might be induced in local tissues due to the increased temperature. Nonthermal effects are associated with the visible light and infrared radiation emitted by burning moxa and absorbed by the connective tissue, blood and lymphatic vessels, and nerves, which might induce some active substances such as cytochrome c oxidase and intracellular water, two photoacceptor molecules or chromophores. Changes in the water dynamics in membranes, mitochondria and/or cells could modulate signaling pathways, the production of reactive oxygen species (ROS), ATP (adenosine triphosphate), Ca^{2+}, nitric oxide (NO), and inositol phosphates group, with effects on stress signaling, metabolic processes, cytoskeleton organization, cell proliferation/differentiation, and homeostasis [141]. The photoelectric effect and photochemical process generate energy that might help adjust the body's immune and neurological functions.

The major subproduct of burning moxa is smoke, and its security is still under debate. Studies using solid-phase microextraction gas chromatography-mass spectrometry (SPME-GC-MS) have shown that moxa smoke is composed of furan-structure substances, aromatic compounds, esters, alkanes, and hydroxyl-containing compounds [135]. Although these compounds' toxicity represents a concern, moxibustion has been considered minimally toxic, safe and effective, with few adverse events [142]. Research has shown that no harmful effects of moxa smoke have been noticed on treated persons' heart rate (HR) and heart rate variability (HRV). Indeed, Cui et al. (2013) reported decreased HR and increased HRV during 25 min moxa smoke exposure, suggesting that moxa smoke has a regulating effect on the autonomic nervous system, and its inhalation has a short-term stress-alleviating effect [143].

Nevertheless, excessive inhalation should be avoided due to the increased incidence of chronic laryngitis, as noticed in five Chinese medicine hospitals in the Guangdong province. A survey of moxibustion practitioners taken in those hospitals showed that moxibustion smoke raised the incidence of chronic laryngitis from 3.7 % (non-acupuncturists) to 26.67 % (acupuncturists) ($p < 0.05$). Moxibustion safety depends on the position, the duration, the distance between moxa and skin, the practitioners' proficiency, patient conditions, stimulations from smoke, room conditions, and extraction [142].

Moxibustion has been reported as a successful therapeutic in treating knee osteoarthritis [144]. Research shows that patients treated with moxibustion experience

significantly improved pain, stiffness, and physical function than sham-moxibustion [145]. Although the majority of systematic reviews and meta-analyses of randomized controlled trials point to absences in the research and request further well-designed, large-scale RCTs, the overall outcome points to positive effects in managing the symptoms of post-stroke urinary incontinence [146] and constipation [147], use as adjuvant therapy for chronic kidney disease [148], and in treating diabetic peripheral neuropathy [149]. Limited or low evidence of positive effects was found in chronic low back pain [150] and treating lumbar disc herniation [151].

2.1.2.3 Cupping

Cupping is another ancient technique commonly used in TCM. This technique helps the body expel pathogenic factors such as cold or “algor”, dampness or “humor”, and wind or “ventus”, and treats conditions related to the stagnation of “qi” and “xue”, such as bruises or sore muscles. It is beneficial for various pain types in the lower back, shoulders, and legs [152,153]. However, it has also been reported as a successful intervention in usual and emergency treatments, such as herpes zoster, acute asthma episodes, angina pectoris, and abdominal pain induced by poisoning [154–156]. Cupping moves stagnant blood out of deep bruises by bloodletting and reduces swelling and pain in sprains. Cupping can be done by heating the air within the cupping glass and then putting the cupping glass on the skin. Cooling the air by clapping the cup over the affected area exerts mild suction. The pull exerted pushes the flesh into the cup, mobilizing body fluids into the area [64]. Simple cupping of a point is believed to suck off “humor”, removing excess fluid from the point. Often, this “humor” comes with “ventus” as “humor venti”. Thus, cupping is also used to treat “ventus” [12]. Cupping can also be performed over the needle to enhance acupuncture effects. From a Western perspective, the cupping action mechanisms are still unclear. The sub-atmospheric pressure inside the cup changes the skin’s biomechanical properties, increasing peripheral blood circulation and pain threshold, improving local anaerobic metabolism, reducing inflammation, and modulating the cellular immune system [157]. On a systemic level, the comfort and relaxation sensation often reported after cupping might be related to the resulting increase in endogenous opioid production in the brain, leading to improved pain control [158].

2.1.3 Chinese Manual Therapy (“Tuina”)

Although the origins of Chinese bodywork predate written records, written sources from the Qin Dynasty in the third century BC refer to manual therapy as “Moshou” (hand

rubbing). The term “manual therapy” indicates treatment where the hands are used as the primary intervention tool. A century later (Han Dynasty, 206 BC-221 CE), it was called “Anmo” (press and rub), a term still used today. Palpatory techniques for diagnosis and manual treatment are described in the “Huangdi Neijing” [64]. Chinese labourers developed, improved, and spread this art over time in their continuous fight against diseases. Many aspects of “Tuina” have come from the martial arts lineage. Here, the bodywork was used to heal traumatic injury, correct structural misalignments, and keep the martial artist fit and healthy [159]. “Tuina” can affect the five sense organs’ health and help a person feel more vivid via hetero or auto treatments, wherein specific self-massage applications play an essential role [64].

“Tuina” (push and pull) and “Anmo” (press and rub) refers to a system of massage, manual acupoint stimulation, and structural manipulation performed by a fully trained practitioner, who combines skills that in the West would usually be divided into massage, physical therapy, osteopathy and chiropractic [160]. A practitioner may also know and incorporate Chinese herbs, plasters, bone setting, and “qi” projection. Originally, “Tuina” was developed to treat traumatic injury and for use in pediatric care, whereas “Anmo” was directed toward the treatment of internal diseases [64]. A distinct aspect of “Tuina” is the extensive training of the hands necessary for clinical practice. The practitioner’s hands are trained to accomplish focused and forceful movements applied to several body areas. Techniques such as pushing, rolling, kneading, rubbing, and grasping are practiced until they become second nature (Figure 2.9). Students practice on a small bag full of rice until their hands develop the necessary strength and dexterity. “Tuina” is often applied to limited body areas, and the techniques can be quite forceful and intense [160].

“Tuina” is known as “outer therapy”, and like acupuncture and other techniques, acts on acupoints and structures of the skin. It integrates various techniques to stimulate specific points, muscles, and connective tissue and trigger the reflexes. A typical intervention has three phases: 1) in the activation phase, the channel is stimulated to remove the build-up more easily; 2) in the intervention phase, specific diagnosis-related techniques are performed to remove the build-up; 3) in the harmonization phase, the intervention’s strong effect is normalized with the surrounding tissue’s physiological proportions, and it is, therefore, “harmonized”.

“Tuina” manipulation is experience-dependent, and its therapeutic efficacy is influenced by many operating variables, mainly frequency, duration, and force, making the standardization process difficult. Research to identify the standard features for “Tuina” manipulation should consider the muscle groups involved and their potential cooperation, the motion angle, and the joint forces during manipulation. It is also essential to quantify the

frequency, duration and applied force's biological effects. Even so, based on the available literature, the most standardized "Tuina" manipulations seem to be those involving minimum consumption but achieving maximum therapeutic benefits [161].

Figure 2.9. Examples of "Tuina" techniques used to treat various complaints.

"Tuina" is routinely used in patients with orthopedic and neurological conditions and for treating joint and injury problems, chronic conditions, and back problems [162,163]. Because these techniques can affect the functioning of the body's internal organs, they are appropriate for internal medicine, gynecology, and trauma and for patients with conditions that may not be thought of as susceptible to treatment through manipulation. The previous may include asthma, dysmenorrhea, chronic gastritis, hypertension, failure to thrive in preterm infants, major depressive disorder, substance abuse and dependence, pain syndromes, and immune and autoimmune conditions [164–169].

"Tuina" is an adjunct to acupuncture, used to increase the range of motion of a joint, or instead of acupuncture when needles are uncomfortable or inappropriate, such as in pediatric applications [160]. In this field, Wang et al. (2012) conducted a study to evaluate the impact of "Tuina" in treating pediatric muscular torticollis [170]. Of the 38 treated cases, the authors reported 34 cases as full recovery, 3 cases as remarkable effectiveness, 1 case as effective, and none as ineffective. With a 100 % total effective rate, they concluded that the combined method for treating muscular torticollis regulated tendons, thus relieving blood stasis, and it also improved muscular spasms, dispersed mass, and enhanced and restored

neck function [170]. “Tuina” combined with medicinal decoctions has shown positive therapeutic efficacy in treating pediatric allergic rhinitis [167]. As a standalone technique, “Tuina” seems to reduce diarrhea frequency in children aged 0–6 years, compared with sham [171].

2.1.4 “Qigong”

The term “Qigong” is composed of two words: “Qi”, which was previously explained and could be understood as vital energy or, according to some authors, ethereal dynamic energy with feedback potential [172] and “gong”, which means the development of capacity. Therefore, “Qigong” is a practice that allows developing the capacity to collect, circulate and apply vital energy.

“Qigong” integrates three primary schools: medical, martial, and spiritual. Although they differ in purpose, they are based on the same philosophical system, sharing several techniques. In essence, medical “Qigong” promotes health, longevity, and the prevention, diagnosis, and treatment of diseases and imbalances. Martial “Qigong” focuses on developing the strength and power of martial artists, and spiritual “Qigong” searches for spiritual enlightenment and transformation.

The main therapeutic goals of “Qigong” are: 1) to eliminate internal pathogenic factors (excessive accumulation of emotions such as anger, sadness, fear, worry) as well as external pathogenic factors (cold or “algor”, heat or “calor”, dampness); 2) to harmonize the “qi” flow, promoting orthopaty (self-healing power) and avoiding inauspicious depletion (lack of activity) and repletion (excess of activity); 3) to regulate and balance the patient’s “yin yang” functional status to restore harmony [6,173].

As a therapeutic tool, “Qigong” can be used as a self-regulation practice or a mediated healing intervention. In the first case, several exercises can be prescribed according to the person’s condition and performed with the required periodicity. In the second case, the practitioner uses the so-called “qi emission” techniques to restore balance in the patient. Distance therapy (also called “qi” emission or “external qi”) requires the “Qigong” practitioner to manipulate the patient’s “qi” by focusing on the energetic properties of the patients’ channels, collaterals, and points, as well as internal organs, from a distance of several inches, several feet, or even several miles away [6].

2.1.4.1 “Qigong” and the Defensive “Qi”

TCM theory considers that the human body generates an external defensive field known as “wei qi”. According to the Heidelberg model of TCM, the defensive “qi” is located

outside the conduits, within the tissue. It has its origin in the three functional sections of the body (three burners or “calorics”) and centers on, predominantly, the surface (“extima”), where the pulmonary orb ensures its distribution [7,10,13,173]. This “wei qi” field is believed to include three external layers of subtle energy (physical, emotional, and spiritual), each one connected to one of the three “dantians” and surrounding the physical body.

The external “wei qi” field protects the body against external pathogenic factors’ incursions, interacting with the surrounding environmental energetic fields. These may include geomagnetic rhythms, Schumann resonance, shallow frequency electromagnetic radiation, X-rays, cosmic rays, as well as the radiation provided by our technology [174–178]. Both external and internal pathogenic agents affect the “wei qi” field’s structural formation. Internal factors include repressed emotions such as anger and pain from emotional traumas. Strong non-processed emotions block the regular circulation of “qi”, creating stagnation in the body. The external factors include chronic and severe environmental agents, such as coldness, humidity, dampness, heat, and wind. Physical traumas also affect the “wei qi” field by creating fragilities in the external energetic matrix. These fragilities create vulnerabilities, making it easier for disease-causing pathogens to enter.

During “Qigong” practice, the “qi” is captured and absorbed in the lower “dantian”. The practitioner should idealize and feel this energy extending into the Earth (as an anchor) and the surrounding “wei qi” field increasing and expanding [6].

2.1.4.2 “Qigong” as Traditional Biofeedback Therapy

“Qigong” practice promotes the development and control of “qi” and its balanced distribution through the body. “Qigong” is considered a traditional vegetative biofeedback therapy that uses postures, movements, and breathing exercises combined with meditation to induce the vegetative stabilization and self-regulation of the body’s biological systems. The “qi activation” is achieved by breath control and a particular mental state of “awareness” [179,180], thereby improving and strengthening the overall state of vegetative regulation (homeostasis) [181–185]. The “Qigong” practice consists of specific techniques (Figure 2.10) that use knowledge of the body’s internal and external energy fields to purge, invigorate, and balance these energies. Medical “Qigong” therapy offers patients a safe and effective way to rid themselves of pathogenic agents, such as painful emotions that otherwise can cause mental and physical illness. As mentioned above, this therapy combines breathing techniques with movement, creative visualization, spiritual intent to improve health, personal power, and control [6].

Breathing control is particularly important in “Qigong” practice. The breath is the most important source of “qi”, related to the Metal Phase (rhythmical distribution of energy) and the pulmonary “orb”. In addition, breathing is the pacemaker of several vegetative functions, such as the muscular tonus and the capillary blood flow. Therefore, “Qigong” breathing exercises (“Tu Gu Na Xin” – “expel the old and absorb the new”) promote the capture and absorption of “qi” from the air, increasing the body’s vitality and the harmony between “qi” and “xue” while promoting health and purging disease [6].

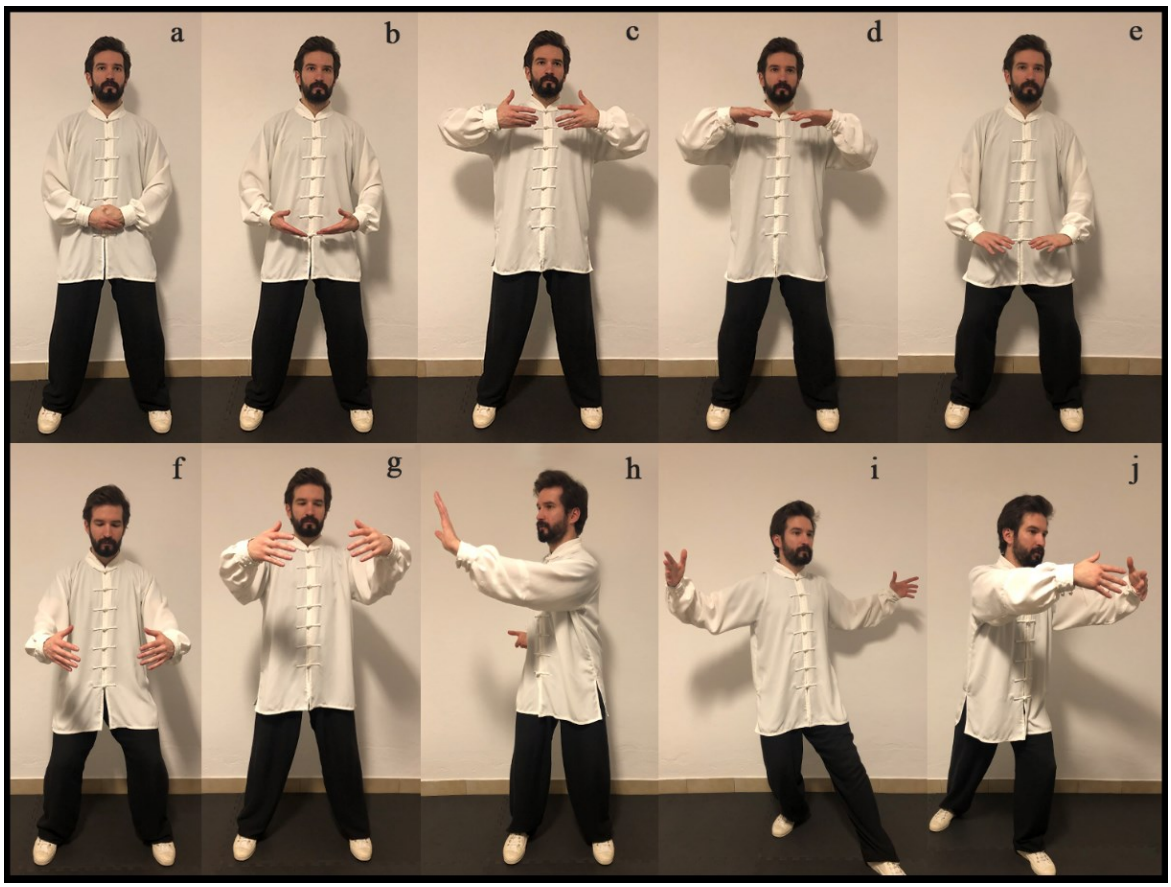

Figure 2.10. “Qigong” exercises. Sequence (a–g): (a) focus on the lower “dantian”; (b) to (e) moving the “qi”; (f) white ball lower “dantian”; (g) white ball middle “dantian”. Sequence (h–j): (h) “Taiji “Qigong” pushing palm; (i) and (j) “Taiji “Qigong” spreading the wings.

As part of the “orbs”, breathing patterns are directly connected to the five primary emotions significantly affecting the “qi” circulation. Breathing is a connection between mind and body, with effects on physiological functions and emotional balance. Anger or “Ira”, which belongs to the Wood Phase, increases the “qi”, making the exhalation more vigorous than the inhalation. Sadness, grief, and pain (“maeror”), which belong to the Metal Phase, deplete the “qi”, making the inhalation more substantial than the exhalation. Fear and shock (“pavor”), which belong to the Water Phase, decrease and disperse the “qi”, inducing a short

and superficial breath as a result of the kidney's incapacity to retain the "qi". Excitation and luxury ("voluptas"), which belong to the Fire Phase, induce irregular breathing with fast-shifting patterns. Worry ("solicitude") and reflection ("cogitation"), which belong to the Earth Phase, block the "qi" and make the inhalation short and weak, which is sometimes sustained during a period followed by fast inhalation and exhalation [6,173].

2.1.4.3 Physiological Effects and Mechanisms of "Qigong" Practice

One of the prime benefits of "Qigong" is stress reduction, and one of the main concepts of this practice is to use the mind to guide activation and deactivation patterns by imagination. Excessive stress may negatively impact a person's health state and may be associated with increased anxiety, psychological disorders, and functional impairments of the organs within the body [186]. It has been shown that "Qigong" and "Taijiquan" training may reduce emotional exhaustion depersonalization and even improve anxiety, and reinforce attention and effectiveness in high school students [187–193].

The "White Ball" is one specific type of "Qigong" similar to the "Zhan Zhuang" system. When enrolled in a formal training program, children quickly learn this system, with evident development of their individual vegetative skills and reduced anxiety-induced effects [187,188,194]. Research has shown that these skills are stable after weeks of training, allowing young musicians to play the flute in auditions, with warm fingers and reduced anxiety-induced heart rate elevation, even without a momentary prior application of the learned "Qigong" exercises. It seems that positive vegetative changes in the behavioral pattern appear to be naturally available on-demand in critical stressful situations as a part of the child's reactive behavioral repertoire [187].

Infrared thermography can be used to measure the dynamic changes of temperature in the hands during "Qigong" practice (Figure 2.11). This technique has been reported while studying "Qigong"-related effects [195,196].

Thermography measurement showed that the "Qigong" exercise could change the fingers' temperature. Therefore, skin temperature changes may be interpreted as an increase in microcirculation. Researchers found that when a particular mental state of awareness was achieved, and the "qi" sensation was felt, skin temperature increased to 37 °C [194]. These data may also help demystify Chinese medicine, while thermography allows for visualizing the microcirculation effects on the hand's temperature during "Qigong" practice. TCM holds that the "mind" guides the "qi", which therefore guides the "xue" ("blood"). The Heidelberg model of TCM sees strong analogies between the effects of "xue", as described by the classical scriptures, and the clinical effects of microcirculation in Western medicine. Therefore, "qi", translated by this model as a vegetative functional

capacity, guides and steers microcirculation. In other words, this old phrase from classical scriptures can be demystified accordingly: “the mind” (imagination and awareness) can guide and therefore activate vegetative capacities, which in return lead to changes in the microcirculation [187].

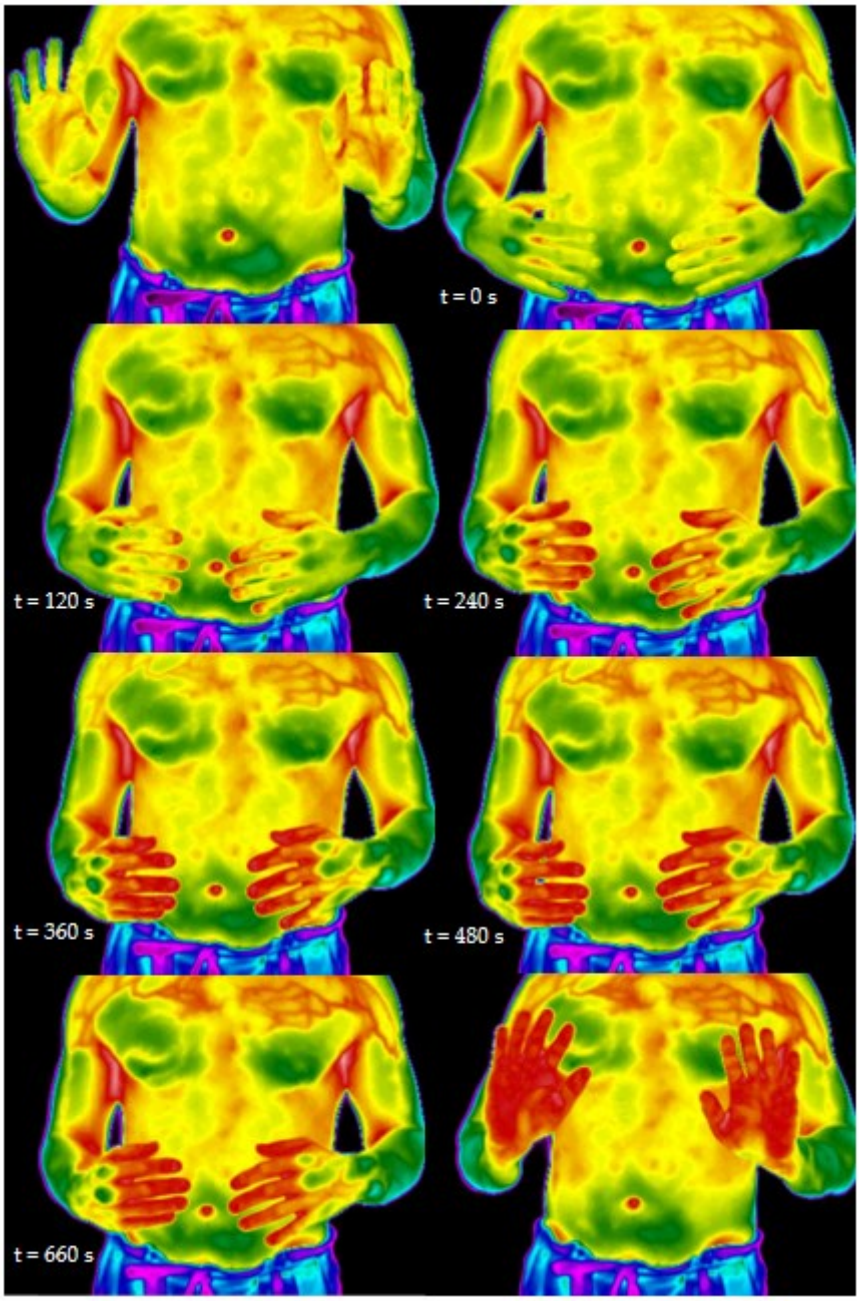

Figure 2.11. Thermograms of the “Qigong” exercise known as “White Ball”. Reprinted with permission from ref. [197].

The effects of “Qigong” and meditation on brain activity self-regulation through biofeedback have been reported. Research has explored brain activity biofeedback with real-time functional resonance magnetic imaging (fMRI) during pain stimuli and has found

that subjects could learn to control activation in the rostral anterior cingulate cortex (rACC). Researchers found a deliberate increase or decrease in fMRI signal in the rACC, corresponding to a change in the perception of a thermal pain stimulus. Furthermore, chronic pain patients could be trained to control activation in rACC, thereby decreasing their ongoing chronic pain level. Meditation has also been explored to control clinical pain. It has been shown that long-term meditators have a diminished thalamic response to experimental pain stimuli compared with age-matched non-meditators. Meditation involves a state of altered consciousness and may increase alpha wave power in occipital, parietal and temporal brain regions and gamma power, as measured by magnetoencephalography (MEG) and electroencephalography (EEG), respectively. Long-term meditation practices may also help preserve the brain's regions, including the prefrontal cortex and right anterior insula [67].

Research has shown that the effectiveness of "Qigong" in balancing the spirit ("shen") is remarkable. Tsang et al. (2006) studied the effect of "Qigong" practice on the psychosocial behavior of depressed elderly individuals and concluded that regular "Qigong" practice could relieve depression and improve personal efficacy and well-being [184]. Furthermore, in the field of psycho-emotional imbalances, Griffith et al. (2008) found a significant reduction in stress while studying the efficiency of a "Qigong" training program on hospital staff's stress management [190]. Saganha et al. (2012) obtained similar positive results after a three-week "Qigong" training program for physiotherapists suffering from burnout. In the previous study, the program's efficacy was accessed by the Maslach burnout inventory (MBI) questionnaire, and the results show that the program was able to decrease the mean values of emotional exhaustion and lower the mean values of depersonalization [189].

Furthermore, in autism, some positive effects could be noticed, as shown in the study conducted by Silva et al. (2005). These authors found that a group of eight children aged below six years, regularly submitted to "Qigong" massage, had decreased autism behavior, improving speech, sensory and motor skills, and general well-being [198].

A considerable number of studies point to significant changes in physiological parameters, such as blood pressure and circulation, heart rate and variability, plasma triglycerides, total cholesterol and low-density lipoprotein (LDL) cholesterol, HDL cholesterol, skin temperature, lung functions (such as the increment in forced expiratory volume and a reduction in the number of exacerbations), relaxation state measured by electroencephalography, light emission measured by photon counting, electrical charge measured by gas discharge visualization, and electrical conductance and the potential of acupoints [194,196, 197, 199–205].

Hypertension is a worldwide transversal concern, especially in the elderly, as aging may decrease the blood vessels' elasticity and increase the risk of other hypertension-related comorbidities, such as obesity, diabetes, and kidney disease. Lee et al. (2003) found that "Qigong" promotes the relaxation and stabilization of the sympathetic nervous system in hypertension patients, positively modeling urinary catecholamine levels and blood pressure and improving ventilatory functions [180]. Recent systematic reviews on the subject confirm these results [206,207]. Controlled studies developed by Lan et al. (2004) to access the cardioventilatory behavior of elderly "Qigong" and "Taijiquan" practitioners showed an improvement in aerobic capacity [185]. "Qigong" also seems to benefit the overall quality of life of older adults with chronic diseases [208].

Other common diseases treated by "Qigong" include diabetes, arthritis, hypertension, breast and ovary cysts and tumors, migraine, fibromyalgia, insomnia, acute abdominal pain, colitis, muscular atrophy, brain tumors, stroke, coma recovery, and certain types of cancer [179–183,186,209,210].

2.2 TCM Diagnosis Parameterization and Standardization

Traditional Chinese medicine is an ancient medical system that gives emphasis to the human body's integrity and regulation and its interrelationship with the surrounding environment [211, 212]. The worldwide use of TCM practices has raised the question of how its integration in Western healthcare systems and research could be practically managed. This has encouraged the development of research strategies and the publication of a considerable number of scientific studies on the mechanisms and effects of TCM therapeutics [63, 96, 103, 104, 108, 119, 125, 192-194, 197, 213-216]. Nevertheless, much anecdotal evidence demands appropriate study designs and sample dimensions to break down the resistance within mainstream conventional medicine [217].

The integration of TCM is a bidirectional process that requires the following preconditions: 1) a rational communicable theory; 2) scientific proof of efficacy and safety; 3) measures of quality control [218].

Contemporary TCM could be understood as a model of vegetative systems biology centered on the theory of regulation and the so-called guiding criteria as categories of clinical signs based on four physiological models of body regulation. These involve signs of neurovegetative origin felt as "fullness" or "emptiness", signs of humoro-vegetative origin felt as "heat" or "cold", signs of neuro-immunological stages expressed as "exterior" or "interior" affections, and signs of structural deficiency versus primary regulatory deficiency

understood as “yin yang”. In this context, TCM diagnosis is a way of establishing the body’s vegetative functional status.

This integrated neurovegetative approach, complementary and interactive with Western medicine, translates to Western physiology the structural concepts of TCM language, making possible, therefore, the inherent rational use of reflex therapeutic systems, anti-inflammatory mechanisms, and mental training, which are applied in techniques such as acupuncture and “Qigong” [219, 220]. This methodology requires a science-based conceptualization and a standardization effort from diagnosis to therapeutics [218]. It is critical to develop pragmatic and reliable technological systems to measure TCM-related effects and even calibrate and mimic skillful procedures, such as tongue and pulse diagnosis.

One of the problems involved in operating research protocols and evaluating acupuncture success is rationally establishing the diagnosis by systematically categorizing signs of symptoms. However, a proper diagnosis followed by a coherent intervention is the recipe to achieve positive results, as can be seen, for example, in the study conducted by Maimer et al. (2013) on the effects of needle acupuncture on the pain-induced reduction of lung function after median sternotomy, or even in the study conducted by Karner et al. (2013) on a repeated measures, double-blinded, and placebo-controlled, multicenter trial with 113 patients suffering from chronic osteoarthritis of the knee. This latter compared the effects of three acupuncture modalities (sham, semi-standardized modern, and individualized classical, based on Chinese medical diagnosis as defined by the Heidelberg Model of TCM) within two parameters: joint mobility and pain [136].

The previously mentioned studies show that acupoints’ diagnosis-dependent selection contributed to a higher analgesic effect. If acupoints are understood as reflex points that elicit specific neurovegetative changes, it can be speculated that they might only yield satisfactory treatment results if they match the current vegetative status of the patient [221]. In some cases, the variability between practitioners’ evaluations must be considered [222-224]. This variability, often related to the subjectivity of the variables and subcategories of diseases, can lead to an incorrect selection of acupoints and erroneous therapeutic results. Moreover, non-individualized, non-diagnosis-based interventions could negatively contribute to some acupuncture meta-analyses, which, based on the poor results of some inaccurate trials, evaluate acupuncture treatments as not being statistically different from controls [91]. Furthermore, acupoints’ exact location is critical and might significantly influence the results. In addition to lab-scale experiments involving nitric oxide biocapture over the skin in zones corresponding to acupuncture points [225], advanced technological methods such as magnetic resonance imaging (MRI), functional MRI, synchrotron radiation

phase-contrast X-ray CT imaging, and positron emission tomography might help clarify the channel network and validate the traditional “cun” measurement unit often used to locate acupoints [226, 227].

The concept of syndrome or pattern in TCM (known as “zheng”) is crucial while establishing the diagnosis [228]. It entails the human body’s overall physiological and pathological pattern as a function of a particular condition, which usually reflects an internal unbalance defined by a systematic analysis of the clinical symptoms and signs gathered by a practitioner [211]. Thus, to establish a general picture of the patient condition involving subtle and physical factors related to inner nature [229], pathological agent, and physiological status, Chinese medicine diagnosis considers four main essential examinations: looking, listening-smelling, palpating, and questioning [230]. During this process, tongue diagnosis is evaluated while looking, whereas pulse diagnosis is evaluated while palpating.

2.2.1 Tongue Diagnosis

In Chinese medicine, the tongue shows the state of some fundamental functional powers (“substances”) known as “qi” (commonly referred to as “vital force” or “energy”), “xue” (blood), and “jin ye” (body fluids). Tongue patterns correlate with groups of diagnostically relevant signs (indicating the state of a body island) and the functional properties of channels [10]. TCM holds that “qi” and “xue” are functional powers in the body, or vegetative capacities to function, which may be seen in functional physical signs related to measurable physiological processes and aspects such as the increase of the peripheral microcirculation and skin temperature and the changes on acupoints’ electrical potential and resistance, and even on the surrounding biomagnetic field [194].

The tongue mirrors the internal organs, reflecting the body’s physiological and clinical-pathological condition (Figure 2.12). Therefore, the color, size and form, motion, substance, coating, and geometric shape of the tongue, as well as changes in the tongue body, such as thickness, cracks, and teeth marks, are just a few qualities that must be evaluated and related to the health state of the patient [231].

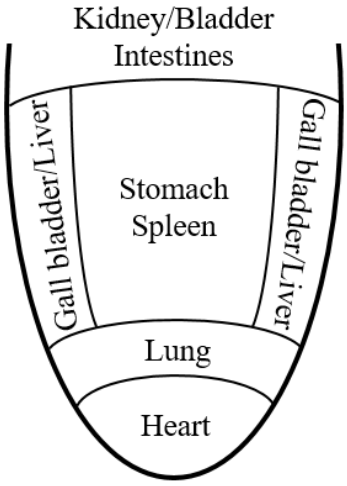

Figure 2.12. Tongue somatotopy in Chinese medicine diagnosis.

Tongue diagnosis requires proper skills and specific light conditions. Despite the difficulty, mainly because the diagnosis relies on the practitioner's experience and knowledge, several approaches based on digital image capture and computerized tongue examination systems have been proposed and used in large-scale studies, demonstrating its applicability for health identification and disease differentiation [231-234]. An Automatic Tongue Diagnosis System (ATDS) is shown in Figure 2.13.

Figure 2.13. Illustration of tongue image capturing with the Automatic Tongue Diagnosis System (ATDS) (reprinted from ref. [235]).

The previous system comprises hardware responsible for the image acquisition and software that allows the tongue body segmentation, feature extraction, and diagnosis. The hardware mainly integrates digital cameras equipped with charge-coupled devices (CCD)

or complementary metal-oxide-semiconductor sensors, light sources such as light-emitting diodes (LED), cold-light halogen lamps, tungsten halogen lamps, and a color checker module embedded inside the digital image providing a color reference to a calibration model. After the tongue image is captured, the image-processing software, based on advanced statistical methods and mathematical models, allows the color correction, tongue segmentation, and classification according to the extracted diagnosis parameters [231].

Tongue segmentation is a complicated procedure that deals with structural difficulties such as the variability of pathological details on the tongue surface and the diversity of tongue body shapes [236]. It requires robust and accurate algorithms based on region or edge approaches to detect tongue boundaries.

The active contour model (ACM) or snake is an edge segmentation technique frequently used in tongue segmentation. However, it presents poor convergence of concavities, limited capture range, undesirable contracting and clustering effects, and a lack of global control [231, 237]. Several methods have been proposed in combination with the ACM to overcome these limitations, such as the bi-elliptical deformable template, the watershed transform, the gradient vector flow, and the knowledge-based initial tongue body boundary detection plus color gradient [236-239]. Other techniques can also be successfully used in tongue segmentation, such as the threshold method using Otsu's thresholding algorithm, the color control-geometric and gradient flow snake, and the double geo-vector flow [240].

The color and coating of the tongue body are the two main criteria used in developing ATDS. Some systems also consider tongue shape, fissures, ecchymosis, tooth marks, and red dots [241]. A bluish tongue, petechiae, and engorged sublingual collateral vessels are potential tongue manifestations of blood stasis, which, according to Hsu et al. (2016), is a relevant predictor of diabetes mellitus [242]. Indeed, some practitioners integrate sublingual vein inspection during their tongue diagnosis routine. Chiu et al. (2002), as well as Yan et al. (2009), found a good correlation between the results of computerized image analysis of the patient's sublingual veins and their physiological and pathological conditions [243, 244].

As a general requirement, the developed ATDS must be able to mimic, in a reproducible way, the traditional tongue diagnosis, and for that, when submitted to clinical tests, their output must correlate with the findings of experienced TCM practitioners. In a study on the agreement between an automatic tongue diagnosis system and the evaluation made by several TCM practitioners, ATDS was shown to be more consistent with significantly higher intra-agreement than TCM doctors. Moreover, the inter-agreements between the ATDS and TCM doctors were both moderate [235]. Similar results were found by Kim et al. (2012) while evaluating the tongue coating thickness [245]. Those positive

results agree with clinical studies designed to assess the tongue color and coating in patients suffering from functional dyspepsia, gastritis, diabetes, colorectal, and lung and breast cancers [242, 246-251].

Despite the encouraging results, each methodology's specificities may lead to inconsistencies in the practical clinical application [231]. Nevertheless, researchers have been interested in the ATDS as a tool to standardize traditional tongue diagnosis and for educational purposes [252, 253]. Some have seen the advances in smartphone technology as an opportunity to create immediate diagnosis applications; however, there is still much work to do to overcome obstacles and limitations such as the environmental lighting conditions and the existence of standard artificial illumination with temperature control, the low image resolution, and absence of color correction of some systems, and the correlation with well-established diagnosis [231, 254].

2.2.2 Pulse Diagnosis

The pulse ("mo") in Chinese Medicine is considered the most important diagnostic technique, requiring a good knowledge of Chinese physiology to interpret the findings. Those can give detailed information on the state of the patient's internal organs, as they reflect the patient's flow of "qi" and "xue" and the "yin yang" character at the moment. The pulse is felt at the radial artery, which is divided into three areas: the pollical site at the front near the wrist, the clusal site at the middle, and the pedal site at the lower level (also known as "cun" or inch, "guan" or barrier, and "chi" or foot, respectively) (Figure 2.14) [12].

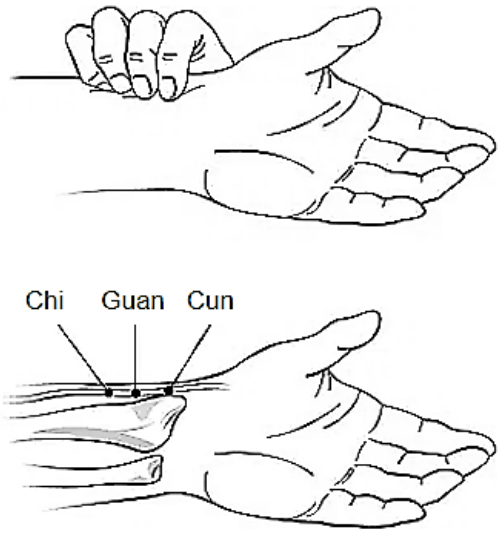

Figure 2.14. Pulse diagnosis gauge sites over the radial artery (adapted from [255]).

The pulse is taken on both sides at three palpable depths related to “qi”, “xue”, and organs [256]. The deepest level corresponds to the “yin” and at the superficial level to the “yang” physiological regulation aspects or, in another language, the deepest level to the “yin” organs (solid organs) and at the superficial level to the “yang” organs (hollow organs) [64]. The two-depth method is commonly taught in Australia, Europe, and the USA and is frequently used by practitioners of these locations [256]. The three areas of the wrist are related to the so-called “Triple Burners”; the front position corresponds to “Heaven” and reflects the diseases from the head to the chest; the middle position corresponds to “Man” and reflects the diseases from the diaphragm to the umbilicus, and the lower position corresponds to “Earth” and reflects the diseases from the umbilicus to the feet [6].

Pulse diagnosis requires sensitivity and special skills. Each practitioner must learn how to identify them by experience and continuous practice to feel its subtle variations. Despite its importance, palpation remains subjective and mysterious, standing as an obstacle in clinical practice and research [257]. Indeed, ancient TCM canons document dozens of pulse qualities, including floating, sunken, slow, rapid, surging, fine, vacuous, replete, long, short, slippery, rough, string-like, tight, soggy, moderate, faint, weak, dissipated, hollow, drum skin, firm, hidden, stirred, intermittent, bound, skipping, and racing, to mention a few [258]. The amount of detail requires a unique perception, and even with practice, the variability in the diagnosis is considerable, making the intra- and inter-rater pulse diagnosis reliability not high between TCM practitioners [259].

The quantification of pulse patterns is an essential requirement for objectifying TCM pulse diagnosis. Arterial pulse waveform has been studied in order to develop quantification strategies [260-265]. Researchers have used a wide range of sensors in this process, including piezoelectric sensors, piezoresistive strain gauges, magnetic sensors, liquid sensors, acoustic sensors, Doppler ultrasonic devices, infrared, optical and photoelectric sensors, among others [266]. Once the signal is acquired, processing and analysis strategies are necessary to interpret the Chinese pulse waveform patterns objectively. Shu et al. (2007) proposed four classification indices: the wavelength, the relative phase difference, the rate parameter, and the peak ratio. The relative differences between the mentioned indices allowed the authors to distinguish 13 pulses [267], while others have reported the differentiation of pulse qualities by using neural network strategies to classify patterns shown in pulse images [268].

Pulse taking can be performed by pressing with one finger in each gauge site or simultaneous palpation, which indicates the whole body state trend. These two methods are used together to obtain complete information; however, regarding different clinical viewpoints, some practitioners insist on using simultaneous pulse taking, while others use

site-to-site evaluation. This stands as an obstacle in automatic pulse taking, and for that reason, to clarify this issue and find differences in these two approaches, Chung et al. (2013) conducted a study using a tactile array sensor. They found both methods positively correlated with the entire trend and specific pulse-taking depth, with no discrimination while checking the diagnosis patterns. Nonetheless, once site-to-site evaluation cannot simultaneously compare the three gauging sites, simultaneous pulse-taking seems to be the best option for a possible standard pulse-taking procedure [269].

Tactile array and pressure sensors have been used with success to detect some pulse particularities [267,269,270]. In this field, Luo et al. (2012) developed and tested a Bi-Sensing Pulse Diagnosis Instrument with a Pressure-Displacement Bi-Sensing System coupled to a robot finger system (Figure 2.15). This device was equipped with pressure sensors whose signals simulated the practitioner's fingertip sensations. The authors found that the pulse signals obtained from the robot fingertips accurately represented the TCM practitioner’s fingertip sensations at the level of their finger-reading ability. These authors concluded that this method could demonstrate the experienced finger-reading skills of a TCM practitioner and quantitatively record the inherent pulse findings [270].

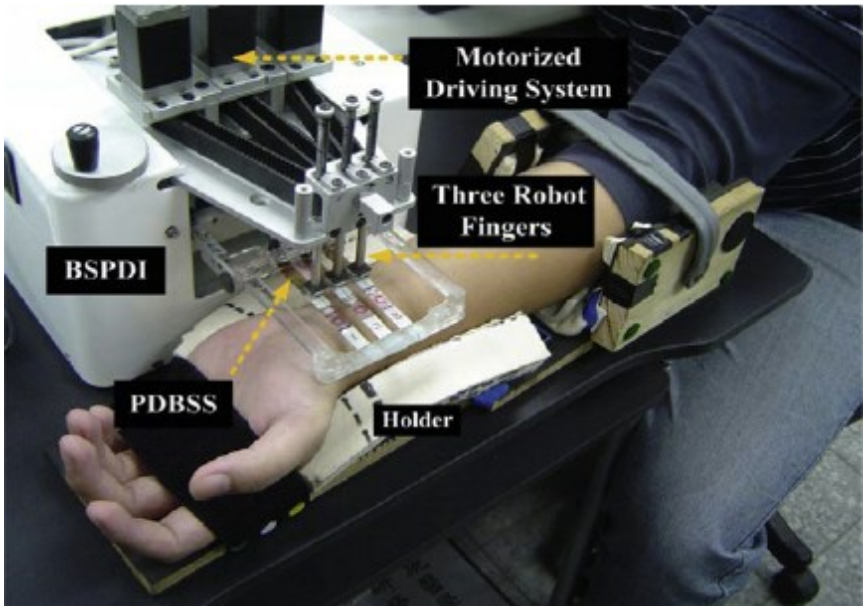

Figure 2.15. Bi-Sensing Pulse Diagnosis Instrument (BSPDI) equipped with a Pressure-Displacement Bi-Sensing System (PDBSS) (reprinted with permission from ref. [270]).

Chu et al. (2014) conducted a study to evaluate the pulse qualities at three positions and three depth levels using the same technology. These authors found a relation between the measurements and the patterns expressed by a three-dimensional pulse mapping, representing the mimicking of the practitioner’s fingertip sensations [257]. Despite the effort, there is still a lack of studies exploring the pulse depth qualities and their relation to

pathological features. Chung et al. (2015) proposed a method that defines the pulse-taking depth based on the artery's width, considering the initial touching position as the starting point and the artery obstructed position as the ending point. With this approach, the different depths are defined by the different percentages of the artery width [271].

The previous studies corroborate the validity of these devices in the parameterization of pulse diagnosis; however, more research is needed to improve the detection and quantification of subtle wall-dependent qualities and overcome waveform artifacts related to the subject's movement or breathing.

2.2.3 Electrophysiological Diagnosis Devices

For many years, researchers have claimed that acupuncture points are unique locations on the body surface where the skin's electrical conductance is maximal compared with neighboring spots [78, 79]. Moreover, the electrical properties of these "bioactive" points are also characterized by a reduced impedance and resistance, an increased capacitance and higher electrical potential compared with non-acupuncture points [272]. Once the conductivity between two points along the same conduit (or meridian) is greater than that between points not sharing this relationship, conduits could be considered pathways of lower electrical resistance throughout the body where electrical potentials are spread without needing to overcome the resistances of cellular membranes. These low-resistance extracellular pathways might be connected to the internal organs, thus providing a theoretical basis for the traditional Organ-Conduit associations [64].

Nowadays, several devices can measure the electrical resistance (related to the electrical conductance) in specific skin areas coincident with the acupuncture points [273]. An example of these devices can be seen in Figure 2.16a and the electrical conductance during three consecutive measurements along the large intestine conduit (LI channel) (Figure 2.16b).

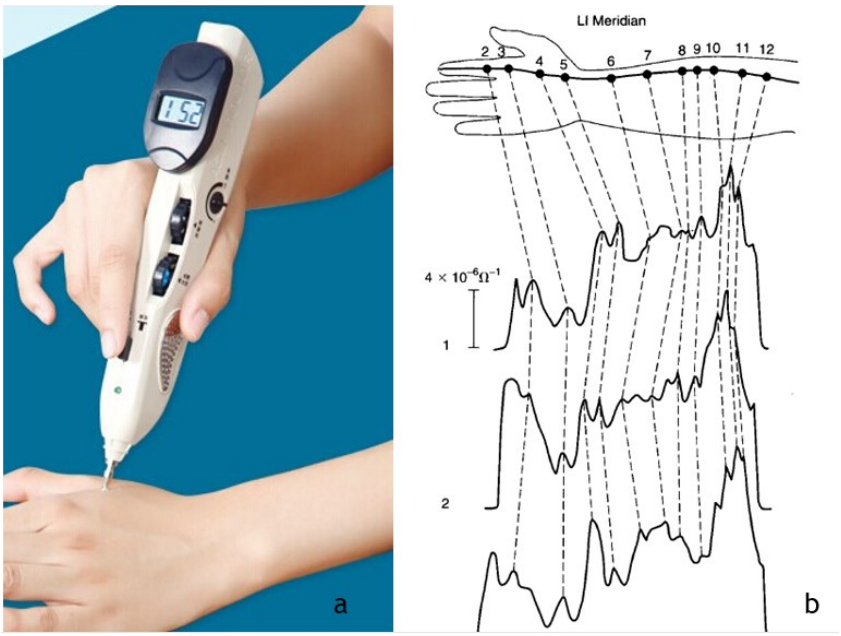

Figure 2.16. Acupoint detector device ((a) – adapted from ref. [274]) and three successive conductance scans along the Large Intestine Channel – numbers in the upper limb correspond to acupoints ((b) – adapted with permission from ref. [64]).

Some authors have shown that it is possible to distinguish between the conduit and non-conduit tissue by applying low-frequency electrical stimulation in the skin [275-278]. Based on this principle, several electrodermal screening techniques were developed for point location and diagnostic and therapeutic purposes [275, 279-283]. However, the development of this kind of technology must consider critical technical issues that contribute to the final electrodermal reading and may cause doubts about the validity of these devices, such as the electrode polarizability, the stratum corneum impedance, the presence of sweat glands, the choice of contact medium, and the electrode geometry, among others [272].

An acupoint's electrical potential is a relative quantity that quantifies how much energy capacity it possesses compared to a reference. It is a standard measure used to study bioelectricity related to low-level endogenic currents and assess functional effects and particularities along conduits. Lee et al. (2005) show that while studying the effects of acupuncture on the potential along the stomach conduit of healthy and unhealthy patients suffering from gastric disease, a diagnosis can be made by comparing the levels of potential difference and its regularity in the conduit [279]. Research has shown that the electrical potential differences can be used to monitor changes in the conduits and acupoints [284, 285]. Acupoints' states modify as a function of different stimuli, inducing physiological changes and altering the tissue's endogenous electrical potential and current [285, 286]. As shown by Matos et al. (2019; 2021), "Qigong" practice, acupuncture and moxibustion can be used as stimuli to generate electrical potential changes in acupoints. Those changes

seem to corroborate TCM theory and may contribute to explaining the vegetative physiological changes associated with “qi flow” in Chinese medicine [287, 288].

The Electroacupuncture According to Voll (EAV) and the Ryodoraku mechanism for measuring conduits’ electrical activity are two well-known systems. In the first one, the acupoint direct current (DC) resistance reflects the condition of the associated organs or systems and could diagnose and monitor the patient’s health. The diagnosis depends on measuring the relative electrical conductance (on a scale ranging from 0 to 100) and its time dependence. According to Voll’s calibration, readings from 50 to 65 (or resistance between 53 and 95 kΩ) are regular; readings above 65 (or resistance less than 53 kΩ) indicate inflammation, and readings below 50 (or higher than 95 kΩ) indicate degeneration in the organs associated with the measured point [289]. These devices measure the current intensity in a series circuit containing a voltage source (usually a few volts) and two resistors: one is the resistance between the electrode-acupuncture point and a cylindrical contact electrode kept firmly in one hand, and the other is usually chosen to represent the mean value of repeated measurements on acupuncture points of healthy persons [78]. EAV theory is the base for the standard electrodermal screening (EDS) techniques used to evaluate the electrical resistance. This technology seems to help diagnose upper gastrointestinal bleeding, kidney failure, or even cancer [290, 291].

Yoshio Nakatani developed the Ryodoraku mechanism for measuring the electrical activity of conduits in the 1950s. Ryodoraku means “good conductive line” [292], and its output reflects the condition of specific organs by analyzing and comparing their mutual relations, considering the measurable changes in the electrical properties of some points known as Source (Yuan) acupoints [293]. Those are located in the wrists and ankles, which are the places where the “yuan qi” (original “qi”) of the corresponding organs passes through abundantly to represent the respective conduits. Some studies show that this system could investigate changes in physiological and psychological variables of subjects submitted to different stimuli [294, 295]. Moreover, Ryodoraku is a supplementary diagnostic method of renal colic [293] and a valuable tool for evaluating the therapeutic effects of acupuncture and related techniques in treating certain conditions such as back pain, gall-bladder conduit dysfunction, and obesity [60, 292, 296, 297].

Although much of these findings corroborate the assumption that conduits act as a preferred pathway for electrical stimulus conduction, more studies are needed to ensure reproducibility and reliability, overcoming potential misleading factors such as the electrode material, size and shape, pressure exerted by the probe, duration of probe application, the inclination of the probe tip on the skin, and variations in skin condition [298, 299].

2.3 Introduction to the Heidelberg model of TCM

TCM aims to evaluate and regulate the functional flow balance of homeostasis, maintaining its regular status by fighting adverse effects triggered by pathogenic influences. While evaluating and treating a patient, TCM practitioners might act differently according to their background, including school and practical experience. The majority of TCM schools teach the standard curricula whose guidelines have been suggested by the WHO. These educational models stand on a typical “classical” language, while other approaches, such as the Heidelberg model, might differ in the used language, conceptualization and strategy.

The Heidelberg model of TCM was developed and proposed by Henry Johannes Greten, a German medical doctor, PhD in medicine by the University of Heidelberg and former professor of Chinese medicine and applied neurophysiology at the Institute of Biomedical Sciences Abel Salazar. Professor Greten runs a clinic and school at Heidelberg, where he practices and taught his method for more than two decades.

This model scientific approach to Chinese medicine aims to translate the theory and clinical application of TCM practices into Western terms of medical physiology, contributing to the demystification of its concepts facilitating its integration into Western healthcare and research. Therefore, examples such as the five “elements” or phases theory (“Wu Xing”) and the so-called organ patterns or orbs can thus be explained as patterns of vegetative dysregulation. In this context, the diagnosis is defined as a vegetative functional state which may require healing reflexes elicited, for example, by acupuncture, “Qigong”, or Chinese herbal medicine. The cybernetics of regulation conceptualized in this model can be applied to vegetative homeostasis, including neuronal and humoral factors, microcirculation, activation of defense and the assessment of structural stability.

As previously mentioned, the German mathematician Gottfried Leibniz used the binary language to analyze the “Yijing”, allowing for understanding TCM as a logical model of systems biology with a structural mathematical language. “Yin”, represented by a broken line and “yang”, represented by a solid line, was firstly described in this book. By considering 0 as “yin” and 1 as “yang”, Leibniz realized that monograms, bigrams, and trigrams, could be understood as mathematical representations. Those might be further related to the Phases and the circular regulatory processes expressed as sinusoidal functions. The concepts of “yin”, “yang”, and the Phases can be integrated as cybernetic elements and vegetative functional tendencies in human physiological regulation. Indeed, using circular functions to explain physiological phenomena is a straightforward approach as those are often periodic.

Both in nature and technological processes, the control strategies are based on feedback mechanisms. In biological systems, a widely used example of this kind of approach is the control of the human body temperature. In this case, the control action should be adequate to maintain the temperature around a desirable value, in engineering terms, the setpoint, in the Heidelberg model, the target value. The temperature control dynamics in a biological system is complex, involving mechanisms with specific time variables or delays, such as exudation and vasodilatation to cool down or vasoconstriction and muscular contraction to warm up. These actions are elements of the regulation process, and they are tools of homeostasis. Cybernetics is strictly related to the control theory, and to explain it, the example of the water basin temperature control and the respective periodic pattern is part of the Heidelberg model teaching. This example relates the effect of the structure, the “yin” (water content) and the frequency and amplitude of the sine wave (i.e. less water implies a higher frequency). The regulation dynamics and the temperature variation in a thermostatic water bath (Figure 2.17) will be further explored to introduce concepts of the model.

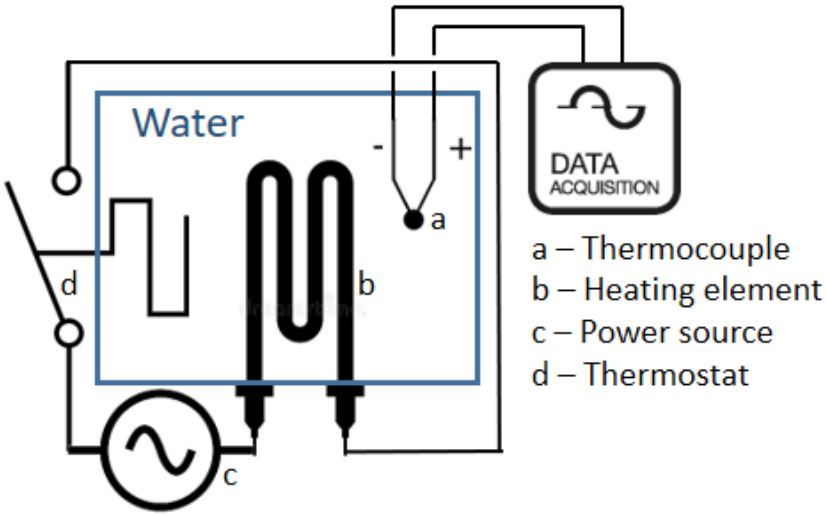

Figure 2.17. Representation of an experimental setup to illustrate the temperature variation in a thermostatic water bath (adapted from ref. [7, 10]).

In this simple case, the temperature control is ensured by a discrete ON/OFF action that causes a well-noted variability around the setpoint. This behavior is known as after-heat (temperature above the target value) and latency (temperature below the target value) within the Heidelberg model terminology. In a real experimental scenario, the temperature profile can only be similar to the sine wave if the overall heat transfer coefficient in the heating part equals the one related to cooling. However, because the heating power is high,

a faster increase in the temperature is noticed when the heating element is on. Figure 2.18 shows the temperature variation profile of a real setup and a modeled sine wave.

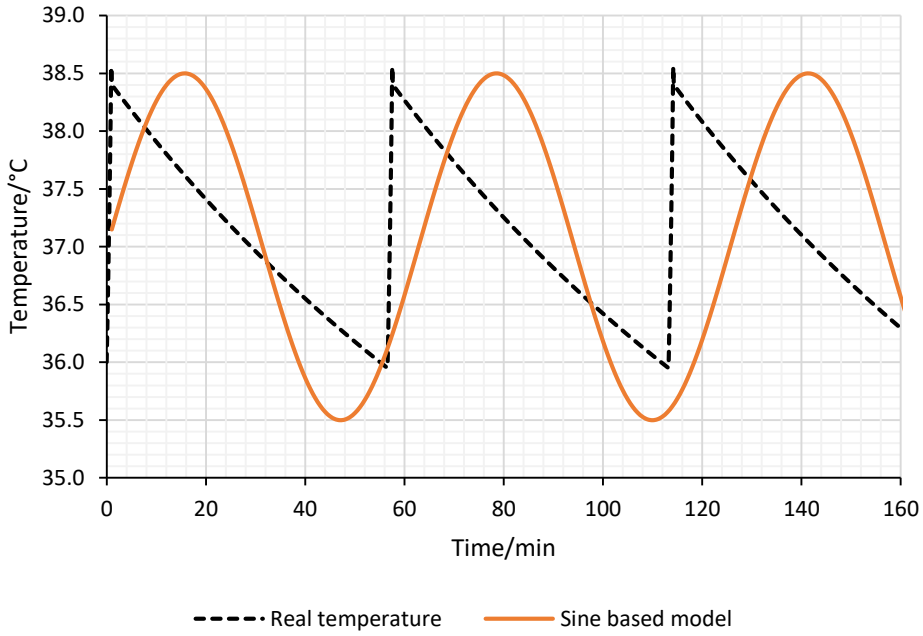

Figure 2.18. Real temperature profile in a thermostatic bath and sine based model.

The previous dynamics might be explained as follows, considering a four phases model shown in Figure 2.19 [3, 7, 10]:

Phase 1 – Building up potential above the target value: The thermostat switches the heater off when the temperature reaches the setpoint. However, it remains hot after being switched off, which causes the temperature to rise above the target value (after-heat).

Phase 2 – Transformation of energy into functioning: This after-heat gradually decreases, so the temperature reaches the target value again. The accumulation of potential in Phase 1, expressed as generated heat (energy), is transferred to the environment.

Phase 3 – Lack of energy causing systemic rhythm change and relaxation: The temperature reaches a point below the target value, and the heater is switched on. Due to the latency of the heating process, the temperature decreases even more until it reaches half of the wavelength. This might be seen as a relative lack of energy and one of the aspects controlling the system's rhythm.

Phase 4 – Systemic energetic regeneration: Gradually, the heater starts to warm up the water again and regenerates the temperature and energy level within the system.

If a circle with center in the meeting point between the measured variable and the target value is drawn around the periodic pattern shown in Figure 2.19, the picture might resemble the taiji symbol. This symbol can be understood as a transition continuum

encompassing the five phases ordered as Wood, Fire, Earth, Metal, and Water (see Figure 2.20).

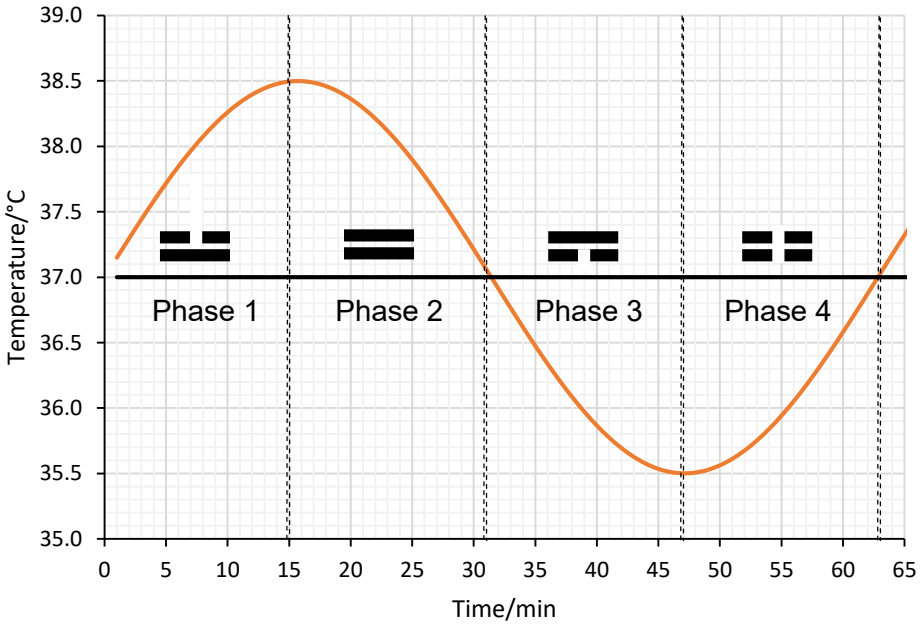

Figure 2.19. Representation of the periodic pattern based on four phases.

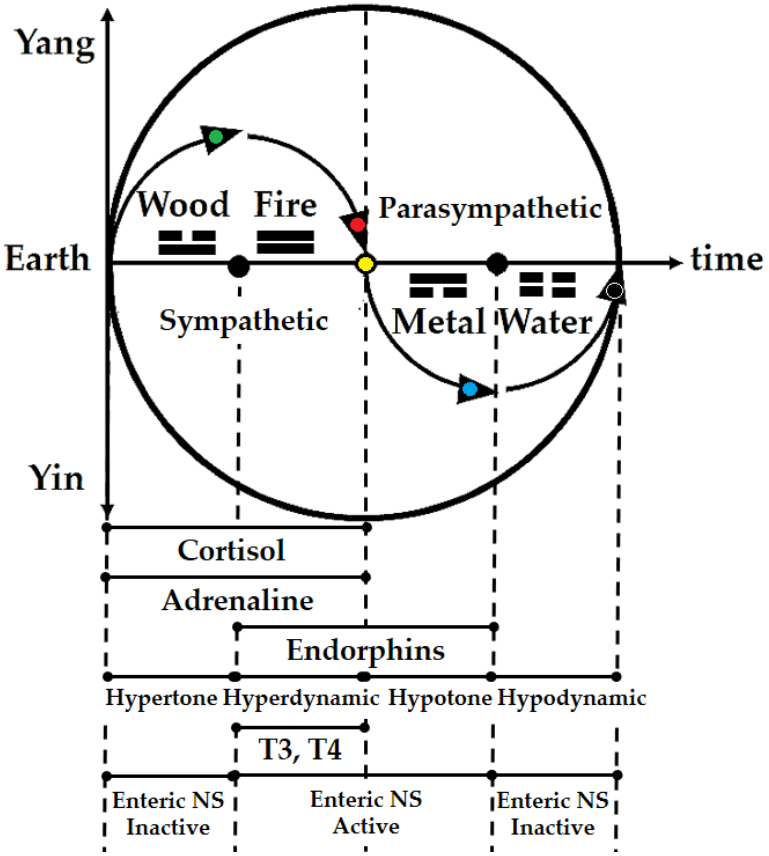

Figure 2.20. Representation of the circular function, including the phases, transmitters and neuronal mechanisms involved in neurovegetative regulation (adapted from ref. [7, 10]).

The phases describe the state of regulated systems within the body, which results in the simplified picture shown in Figure 2.20 when applied to neurovegetative regulation of human vigilance and daily biorhythm.

The diagnosis is a crucial phase of the intervention, whose positive effects are highly dependent on the logical assessment of signs and symptoms and their physiologic categorization.

According to double-blinded studies performed by Greten's research group, when acupoints are chosen regarding the phases criteria and patterns, those seem to have specific clinical effects and higher efficacy compared to Western standard acupuncture [136, 300]. Indeed, other double-blinded placebo-controlled studies carried out by the same group seem to support the idea that the clinical allocation rules of acupoints can be derived from the application of the previously mentioned circular systems [301-303].

TCM aims to maintain or restore the "yin yang" harmony in the body, which within this model might be seen as a tuning of the functional power "qi" wherein "yin" suggests depletion or "emptiness", and "yang" suggests repletion or "fullness". This balance can be further described by a categorical system of symptoms, sensations and findings designed to establish the vegetative functional state of a person, which has inherent the clinical manifestations of the phases. These latter are categorized as "organ patterns" ("zang-fu"), which signs and symptoms are manifestations of the functional power "qi", thus indicating the functional state of inner body regions.

The coupling of functional signs, sensations and symptoms in anatomic organ regions and skin (channels) allows for the treatment through one another. In other words, diagnostically relevant signs indicate the functional state of a body island (body region), which correlates with the channel functional properties. Within this model, this relationship is known as the Chinese Trinity. That is, acupoints may be used to treat regions ("organs") or the symptoms within the course of their channels, as well as for functional signs in their allocated sensory organs and tissues. The treatment strategy stands on vegetative regulatory patterns within a network of phases. For example, channels can be treated by their respective counterpart from another phase (principle of treating the antagonist), or they can also treat the following or precedent phase or patterns according to the sequence of the phases. In this framework, the directional effect of the leading functional powers ("energies") and fluid respect these directions, as the "liver" raises the yang, the "heart" sedates and brings down the "blood", the "lung" brings the qi down, and the "kidney" raises blood and yang.

Suppose the body's autoregulation system fails to maintain balance. In that case, homeostasis is endangered, and therefore symptoms may appear, as the phase Earth

(stomach and spleen) is exhausted or over-challenged by adverse powers such as pathogenic emotions, imbalance of phases or external pathogenic factors. In this case, the phase Earth can produce clinical signs of dysregulation. In the Heidelberg model terminology, the stomach ensures that “the turbid and fluids are led downwards”, while the spleen sharing some aspects with Western metabolism “brings the clear up”. For example, over challenging downregulation might originate symptomatology similar to the Western diagnosis of stress-induced gastritis, while challenging upregulation might originate symptomatology similar to hyperinsulinism.

The circular process of regulation shown in Figure 2.20 can be further divided into eight sections, as shown in Figure 2.21.

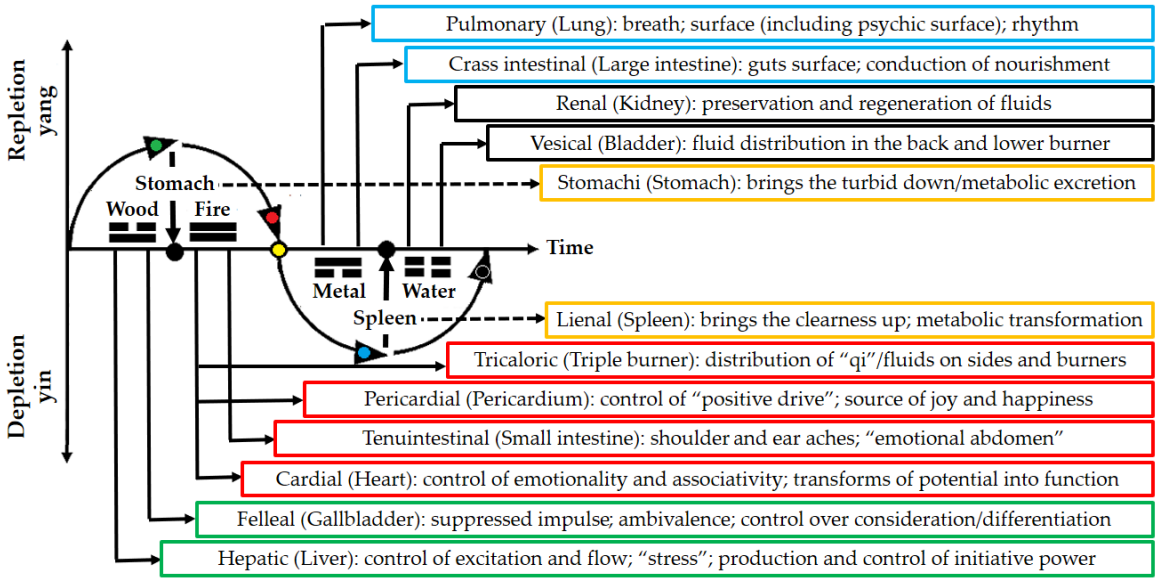

Figure 2.21. Representation of the circular function, phases, orbs and their primary functions (adapted from ref. [7, 10]).

Each pair of components, known as orbs in the Heidelberg model terminology, have a “yin” and “yang” nature, corresponding to the “yin” and “yang” coupled channels within a phase. Indeed, channels located on the interior side of arms and legs are considered “yin”, and those located on the exterior sides of arms and legs are considered “yang”.

According to the Heidelberg model, the diagnosis stands on four models of physiological regulation, categorized in the four guiding criteria used to evaluate clinical signs (Figure 2.22). Those are all based on the previously explained circular function. The first guiding criterion, repletion/depletion, is related to the neurovegetative activation mechanisms (repletion means an excess of “qi”, and depletion means a lack of it). The second guiding criterion, calor/algor, is related with signs of humorovegetative origin, hence, the effects of microcirculation, “xue” (signs of excessive activation of “xue” are known as

"calor", and signs of lack of functional microcirculation or low overall capillary perfusion are known as "algor"). The third guiding criterion, intima/extima, is related to the signs of the neuroimmunological phases present in the "Shang Han Lun" pathophysiological model (the body incursion by the external pathogenic agent cold or "algor"). Finally, the fourth guiding criterion, "yin/yang", is related to signs of structural and regulatory deficiencies, respectively.

The mentioned guiding criteria, together with the evaluation of the person's constitution (inner nature), and the assessment of the pathogenic agent and orb (signs and symptoms), constitute the TCM diagnosis according to the Heidelberg model.

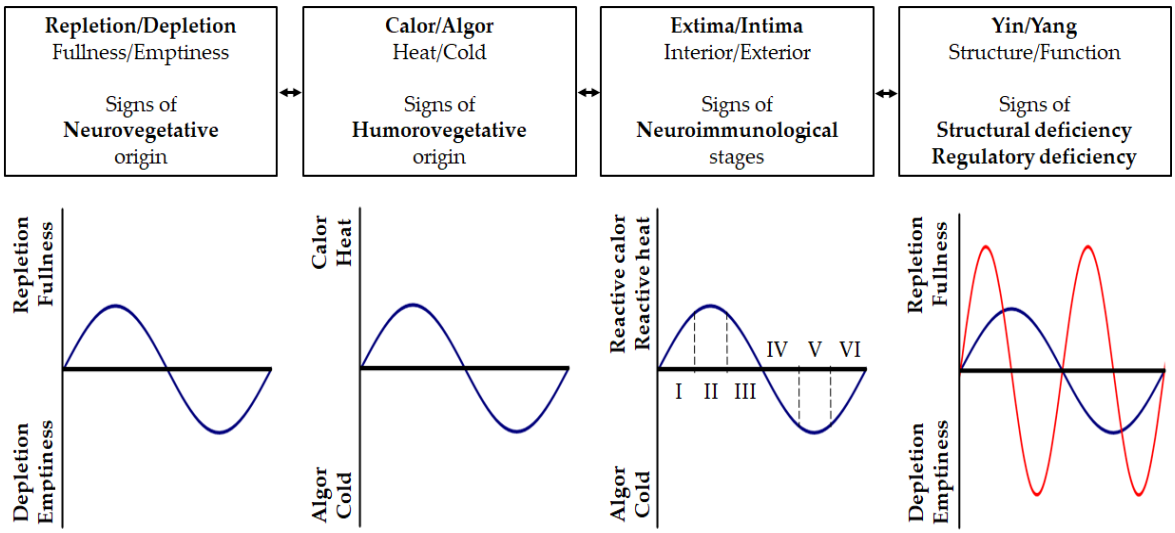

Figure 2.22. Guiding criteria used to evaluate clinical signs (adapted from ref. [7, 10]).

2.4 Perspectives, Measurability and Effects of Non-Contact Biofield-Based Practices

The effects and mechanisms behind nonconventional healing practices have been studied over the last decades. The biofield, a field thought to exist within and around the body, is among researchers' topics. To explore possible biofield effects and their hypothetical mechanisms, practitioners of traditional medicine and the so-called "energy healers" have been often involved in this research field.

Practices such as "Reiki", therapeutic touch, healing touch, and "external "Qigong" are regarded as some form of "energy medicine" or "biofield therapy". Those are supported by therapists' and patients' perceptions and beliefs that some subtle, biological energy surrounds and permeates the body and is accessible for diagnostic and therapeutic interventions [304]. Energy medicine modalities have been categorized in the United States of America using two main classes: the veritable, measurable using conventional technology, and the putative or subtle, which have not been definitively, scientifically measured [304-306]. This classification is no longer included on the website of the National Center for Complementary and Integrative Health (NCCIH); however, its foundation considers that these healing modalities are all based on the concept that human beings are infused with a subtle form of energy, often referred to as the biofield [307, 308]. Indeed, some authors define energy medicine as a branch of integrative medicine that studies the science of therapeutic applications of subtle energies to assess and treat energetic imbalances, bringing the body's systems back to homeostasis [309, 310].

"Qigong" is a therapeutic tool of TCM, which can be understood as a traditional vegetative biofeedback therapy consisting of concentrative motion and postures combined with breathing exercises and a particular mental state of "awareness". Although frequently used as a self-regulation practice, it can also be part of a hetero-treatment performed by a qualified practitioner. In this case, it can be described as some sort of distance therapy (also called "qi" emission, "external qi" therapy or "bu qi") in which the practitioner is thought to manipulate the patient's "qi" by focusing on the energetic properties of the patients' channels, collaterals, and points, as well as internal organs, from a distance of several inches, several feet, or even several miles away [6]. Sharing the Eastern origin and some other particularities, "Reiki" is a practice derived from Japanese healing traditions and means literally "universal life force energy" [20]. In this system, the practitioner does not attempt to adjust the patient's energy field or actively project energy into the patient's body; neither is involved in assessing the patient's energy field or actively attempting to reorganize or adjust it [311]. Instead, "Reiki" practitioners believe that they serve as a conduit and that

healing energy arises from the practitioner's hands and flows to where it is needed. It is in this way customized to the patient's needs and condition [312]. "Reiki" may be given through a laying-on of hands or sent as a wish/prayer from any distance, holding the intention that whatever energy exchanges or transformations are needed, they should occur under a "higher intelligence" guidance [32]. Some aspects of these practices are also seen in the so-called "energy therapies" developed in the West by nurses, such as therapeutic touch and healing touch. These two practices are similar and might involve hands-on or -off approaches and the intention to balance the mind, body, and spirit to promote comfort and accelerate healing [32].

The mentioned CAM modalities see the human being as a holistic living system, exchanging energy and information with the environment. These CAM practices integrate the concept of "vital force" as the primary driving mechanism in health, pathogenesis, and healing. This "vital force" is often named as, for example, "Qi", "Ki", or "Prana" in Chinese, Japanese, and Hindu cultures. In a medical context, "Qi" can be described as a neurovegetative functional capacity of a tissue or an organ, which, in the case of TCM, is therapeutically influenced by reflex points in the body. However, some think that it might further be part of an innate biologic field of the body, in which bioinformation carried by tiny energy signals may trigger changes in molecular structures [313-316]. This sophisticated, dynamic, weak energy field might be involved in maintaining the whole organism's integrity, regulating physiological and biochemical responses, and acting on development, healing, and regeneration [317, 318]. Figure 2.23 illustrates the cybernetics of a hypothetical bioinformation transport mechanism established during a non-contact biofield intervention. In this system, the transfer medium might be understood as the medium carrying the signal generated by the practitioner, and the receptor is the patient receiving the treatment.

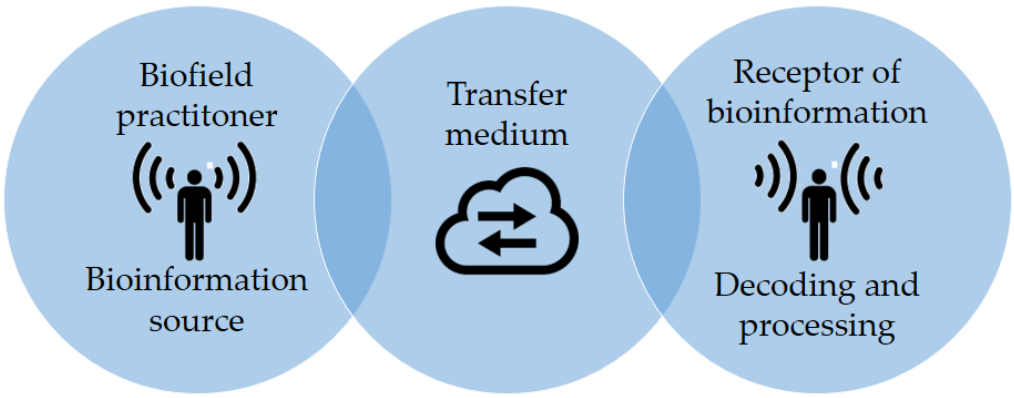

Figure 2.23. Hypothetical bioinformation transport mechanism established during a non-contact biofield intervention (adapted from ref. [319]). Description: the biofield practitioner generates bioinformation signals carried in the transfer medium, reaching the receiving person whose homeostatic system decodes and physiologically process the information.

According to several authors, this phenomenon could be partially related to electromagnetics [320-330], to acoustic- and thermal-related effects [194, 195, 209, 331], and possibly subtle energy fields, which, in some cases, seem to generate physical changes that are measurable with current technological methods, and related to health or disease patterns [176, 177, 313]. On the other hand, some practices appear to act in a manner described as nonlocal and unmediated, defying conventional scientific concepts [324, 332], possibly compromising consciousness and transpersonal realms of being often associated with spirituality [317].

The concept of vital force and the spiritual framework of some of these practices are still not easy to integrate into the dominant biomedical paradigm [333]. However, despite the inherent difficulties, the growing interest in spirituality and its effects, such as in healthcare, has led science attempting to define the subject to make it easier to quantify and validate [308].

Within many of these practices, intention, which could be defined as a directed thought to perform a determined action, plays an essential role in these processes. Some researchers even show data that may make it believable that intention may be powerful enough to change the physical reality, affecting inanimate objects and living things, from unicellular organisms to human beings [334-339].

2.4.1 Electrophysiology and Healing: The Work of Burr, Becker, and Nordenström

Harold Saxton Burr, a professor at Yale Medical School, began studying the effects of energy fields in humans in 1932. According to Burr, all living organisms are surrounded by their energy fields, called Lifefields (L-fields), and changes in the L-field's electric potential would lead to changes in the organism's health state. Changes in environmental electromagnetic fields caused by the moon phases, sunspot activity, and thunderstorms seem to affect L-fields significantly [329, 340]. Indeed, some evidence points towards geomagnetic pulsation strongly entraining brain waves during meditation, making the mind quiet and dominated by geophysical rhythms. The holistic viewpoint emphasizes the connectedness among the body's components and between the organism and its surroundings. In the case of meditation, this might be regarded as a connection with nature [176].

In the 1970s, Burr's research on the development of the nervous system began a series of important but controversial studies about the role of electricity in development and disease. Some of his conclusions can be found in the book entitled "Blueprint for

Immortality, The Electrical Patterns of Life", also published under "The Fields of Life". In this work, he postulates that the organism has a field as a whole, which embraces subsidiary or local fields, representing the organism's parts. Changes in the subsidiary fields would be reflected in variations in the whole system's energy flow. This electrodynamic field could serve as a signpost for various conditions [340]. In this sense, the human biofield might be influenced by the fields of nearby organisms, technology, earth, or even the cosmos.

Robert O. Becker, an orthopedic surgeon who developed research on electrophysiology, authored "The Body Electric. Electromagnetism and the Foundation of Life". In this work, Becker claims that the current flows over the nerves' perineural structures, traveling from the brain, presenting a higher electropositive potential to the body's periphery. He also found a direct relationship between current, tissue growth, and healing processes by measuring the DC electrical potential and current involved in spontaneous and induced regeneration in various species such as salamanders, frogs, and rats. For example, a remarkable level of limb regeneration in adult frogs was reported by applying a negative polarity current to the post-amputation stump, and that fractures of the long bones in frogs demonstrated a negative polarity along with apparent differentiation of the erythrocytes in the fracture hematoma, which later formed the bone "callus" responsible for healing the fracture [341]. In addition, his results show that bone can generate potentials by the piezoelectric effect and that the natural repair of bone fractures can be stimulated by electric current [313, 320].

Björn Nordenström was Chairman Emeritus of the Department of Radiology at the Karolinska Institute. He also chaired the Nobel Assembly Committee that selects the Nobel Laureate in Physiology and Medicine and has performed remarkable research on cancer treatment. He developed the electrical circulatory system theory, where the body comprises "biologically closed electrical circuits". In this model, the body's electrical communication system can be compared to a battery in which the separation of oppositely charged ions drives the circuit. He noticed that when the tissue is damaged by injury or malignant growth, there is a build-up of positively charged ions in the affected area, whereas the adjacent healthy tissue is negatively charged. In his book entitled "Exploring BCEC-Systems (Biologically Closed Electric Circuits)", he points out that ancient Oriental philosophy and approaches are related to his theory, considering that "qi" is analogous to the energy flow through his electrical circulatory system and that "yin" and "yang" deal with negative and positive charges, respectively [329, 342].

2.4.2 Unconventional Healers: Greatrakes, Mesmer, and Estebany

The earliest recorded medical investigations on unconventional healing interventions began in 1665 when Thomas Sydenham and other renowned physicians documented the ability of Valentine Greatrakes, the famous “Irish Stroaker”, to eliminate pain, cure the King’s evil (scrofula), reduce swelling, and alleviate a wide range of other disorders, by lightly stroking his hands either on or proximate to the physical body. Greatrakes was wondrously successful in healing thousands of persons from all across Britain and Ireland. His practices were observed by the best-known intellectuals, philosophers, theologians, and physicians at that time, many of them writing pamphlets and letters detailing their thoughts about the stroker’s amazing cures [343]. One of them was Robert Boyle, one of the founders of modern physics and chemistry and the discoverer of what came to be known as Boyle’s law. Boyle suggested that “perhaps some salubrious streams of spirits” were induced from Greatrakes hands into the patient’s body [344].

One century later, Franz Anton Mesmer, a Viennese physician living in Paris in 1778, postulated that some “fluidium” existed as a force of nature subjected to the laws of physics. His doctoral dissertation, “De Planetarium Influxu” was submitted to the Faculty of Medicine of the University of Vienna in 1766. This work was the theoretical basis for the model known as “gravitas animalis” or “magnetismus animalis”. It explored hypnosis and a primitive description of the cyclical activity in the biosphere, electricity, magnetism, and even a variant on Newton’s recently described gravity [345]. Mesmer began using magnets for healing, and his patients frequently noticed “unusual currents” coursing through their bodies. This phenomenon could be reproduced by only passing his hands above the patient's body. However, when the scientific community was invited to witness his practice in treating some diseases, it was considered ridiculous, closely resembling the laying on of the hands of Jesus and other religious figures [176].

Mesmer stated that the ability to cure comes from a universal force called “animal magnetism”, which he could concentrate on and transmit to patients. The controversy around his practices led Louis XIV to appoint a committee, including Benjamin Franklin, Antoine Lavoisier, and Joseph Guillotine, to investigate his activities’ validity. This group concluded that Mesmer’s claims were false, and the positive results were simply due to his ability to manipulate the patients’ imagination [346]. As a result, hypnosis’s historical roots are frequently associated with Mesmer’s animal magnetism technique [347]. Despite the controversy, Mesmer’s work marks the development of psychophysical self-regulation, hypnosis and psychosomatic medicine. The rise of the mind-body subjects came due to the animal magnetism theory [345].

Oskar Estebany, a Hungarian army colonel in the mid-1930s, noticed that the horses he groomed recovered from illnesses faster than those treated by others [320]. A study conducted by Grad et al. (1961) showed that the recovery of surgical wounds in mice was enhanced by placing Estebany's hands near the cage. These results were statistically significant and successfully replicated, suggesting no placebo effect [348]. Other studies were made with the cooperation of Estebany, who also showed the ability to speed up the growth of barley plants and reactivate ultraviolet-damaged samples of trypsin, a stomach enzyme, in much the same way as a magnetic field, even though no magnetic field could be detected near his body with the instruments of that era [320, 349-354].

2.4.3 The Role of Intention on Healing

Several authors have studied the physical effects of intention. The results of those experiments could even indicate that human intentions would remotely influence cellular function, microbial growth, the growth of tumors in animals, the germination of seeds, the growth of plants, the healing of surgical wounds in animals, the kinetics of biochemical reactions, and have significant effects on nonbiological settings [337, 355]. Furthermore, these results raised the thesis that humans might remotely influence each other's physiology through the simple act of staring and thinking, even when the distant individual is unaware that the effort is being made [343].

The healing process established between a healer and a patient might involve entanglement and some form of mutual awareness. The system is sealed by the intention of healing and the need to be healed [356]. In this process, the healer, with a focused sense of inner quietude, establishes an intention to help, strengthened by empathic compassion or loving-kindness directed toward the patient [357, 358]. This connection enhances the sense of meaning of both the healer and patient and might resemble some aspects of meaning-centered psychotherapy, which has proven beneficial in treating mood and anxiety disorders [359].

Usually, the sense of inner quietude experienced by the practitioner requires a self-process of centering, similar to meditation, whereby he turns his everyday conscious attention inward to a place of stillness to focus his mind and emotions. As the practitioner focuses on his intent, a particular state of awareness is experienced with a sense of wholeness [360]. In this scenario, it is thought that compassionate healing intentions might induce measurable effects on the target, and the empathic connection between the healer and the patient is essential in the process [343].

This phenomenon's nonlocality character is often related to the concept of entanglement, where an element cannot be fully described without considering one or more additional elements [361]. In the case of distant healing, the healer who directs his thought or intent, and the patient, who receives it, create a single system, even physically separated. Here, entanglement is used to describe a connection between two elements, even though separated across space [304].

Studies involving neuron-to-neuron, brain-to-brain, and person-to-person connections have been carried out. For example, the work of Pizzi et al. (2004) showed that by stimulating a group of human neurons with a laser beam, a different group of neurons placed at a distance exhibited similar changes, although the two groups were entirely shielded from each other [362]. Other studies point towards changes in the alpha rhythms of twins' brains when one of the subjects closes his eyes away from his brother. Changes in patients' brains, detected by functional magnetic resonance imaging (fMRI), are also detected when healers focus on their distant intention to heal [355].

Some experiments suggest that water's physical properties, such as the cooling rate, molecular bonding reflected by infrared spectra alterations, Raman spectroscopy, scattered laser light, and the pH level, may be influenced by intention [330, 334, 335, 337, 339, 363-366].

Radin et al. (2006) conducted a double-blinded experiment to evaluate the effects of distant intention on water crystal formation. After a blinded assessment performed by 100 independent judges, the authors concluded that crystals from the "treated" water were given higher aesthetic appeal scores than those from control ($p = 0.001$) [335]. In a previous study, Emoto found that positive intentions tend to produce symmetric, well-formed, aesthetically pleasing crystals, in contrast to the asymmetric, poorly formed, unattractive crystals produced by negative intentions [335, 364].

Although Emoto's findings are not consensual, some authors suggest that this phenomenon might be related to water memory and the imprinting of specific electromagnetic frequencies at a structural level, which may cause distinct physical changes with effects in processes as in crystallization [315, 363]. According to Mayor (2011), a frequency might be retained in a water coherence domain if its protons' magnetic resonance is synchronized with the applied frequency. The protons would generate their internal magnetic field to satisfy the resonance conditions [311].

2.4.3.1 Models for Intention Mechanisms

The hypothetical mechanisms through which intention has a physical effect on the target are still under debate. Some authors suggest that this process may be related to the

ultraweak photon emission naturally occurring in all living organisms [367]. The biophoton emission is considered an excellent communication system, triggering, almost instantaneously, signals between the emitter and the receptor. Research suggests that the human body emits 10 to 103 photons $s^{-1} \cdot cm^{-2}$ and that health and disease patterns could be related to the degree of emission [368].

Biophotons are information carriers, mediating cell-to-cell communication in several microbes, plants, and animals. The nervous system can emit biophotons continuously, and the inherent bioelectrical activities may affect biophotonic emission. Therefore, biophotons can mediate the transmission and processing of nerve signals and encode neural signals through intensity and frequency [369].

There is evidence that intracerebral biophoton activity changes are related to consciousness and phosphene phenomena. For example, some studies had shown that when subjects sitting in the dark imagined a white light, reliable and significant photon emission increases at 15 cm from the right cerebral hemisphere were noticed, strongly correlated with specific frequencies of electroencephalographic activity [370]. These results suggest that imagination, often related to intentional thought in remote healing processes, correlates with ultraweak photon emission and brain activity.

Instrumentation such as the photomultiplier detector and CCD cameras helps measure and differentiate health and disease patterns and identify light channels in the body that might regulate energy and information transfer between different parts [371]. Biophoton research may promote the development of objective diagnosis tools, providing experimental biophysical support to particular TCM theory on channels, as well as to TCM concepts such as the “eight principles” (“yin/yang”, interior/exterior, cold/heat, and deficiency/excess) or even certain aspects of the vegetative effects of the “qi” [74, 369]. Moreover, some anatomical locations, such as the palm of the hands and the forehead, which are thought to be strong emitting areas, are typically associated with acupuncture and “Qigong” essential points.

In 2005, Creath and Schwartz published a paper reviewing some of their findings while developing biophoton imaging instrumentation for monitoring biofields around living organisms to access their health state quantitatively and gather information about the healing process. The main findings of these authors reveal that plants ‘‘glow in the dark’’, that biophoton emission imaging provides information about metabolic functioning, the health state of the organism, and that the phenomenon seems to be reactive to the intention of a healer. Figure 2.24 shows images of Creath’s hands by using a cooled, highly sensitive silicon CCD camera with 10-min exposures in total darkness. The bottom two images were

taken in white light, while the top two images are biophoton images taken in total darkness [372].

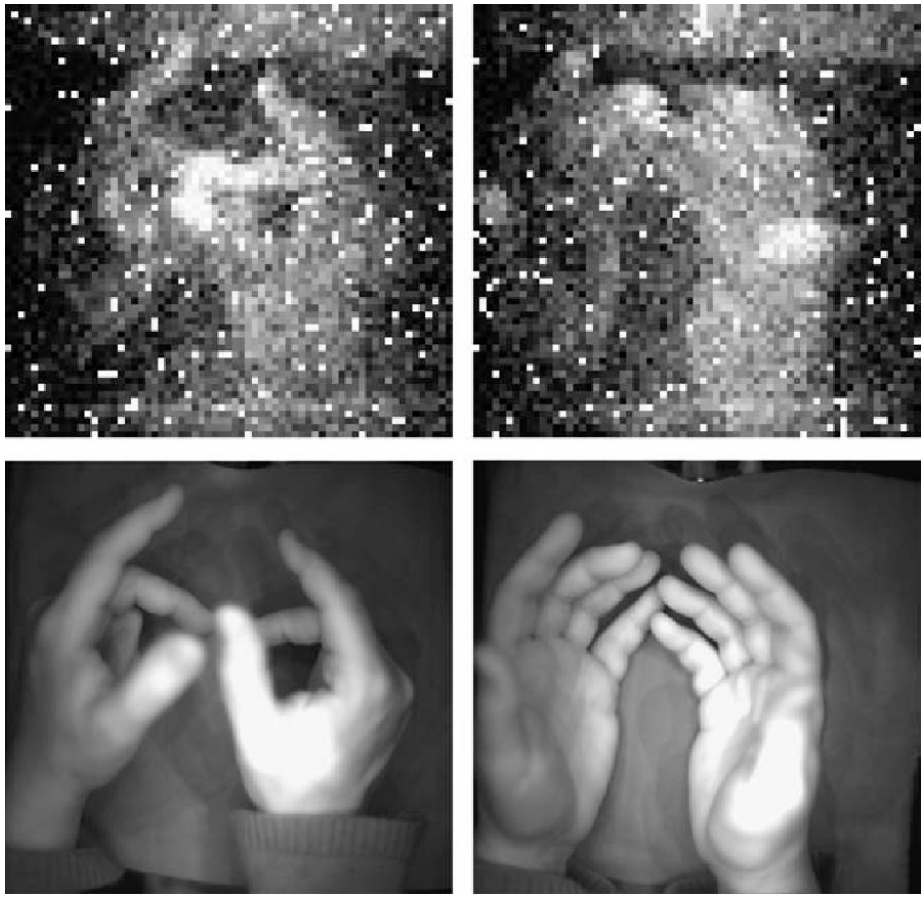

Figure 2.24. Images of biophoton emission from the hands in the darkness and images obtained with white-light illumination. Top images are 10-min exposures taken in total darkness using 20 × 20 binning with a Princeton Instruments VersArray 1300B camera (Teledyne Princeton Instruments, New Jersey, USA) cooled to −100 °C. Bottom images are 10 ms exposure taken with white-light illumination. The top and bottom images are captures of the same situation/subject with different techniques. The top images are the pixelized representation of biophoton emissions obtained with a cooled, low-noise CCD camera in total darkness (biophoton emission: fingertips > palms > back of the hands). The bottom images were obtained with white-light illumination. Reprinted from ref. [372].

According to William A. Tiller, Professor Emeritus of the Department of Material Sciences and Engineering at the University of Stanford, space might become changed or "conditioned" when submitted to a continuous intentional stimulus. Tiller and his colleagues hypothesized that the fundamental symmetry state could be altered by activating the indwelling consciousness of the space to a higher level of physical reality, thus changing the electromagnetic gauge symmetry state of that space, which in turn allows the human intentions to change the properties of materials significantly. Tiller even suggests the existence of two unique levels of physical reality, the uncoupled state, where the electric,

magnetic dipole, molecular, and atomic states are dominant, and the coupled state that appears to function throughout the physical space, interpenetrating the vacuum and the electric, magnetic dipole, atomic and molecular states. Figure 2.25 illustrates Tiller's model for the conditioning of space under the influence of intention.

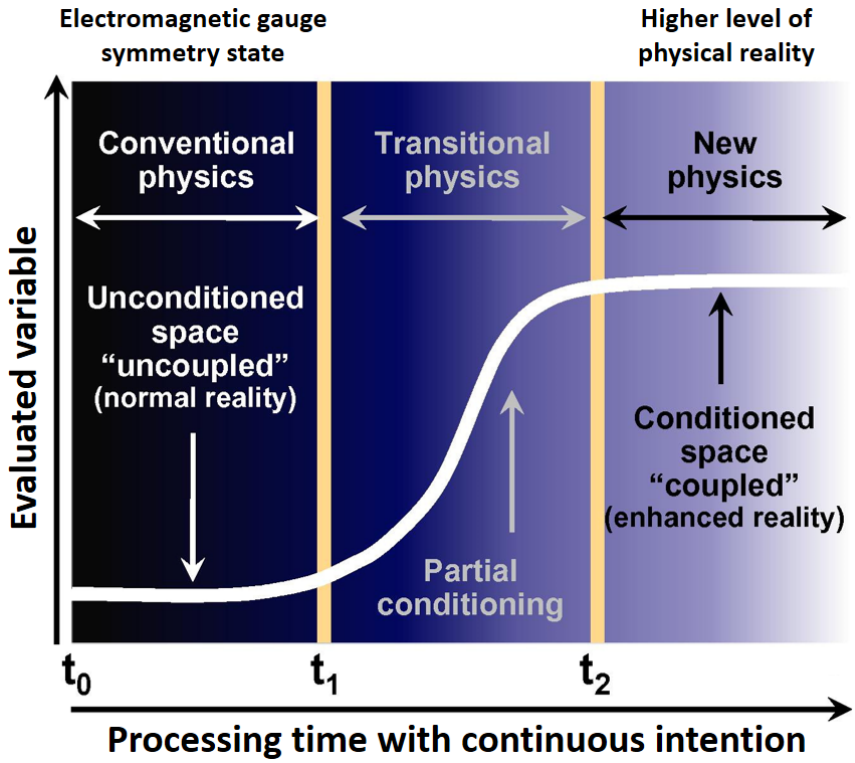

Figure 2.25. The time-evolution pattern of an intention targeted experiment. Adapted from ref. [373]. Time-dependent conditioning of a space in which a variable is measured, for example, water pH, under a continuous intention. As time goes on (time zero – t0; time one – t1; time two – t2), the electromagnetic gauge symmetry state of the space changes from uncoupled to coupled and consequently to a higher level of physical reality (higher electromagnetic gauge symmetry state).

According to this model, human consciousness and intention can promote these two categories' interactions. Considering that the coupled state would have a higher thermodynamic free energy per unit volume than the uncoupled state, it can perform work of any kind on the uncoupled electric, atomic, molecular subsystem [363, 374-379].

2.4.4 Measuring the Effects of Biofield Practices

The biofield hypothesis and related healing practices require the existence of a measurable "healing energy" that, whether produced by a device or projected from the human body, has a particular frequency or set of frequencies that stimulates the repair of one or more tissues. The cascade of activities initiated by such signals may provide

essential information to cells and tissues and open channels for information flow that coordinate prevention and repair processes [176, 380].

Besides other published studies on the medical applications of “Qigong” and emitting “qi” to humans, animals, cell cultures, and plants [209, 379-382], an analytical review on this subject was published in 2004 by Kevin W. Chen, Professor at the University of Medicine and Dentistry of New Jersey. According to this review involving studies conducted in China in the last decades, the assessment of the “external qi” effects was made considering five different categories of detectors: 1) physical signal detectors, 2) chemical dynamics methods, 3) detectors using biological materials, 4) detectors using living sensors, and 5) detectors using the human body [331]. This categorization seems reasonable to aggregate and describe the diversity of studies on the topic and will be used in the present narrative review.

2.4.4.1 Experiments Involving Physical, Chemical, Biological and Living Sensors

Clinical and preclinical studies in real-world populations are needed to provide a complete picture of health, illness, and treatment based on these practices. However, in a preliminary stage, animals, plants, biomolecules, tissue, and cell cultures are good research models because there is no expectation or belief, nor are they affected by psychosocial factors [383]. The following subsections present many studies assessing biofield effects with physical signal detectors, chemical methods, biological materials, and complex living organisms used as sensors.

2.4.4.1.1 Measurements with Physical Signal Detectors

Instrumentation to measure physical parameters is required to access the mechanisms behind biofields practices. Objective measurements are needed to “calibrate” both sources and receptors and standardize the procedure. This approach is essential to know if a negative result is given to the receptor or the healer.

The existence of electromagnetic fields within and around the body and how these fields affect biological systems is often related to the body’s movement of charged particles. Considering that biological systems radiate and absorb electromagnetic frequencies, external or environmental radiation might also induce body changes [377]. Research has shown that humans can change these fields’ properties [321,325,384]. Table 2.2 presents the main findings of selected studies and reviews that explored the effects of non-contact biofield practices assessed with physical signal detectors.

During a biofield intervention, anomalous magnetic field activity was detected in the study conducted by Moga et al. (2014) on the effects of hands-on healing and distant healing of mice with induced tumors. The peak-to-peak variations of magnetic field (MF) oscillations were higher than baseline and had a symmetrical wave-like appearance, resembling discrete packets of sinusoidal waveforms, decreasing and increasing in frequency over time. Using fast Fourier transform analysis, the authors found that the frequency was 20 to 30 Hz initially, slowing to 8 to 9 Hz and then to less than 1 Hz, and from this point, the wave reversed and increased again. The MF oscillation ranged from 1 to 8 mG in strength with a duration of 60 to 120 s. Another study carried out by the same author using a Hall-type gaussmeter close to healer-client pairs during healing touch sessions showed low-frequency magnetic field oscillations during 24 of 26 healing touch sessions and 14 of 16 guided progressive relaxation sessions. The magnetic field oscillations (peak-to-peak) amplitude was significantly greater during the healing touch session and post-session periods than in the pre-session period. Peak-peak showed no significant change across the guided progressive relaxation periods. Large-amplitude magnetic field oscillations > 1.0 milliGauss during healing touch were associated with healer/client qualitative reports of emotional release and clearing of the biofield [385].

Unusual large body voltages have also been reported during therapeutic touch practitioners' treatments. Considerable anomalous body potential surges ranging from −4 V to −190 V in therapeutic intervention and from −4 V to −221 V, lasting from 0.5 to 12.5 s in meditation, were measured at the ear lobe with an electrometer. On average, these electrical signals were 103 times larger than psychophysiological galvanic skin potential changes associated with emotional responses, 105 times larger than electrocardiographic voltages, and 106 times larger than electroencephalographic voltages [386]. Comparable results were obtained by Tiller et al. (1995) under well-controlled conditions. In this study, an experienced therapeutic touch practitioner produced voltage changes between −20 V and −80 V from baseline, with similar durations [387].

Table 2.2. Research exploring the effects of non-contact biofield practices assessed with physical signal detectors.

Study	Main Findings
Green et al. (1991) [386]	Anomalous body potential surges ranging from −4 V to −190 V in therapeutic intervention and from −4 V to −221 V, lasting from 0.5 to 12.5 s in meditation, were measured at the ear lobe of therapeutic touch practitioners.
Seto et al. (1991) [326]	Three subjects exhibited a strong bio-magnetic field of 2 to 4 m Gauss in a frequency range of 4 to 10 Hz near the palms during “qi” emission.
Sancier&Hu (1991) [209]	Increased infrasonic sound signals emitted by “Qigong” masters were above 70 dB with a dominant peak frequency in the range of 8 Hz to 12.5 Hz, coinciding with the EEG alpha waves' frequencies.
Tiller et al. (1995) [387]	Anomalous body potential surges ranging from −20 V to −80 V lasting from 0.5 to 12.5 s were measured at the ear lobe of therapeutic touch practitioners.
Hisamitsu et al. (1995) [327]	A strong magnetic field was emitted from two subjects during “Qigong” breathing practice.
Waechter&Sergio (2002) [321]	The fields projected by the hands of “Qigong” masters affected the magnetic field power at specific frequencies near the detector.
Yan et al. (2002) [388]	The “external qi” emitted by Yan Xin interacted with thermoluminescence dosimeters (TLD detectors) and generated responses similar to that induced by a mixed field of gamma rays and neutrons.
Chen (2004) [331]	Modified far-infrared radiation was emitted at a distance of 50 cm from the palm of a “Qigong” practitioner, with variations in intensity as high as 80 % at a frequency of 0.3 Hz, which contrast with the control group (non-practitioner) that showed almost no difference in intensity.
	Changes in the body surface temperature were measured with infrared sensors during “Qigong” practice, both in the “Qigong” practitioner and patient.
	Changes were detected in the signal emitted by Ge (germanium) micro-pressure detectors placed at the distances of 0.5, 1, 1.5, and 2 m from the “Qigong” practitioner who emitted “external qi” toward the target through two of his fingers.
	Significant increases in wavelength to above 10 mm during “external qi” emission were measured by mm-wave radiation meter placed 20 to 40 cm from the “Qigong” practitioner.
	Changes were detected in the magnetic field during “qi” emission, in well-controlled conditions in a zero-magnetism laboratory, with signals reaching 105 nT and contrasting with the weak ones emitted by non-practitioners.
	Infrasonic sound pressure measured in acupoints during “qi” emission by experienced practitioners (48.8 to 54.7 dB) were higher than those emitted by the control group (40.6 to 43.6 dB).
Moga&Bengston (2010) [325]	Anomalous magnetic field activity was detected during hands-on healing and distant healing adjacent to the mice cages.
Joines et al. (2012) [384]	Infrared and ultraviolet light-sensitive equipment detected energies from some healers and meditators who intentionally projected this energy.
Baldwin et al. (2013) [389]	No electromagnetic field intensities greater than 3 pT were detected, concluding that practicing Reiki does not appear to produce high-intensity electromagnetic fields from the heart or hands routinely.
Moga (2014) [385]	Low-frequency magnetic field oscillations were detected during 24 of 26 healing touch sessions and 14 of 16 guided progressive relaxation sessions. The magnetic field oscillations (peak-to-peak) amplitude was significantly greater during the healing touch session and post-session periods than in the pre-session period.

As previously mentioned in the introduction, the “external qi” therapy is part of the medical “Qigong” tradition. Although most “Qigong” practice tries to reach the empty mind or nothingness state, some practitioners have shown the ability to use their mind or intent to guide the “qi” to the desired place. Some “Qigong” healers are thought to direct their “qi” outward to help unhealthy individuals break the “qi” blockage or balance the “qi” system [6]. Over the last 30 years, researchers have been trying to measure the “external qi” (“wai qi”) during “Qigong” healing. Although none have shown the primary nature or mechanism

behind the phenomenon, some attempts point towards measurable effects. Moreover, some results cannot be explained by psychosocial effects or known biological processes, but do share the following aspects: the manifestation of the “external qi” is only noticed when a well-trained “Qigong” practitioner enters into a particular mental state of awareness, and it does not manifest in a normal state of mind; it can affect distant objects and produce measurable signals; it might affect a specific target not producing changes in the objects nearby the practitioner, where his intention is not focused [331].

Researchers have used different instruments to measure the related effects because the phenomenon was often thought to be connected to light, electricity, heat, sound, and magnetism. These include magnetometers, voltmeters, photometers, gamma radiation counters, sound equipment, and gas discharge visualization. Measurable changes have been reported, such as: modified far-infrared radiation emitted at a distance of 50 cm from the palm of a “Qigong” practitioner, with variations in intensity as high as 80 % at a frequency of 0.3 Hz, which contrast with the control group (non-practitioner) that showed almost no difference in intensity; changes in the body surface temperature measured with infrared sensors during “Qigong” practice, both in the “Qigong” practitioner and patient; changes in the signal emitted by Ge (germanium) micro-pressure detectors that were placed at the distances of 0.5, 1, 1.5, and 2 m from the “Qigong” practitioner who emitted “external qi” toward the target through two of his fingers; significant increases in wavelength to above 10 mm during the “external qi” emission, measured by a mm-wave radiation meter placed 20 to 40 cm from the “Qigong” practitioner; changes in the magnetic field during “qi” emission, in well-controlled conditions in a zero-magnetism laboratory, with signals reaching 105 nT and contrasting with the weak ones emitted by non-practitioners; infrasonic sound pressure measured in acupoints during “qi” emission by experienced practitioners (48.8 to 54.7 dB) higher than those emitted by the control group (40.6 to 43.6 dB), reproducible in other studies where “Qigong” masters were able to increase these signals above 70 dB with a dominant peak frequency in the range 8 Hz to 12.5 Hz, which coincides with the frequencies of EEG alpha waves [209, 326, 327,331].

Seto et al. (1991) studied the magnetic field strength adjacent to the palms of “Qigong” practitioners’ hands during “external qi” emission. In 3 out of 37 cases, the authors observed a 4 to 10 Hz oscillation in the magnetic field, with a peak-to-peak magnetic field strength of 2 to 4 mG [326]. Such results represent an increase in strength 1000-fold higher than usual, as the human body radiates magnetic fields of less than 10^{-10} to 10^{-5} gauss [390]. Similar magnetic field strengths during healing practices have been reported by other authors [325]. Although the phenomenon origin is not yet understood, the physical effects seem measurable [388,391,392].

Emerging concepts in physics such as nonlocality and entanglement might provide a theoretical basis for these observations. There is also a view of consciousness and relativistic quantum physics that attributes an essential role to the mind, which might be relevant in this phenomenon [313,317,355].

An excellent example of this paradigm is the Yan Xin “Qigong” phenomenon. Yan Xin is a reputed chief physician, “Qigong” Master, and researcher with close relations to some Chinese Government Institutions, such as the Chinese National Natural Science Foundation, who supported some of his research projects. Since the 1980s, several scientists from leading universities and research institutes, such as Tsinghua University (Beijing, China), the Chinese Academy of Sciences (Beijing, China), Harvard University (Cambridge, USA), University of California (Berkeley, USA), and Oklahoma University (Norman, USA), have been using scientific methods and protocols to investigate the various effects of the “external qi” emitted by Yan Xin. The results are challenging and suggest that the “qi” of Yan Xin can be projected out of the body and affect physical substances and objects. Some relevant findings are the detection of the “external qi” effect by thermoluminescent dosimeters and liquid crystals; the ability to change the conditions of chemical reactions; the interaction with matter from molecular to nuclear levels, specifically the molecular structure of liquid water and other water solutions measured by Raman spectroscopy; the effects on the half-life of radioactive isotope 241Am, measured by gamma-ray spectrometry and solid-state nuclear track detector, after “qi” emissions from a distance that ranged from 3 m to 10,000 km [388,391,392].

Although many reported outcomes seem to show changes in the assessed variables, other studies detected no changes. A good example is a study conducted by Baldwin et al. (2013) to determine whether “Reiki” practice increases the electromagnetic field strength from the heart and hands of Reiki practitioners using a superconducting quantum interference device (SQUID). These authors found no electromagnetic field intensities greater than 3 pT in any of the recordings, leading to the conclusion that practicing “Reiki” does not appear to routinely produce high-intensity electromagnetic fields from the heart or hands [389].

2.4.4.1.2 Measurements with Chemical Methods

Some authors have noticed that the “external qi” can change the dynamics of some chemical reactions. For example, it seems that “Qigong” practitioners can use the “external qi” to change the activity of glucose oxidase (GOD), accelerating the kinetics of the following reaction:

$$C_6H_{12}O_6 + O_2 + H_2O \overset{GOD}{\Rightarrow} C_6H_{12}O_7 + H_2O_2 \quad (2.1)$$

The hydrogen peroxide produced in the previous reaction reacted with luminol, and the resulting fluorescence was measured with a photoelectron detector. Ren et al. (1990) found that “Qigong” practitioners can increase the reaction velocity by 400 % from a distance ranging between 2 and 10 m, while 5 % is the regular standard deviation for the reaction under the same conditions [393].

Under normal conditions, hydrogen peroxide gradually decomposes into water and oxygen; however, the decomposition was shown to be faster under the “external qi” influence [331, 394].

Under the effect of intense light, normal hexane and bromine produce bromohexane and hydrogen bromide. Although this reaction requires intense light, researchers have shown that the reaction occurs without light under the influence of “external qi” [331, 395].

Biofield practices were also shown to enhance sucrose crystals’ growth from super-saturated solutions previously submitted to thermal treatment. Teixeira et al. (2010) suggest that biofield interventions act synergistically on these mechanisms and that water may be the target, the vehicle, and the medium for these processes [396].

2.4.4.1.3 Measurements with Biological Materials

The mechanisms through which biofield practices exert an effect on the biological domain are not clear-cut. Some authors suggest that connective tissue plays an essential role in this process. The living matrix is regarded as the continuous molecular fabric of the organism, consisting of fascia, other connective tissues, extracellular matrices, integrins, cytoskeletons, nuclear matrices, and DNA [397]. That continuum might be granted by integrins connecting the cytoskeleton of every cell with neighboring cells and the surrounding extracellular connective tissue and connections across the nuclear envelope, which join the cytoskeletal matrix with the nuclear matrix. In this picture, fascia could play an essential role in physiological regulation due to its connections to the interior of cells and cell nuclei and its electronic conduction properties. Collagen embedded in a soft polymer gel known as the “ground substance” is thought to store electrical charge as collagen acts as a semiconductor and the matrisome as capacitors. Once each collagen molecule has a helical shell of water molecules intimately associated with it and orientated in an electric field, the coherent phase-correlated system formed by water might explain the sensitivity to resonant interactions with signals such as those generated biofield practices [311].

The biological effects of subtle energies of biofield practices could be mediated and enhanced by cellular amplification and stochastic resonance, as shown in Ross Adey and A. R. Liboff's research [398-401]. Thus, the cell wall might work as an amplifier for these stimuli besides being a protective shield. The subsequent cascade of signals can act on various intracellular processes, among them calcium ion transport and enzymatic activity, which, by themselves, can trigger changes at the physiological regulatory level [313, 329, 402-404]. Table 2.3 presents the main findings of selected studies and reviews that explored the effects of non-contact biofield practices on biological materials.

Changes in the structure of biomolecules under the influence of "external qi" were reported by Chu et al. (2001). While studying the effects of "external qi" emitted by a Chinese "Qigong" master on poly-D-glutamic acid sodium salt and RNA conformations, these authors found that all poly-D-glutamic acid sodium salt samples presented some changes in circular dichroism spectra measured with a 62DS spectropolarimeter. A total of 67 % of those samples had significant changes (more than three standard errors), and a ratio of ellipticity change of 1 to 10 % with a maximum change of over 10.9 %. No significant differences were noticed on RNA conformation [405, 406]. "External qi" was shown to have effects on liver cancer cells (BEL-7402) and lung cancer cell culture (SPC-A), on blood plasma cAMP, on the structure and pharmaceutical characteristics of vitamin C, on the DNA synthesis and living cycles of liver cancer cells, on the phase behavior of dipalmitoylphosphatidylcholine (DPPC) liposomes, on the microstructure of Escherichia coli and tumor cells in mice. Some authors have shown that the "external qi" also enables the growth of Fab protein crystals, has an inhibitory effect on the growth of hepatitis B virus in vitro, and has an inhibitory effect on the growth of human liver cancer cells (BEL-7402). Changes in the electric potential in fresh tree leaves, the acceleration of the germination and growth of plant seeds, including rice, wheat, peas, beans, peanuts, flowers, and physical mutagen activity of Streptomyces species have also been reported [209,331,382,391,392].

The effects of "Reiki" on biological materials have been studied in controlled conditions. Kent et al. (2020) found that a "Reiki" practitioner with more than 30 years of experience was able to significantly increase the photon emission of mice intervertebral disc cells compared to sham ($p < 0.05$). Real-time PCR (RT PCR) showed an increase in collagen II and aggrecan ($p < 0.05$) after the "Reiki" treatment, which might indicate an enhancement of the healing cascade in cells [407].

Table 2.3. Research exploring the effects of non-contact biofield practices on biological materials.

Study	Main Findings
Chien et al. (1991) [382]	Facilitating "qi" caused a 1.8 % increase of the human fibroblast FS-4 growth in 24 h, 10 to 15 % increase of DNA synthesis, and 3 to 5 % increase of protein synthesis of the cell in a 2-h period; inhibiting "qi" caused a 6 % decrease of cell growth in a 24 h period, 20 to 23 % decrease of DNA synthesis and 35 to 48 % of protein synthesis in a 2-h period. The respiration rate of boar sperm increased by 12.5 to 13.0 % after 5 min exposure to facilitating "qi" and decreased by 45 to 48 % by exposure to 2-min of inhibiting "qi".
Chu et al. (2001) [405]	All poly-D-glutamic acid sodium salt samples presented some changes in circular dichroism spectra measured with a 62DS spectropolarimeter. A total of 67 % of those samples had significant changes (more than three standard errors), and a ratio of ellipticity change of 1 to 10 % with a maximum change of over 10.9 %. No significant changes were noticed on RNA conformation.
Chen (2004) [331]	"External qi" was shown to have effects on liver cancer cells (BEL-7402) and lung cancer cell culture (SPC-A), on blood plasma cAMP, on the structure and pharmaceutical characteristics of vitamin C, on the DNA synthesis and living cycles of liver cancer cells, on the phase behaviour of dipalmitoylphosphatidylcholine (DPPC) liposomes, on the microstructure of Escherichia coli and tumor cells in mice, on enabling the growth of Fab protein crystals, on inhibiting the growth of hepatitis B virus in vitro.
Yan et al. (2004) [391]	The exposure of cultured retinal neurons to "external qi" significantly attenuated neuronal death induced by 24-h exposure to hydrogen peroxide and significantly inhibited hydrogen peroxide-induced apoptosis. "External qi" also upregulated IGF-I gene expression and increased PI3K activity.
Yount et al. (2004) [408]	"External qi" increased cell proliferation in normal brain cell samples showing, on average, more colony formation than sham samples (p = 0.036); however, in a replication study (60 experiments), no significant difference between treated samples and sham samples was observed (p = 0.465).
Taft et al. (2005) [409]	No evidence of a reproducible cellular response to "Johrei" treatment was noticed regarding cell death and proliferation rates of cultured human cancer cells.
Yan et al. (2006) [392]	"External qi" inhibited basal phosphorylation levels of Akt and extracellular signal-regulated kinases, epidermal growth factor-mediated phosphorylation of extracellular signal-regulated kinases, phosphatidylinositol 3-kinase activity, constitutive and inducible activities of nuclear factor-kappa B. A 5 min exposure of BxPC3 cells to "external qi" induced apoptosis, accompanied by an increase of the sub-G1 cell population, DNA fragmentation, and cleavage of caspases 3, 8 and 9, and poly(Adenosine diphosphate ribose (ADP-ribose)) polymerase. Prolonged exposure caused rapid lysis of BxPC3 cells. Treatment of fibroblasts with "external qi" induced transient activation of extracellular signal-regulated kinases and Akt and caused no cytotoxic effect.
Shao et al. (2009) [410]	Opposite intentions of promoting the proliferation of Escherichia coli and killing during the "external qi" therapy resulted in higher and lower optical density, respectively, after incubation compared to control.
Yan et al. (2012) [411]	"External qi" induced cell death and gene expression alterations, promoting apoptosis and inhibiting proliferation, migration, and glucose metabolism in small-cell lung cancer cells.
Yan et al. (2013) [412]	"External qi" decreased viability and blocked colony formation of HT-29 cells, downregulated cyclin D1 expression, and increased the accumulation of cyclin-dependent kinase inhibitors p21(Cip1) and p27(Kip1), resulting in G1 cell cycle arrest. "External qi" induced apoptosis in HT-29 cells in association with decreased expression of anti-apoptotic proteins Bcl-xL, XIAP, survivin, and Mcl-1 and elevated expression of proapoptotic protein Bax. "External qi" significantly repressed phosphorylation of Akt and Erk1/2 and NF-κB activation in HT-29 cells, suggesting a cytotoxic effect through regulating signaling pathways critical for cell proliferation and survival.
Lucchetti et al. (2013) [413]	Significant differences were found between the Spiritist "passe" and "no laying on of hands (LOH)" groups (p = 0.002 after 48 h, and p = 0.008 after one week) and also between the Spiritist "passe" and "LOH" groups (p = 0.005 after 48 h, and p = 0.009 after one week) while inhibiting bacterial growth. No statistically significant difference was found in the experiments with no intention, with an intention to promote growth, and when LOH was performed under the influence of a negative factor.
Trivedi et al. (2015) [414]	Biofield treatment exponentially increased (41 %) the cell death rate of human glioblastoma, compared to control, which remained relatively constant throughout the 20-h testing period. The treated healthy brain cultured cells showed a significant reduction (64 %) of the death rate.
Yan et al. (2018) [415]	"External qi" induced apoptosis in A549 cells, resulting in a pronounced reduction in viability and clonogenic formation, associated with inhibition of phosphorylation of Akt and Erk1/2 and reduced expression of anti-apoptotic proteins Bcl-xL, XIAP, and survivin. "External qi" inhibited EGF/EGFR signaling, and EGF mediated migration and invasion of A549 cells. While TGF-β1 induced phosphorylation of SMAD2/3 and EMT in A549 cells, "External qi" suppressed TGF-β/SMAD signaling and induced cell death in these cells in the presence of TGF-β1.
Kent et al. (2020) [407]	"Reiki" treatment significantly increased the photon emission of mice intervertebral disc cells compared to sham (p < 0.05) and increased collagen II and aggrecan (p < 0.05) measured by real-time PCR.

Abbreviations: cyclic adenosine monophosphate (cAMP); insulin-like growth factor (IGF-I); phosphoinositide 3-kinase (PI3K); human pancreatic cancer cell line (BxPC3); protein that in humans is encoded by the CCND1 gene (cyclin D1); protein cyclin-dependent kinase inhibitor 1 (p21(Cip1)); protein cyclin-dependent kinase inhibitor 1B (p27(Kip1)); the first phase of the cell cycle that takes place in eukaryotic cell division (G1); human colon cancer cell line (HT-29); B-cell lymphoma-extra large (Bcl-xL); X-linked inhibitor of apoptosis protein (XIAP); protein kinase B (PKB also known as Akt); extracellular signal-regulated kinase 1/2 (Erk1/2); nuclear factor-kB (NF-kB); epidermal growth factor/epidermal growth factor receptor (EGF/EGFR); transforming growth factor beta 1 (TGF-β1); proteins that are the main signal transducers for receptors of the transforming growth factor beta (SMAD2/3); epithelial-mesenchymal transition (EMT).

Trivedi et al. (2015) tested the effects of a noncontact biofield treatment over in vitro cultures of human glioblastoma cells and healthy brain cells compared to untreated controls. The practitioner, seated at a short distance from the cells, was instructed to deliver the treatment outside an acrylic chamber that enclosed the cells and microscope. Cell behavior was followed by time-lapse videomicroscopy, and data analysis was performed by a technician blinded to the treatment. The authors found an exponential increase in the cell death rate (41 %) after treatment compared to control, which remained relatively constant throughout the 20-h testing period. The treated healthy brain cultured cells showed a significant reduction (64 %) of cell death rate, suggesting a protective effect of the biofield treatment [414].

Similar results were found by Yan et al. (2012) while studying Yan Xin “Qigong” effect over small-cell lung cancer cells. The results show that “external qi” induced cell death and gene expression alterations, promoting apoptosis and inhibiting proliferation, migration, and glucose metabolism in small-cell lung cancer cells. This phenomenon may have induced an anticancer effect by modulating gene expression to facilitate cancer cell apoptosis while repressing proliferation, metastasis, and glucose metabolism [411]. In 2013, the same author published a study showing that “external qi” had a strong cytotoxic effect on colorectal cancer HT-29 cells, suggesting that it can be potentially used for colorectal cancer treatment directly or indirectly via carriers [412]. Additionally, “external qi” seems to exert anti-lung cancer effects while inhibiting signaling pathways that are important for non-small lung cancer cell survival and metastasis [415].

Although the previous studies show measurable positive effects over cultured cells, this behavior does not seem consensual or reproducible. In a study conducted by Yount et al. (2004), “Qigong” practitioners directed healing intentions toward normal brain cell cultures for 20 min from a minimum distance of 10 cm. A standard colony-forming efficiency assay measured cell proliferation. The authors found a trend of increased cell proliferation in “Qigong”-treated samples showing, on average more colony formation than sham samples (p = 0.036); however, in a replication study (60 experiments), no significant difference between Qigong-treated samples and sham samples was observed (p = 0.465) [408]. Using time-lapse videomicroscopy to access potential glioblastoma cellular responsiveness to “Johrei” from a short distance, Taft et al. (2005) found no evidence of a reproducible cellular response to “Johrei” treatment, concluding that the cell death and proliferation rates of cultured human cancer cells do not appear responsive to this biofield treatment from a short distance [409]. To clarify if the treatment duration (dose) or the distance between the biofield practitioner and the target cells play a role in expressing the results, Yount et al. (2013) invited an internationally recognized biofield practitioner to treat

human glioblastoma cultured cells in well-controlled conditions. The authors found that the three mock/control experiments' cell-viability ratios were all close to zero, while those involving biofield treatments of increasing dosage appeared to be monotonically decreasing. Thus, the most significant cancer-cell inhibition was observed when the practitioner was closest and delivered the highest dose. Further experiments from different distances, including replicating one of the first sets of tests, failed to produce significant differences, leading the authors to consider the data inconclusive because of the inability to reproduce the cellular response in a replicate experiment [416].

The role of intention in the manifestation of the "external qi" was studied in a controlled experiment using the proliferation of Escherichia coli as a target. Opposite intentions of promoting proliferation and killing during the "qi" therapy application resulted in higher and lower optical density, respectively, after incubation compared to control [410]. The manifestation of opposite intentions during "external qi" emission might result in distinct physical effects, such as increased or decreased infrared radiation and temperature near the practitioner's hands. Bacterial growth has been used as a parameter to measure biofield effects. Lucchetti et al. (2013) studied the effects of Spiritist "passe" and laying on of hands (LOH) in four settings: no intention, intention to inhibit bacterial growth, intention to promote growth, and influence of a negative factor. Those experiments, carried out with control, showed that under the intention to inhibit bacterial growth condition, statistically significant differences were found between the Spiritist "passe" and "no LOH" groups (p = 0.002 after 48 h, and p = 0.008 after one week) and also between the Spiritist "passe" and "LOH" groups (p = 0.005 after 48 h, and p = 0.009 after one week). No statistically significant difference was found in the experiments with no intention, with an intention to promote growth, and when LOH was performed under the influence of a negative factor (watching a war scene of a movie) [413].

Still exploring the biochemical effects of intention and "external qi" therapy on human fibroblast FS-4, researchers found that facilitating "qi" caused a 1.8 % increase of cell growth in 24 h, 10 to 15 % increase in DNA synthesis and 3 to 5 % increase in protein synthesis of the cell in 2 h. Also, inhibiting "qi" caused a 6 % decrease of cell growth in 24 h, 20 to 23 % decrease of DNA synthesis and 35 to 48 % of protein synthesis in 2 h. Additionally, the respiration rate of boar sperm increased by 12.5 to 13.0 % after receiving facilitated "qi" for 5 min and decreased by 45 to 48 % after receiving inhibiting "qi" for 2 min [382].

2.4.4.1.4 Measurements with Living Sensors

This group includes research involving complex living organisms that resemble humans' biological characteristics, such as mice, rats, flies, rabbits, fish, dogs, toads, and pigs.

Baldwin et al. (2006) studied "Reiki" effects on noise-induced microvascular damage in rats. The authors found that rats submitted to 15 min of noncontact "Reiki" before 30 min of noise every day for three weeks presented a reduced amount of mast cell degranulation and less extension of microvasculature leakage. Sham "Reiki" was delivered by students who were naive to this therapy by mimicking the "Reiki" practitioner's hand positions. Rats submitted to sham "Reiki" showed no significant reduction in stress-related biomarkers [417].

Mice are often chosen as an animal model in research, mainly when the studies deal with cancer therapeutics. The possible effects of "external qi" on cancer growth, metastasis, and survival time of mice transplanted with cancer cells have been studied for decades. For example, in a study from the 1990s, tumor models were formed in 114 mice by transplanting U27 or MO4 cells into their subcutaneous tissues. The results showed that the average tumor volume in the "Qigong" group was lower than that in the control group (2.2 vs 6.3 cm^3; $p < 0.001$), the metastatic rate was lower (1/16 vs 6/15; $p < 0.05$), and the average survival time was longer (35.4 vs 30.5 days; $p < 0.01$) [418]. In another study from the same decade, the anti-tumor efficacy of "external qi" emission from a "Qigong" healer on transplanted hepatic cancer in mice was evaluated. Thirty mice injected with transplanted hepatic cancer cells were randomly assigned into one of three groups: 1) the control group (no-treatment), 2) the imitation group (sham treatment with imitation of "Qigong" movements), and 3) the "Qigong" group. The "Qigong" and sham treatment included four "qi" emission sessions towards the mouse cage at a distance of 8 to 10 cm for 10 min. The results from three repeated experiments were similar. The true treated group's tumor growth inhibitory rates were 70.3 %, 79.7 %, and 78.7 %, respectively ($p < 0.0001$), higher than the control group. The inhibitory rates of the imitation-treated group were 9.5 %, 2.6 %, and 2.5 %, respectively ($p > 0.05$). Electron microscopy showed that the morphological alterations in mice treated with "Qigong" included decreased cell volume of most cancer cells, nuclear condensation, nuclear fragmentation, decreased nucleus and cytoplasm ratio swollen mitochondria with poorly organized mitochondrial cristae, some vacuolated, and many apoptotic bodies in extracellular space. These results indicate that the "qi" emitted from a well-trained "Qigong" healer could inhibit transplanted hepato-carcinoma growth in mice [331, 419].

Even with the growing interest in this thematic, there is still limited research examining if humans could inhibit cancer cells' proliferation and suppress tumor growth by modifying

inflammation and the immune system. Recently, a study carried out by Yang et al. (2019) suggests that exposure to purported biofields from a human may be capable of suppressing tumor growth, which might in part be mediated through modification of the tumor microenvironment immune function and anti-inflammatory activity in the mouse lung tumor model. Indeed, these authors found that human NSCLC A549 lung cancer cells exposed to a purported healer showed reduced viability and downregulation of pAkt. The authors further observed that the experimental exposure slowed the growth of Lewis mouse lung carcinoma, evidenced by significantly smaller tumor volume in the experimental mice (274.3 ± 188.9 mm^3) than that of control mice (740.5 ± 460.2 mm^3; $p < 0.05$). Furthermore, exposure to the experimental condition markedly reduced tumoral expression of pS6, a cytosolic marker of cell proliferation, by 45 % compared with the control group. The reversed-phase proteomic array suggested that the experimental exposure downregulated the PD-L1 expression in the tumor tissues. Similarly, serum cytokines, especially MCP-1, were significantly reduced in the experimental group ($p < 0.05$). Furthermore, TILs profiling showed that $CD8^+/CD4^+$ immune cell population was increased almost two-fold in the experimental condition, whereas the number of intratumoral $CD25^+/CD4^+$ (T-reg cells) and $CD68^+$ macrophages were 84 % and 33 %, respectively, lower than that of the control group [420].

A subsequent publication involving the same experimental setup showed that the biofield treatment did not inhibit tumor growth but enhanced cancer cell death, in part mediated by modifying the tumor microenvironment and stemness of tumor cells. Tumors exposed to biofield treatment had a significantly higher percentage of necrosis (24.4 ± 6.8 %) compared with control (6.5 ± 2.7 %; $p < 0.02$), and cleaved caspase-3 positive cells were almost 2.3-fold higher ($p < 0.05$). Similarly, tumor-infiltrating lymphocytes profiling showed that the $CD8^+/CD45^+$ immune cell population was significantly increased 2.7-fold when exposed to biofield ($p < 0.01$), whereas the number of intratumoral $FoxP3^+/CD4^+$ (T-reg cells) was 30.4 % lower than control ($p = 0.01$), leading to a significant 3.1-fold increase in the ratio of $CD8^+$/T-reg cells ($p < 0.01$). Additionally, there was a 51 % lower level of strongly stained $CD68^+$ cells ($p < 0.01$), 57.9 % lower level of $F4/80high/CD206^+$ (M2 macrophages; $p < 0.02$) and a significant 1.8-fold increase of the ratio of M1/M2 macrophages ($p < 0.02$). Furthermore, biofield treatment resulted in a 15 % reduction of stem cell marker CD44 and a significant 33 % reduction of SOX2 compared with control ($p < 0.02$). The experimental group also engaged in almost 50 % less movement throughout the session than the control [421].

A controlled study on mice injected with 66cl4 mammary carcinoma cells involved an internationally known healer who provided the subjects' biofield treatment. Each treatment

lasted approximately five minutes and consisted of the practitioner sitting two feet away from the mice on a low bench with the tops of their cages open (four mice per cage) and performing a mental energy transmission technique. The authors reported no significant differences in weight, tumor size, or metastasis in subjects treated with biofield therapy. Nevertheless, significant effects were found in the immune responses of mice treated after the cell injection. The biofield treatment significantly reduced the percentage of $CD4^+$ $CD44loCD25^+$ and the percentage of $CD8^+$ cells, elevated by cancer in the lymph nodes, to control levels determined by FACS analysis. Only $CD11b^+$ macrophages were increased with cancer in the spleen, and the biofield therapy significantly reduced them. Of 11 cytokines elevated by cancer, only interferon-γ, interleukin-1, mono-kine induced by interferon-γ, interleukin-2, and macrophage inflammatory protein-2 were significantly reduced to control levels with human biofield therapy. No additional effects were found in mice treated before the cell injection. The authors concluded that human biofield therapy had no significant effect on tumor size or metastasis but produced significant effects on immune responses in the down-regulation of specific lymphocytes and serum cytokines in a mouse breast cancer model [422]. Previously, the same authors reported similar results but involving therapeutic touch practitioners. In that study, human biofield therapy had no significant effect on tumor size but produced significant effects on metastasis and immune responses compared to mock-treated mice. Therapeutic touch treatment was proved to reduce IL-1-a, MIG, IL-1b, and MIP-2 to control/vehicle levels and reduce specific splenic lymphocyte subsets [423]. Using a randomized and controlled study design, other authors have shown that the biofield treatment provided by a certified healing touch practitioner was able to decrease cortisol levels in mice injected with murine mammary carcinoma 4T1 [424].

Eighteen pigs (weighing 8.5 to 12.5 kg) were deliberately injured by cutting off their T-vertebrae, removing external fat, and damaging their spinal cords with Allen's method to produce the standard model of spinal paralysis. The injured pigs were randomly assigned into three groups: group A (n = 6) was treated by "external qi" 12 h after the injury, had three treatments a day for the first week, then had two treatments daily for 84 days. Group B (n = 6) started the "Qigong treatment" seven days after the injury, with two treatments a day for 84 days. Group C (n = 6), the control, had no treatment and was observed for a total of 90 days. All pigs were equally fed during the experimental period. At the end of the study, all pigs in group A could walk around freely, and two of them could run and jump, showing different degrees of recovery of their nervous functions. In group B, all except one pig could stand by themselves, and one could run around. However, none of the pigs could stand up in group C, and only two had some avoidance response to stimulation [425]. Similar findings

were reported when the experiment was conducted with dogs using the same design and the same "Qigong intervention" [331, 426].

2.4.4.2 Experiments Involving the Human Body

The physiological changes in the healer to initiate healing, the mechanisms that allow the person, animal, cells, or other systems to receive and process the healing, and the nature of the transmission between the healer and the receptor are essential topics to explore in research. However, the small sample size of some studies, the reduced amount of randomized controlled trials, and the inexistence of standardized methods to calibrate biofield therapists are limitations in this field of study [427]. Despite these limitations, evidence suggests a significant improvement in well-being compared to control subjects under circumstances that do not seem susceptible to placebo and expectancy effects [428, 429]. Table 2.4 presents the main findings of selected studies and reviews that explored the effects of non-contact biofield practices on the human body.

Table 2.4. Research exploring the effects of non-contact biofield practices on the human body.

Study	Main Findings
Lee et al. (2004) [430]	"External qi" therapy induced significant changes accessed by encephalography and circulating cortisol concentrations in the real intervention compared to the placebo control. Subjects reported improved emotions of satisfaction, relaxation, and calmness during the real intervention compared to placebo treatment.
Jang&Lee (2004) [431]	Compared to placebo control, subjects who received "qi" therapy had significant improvements in negative feelings, pain, water retention, and total PMS symptoms.
Lee et al. (2005) [432, 433]	"Qi" therapy produced significant effects in heart rate (HR), low frequency (LF), high frequency (HF), and LF/HF. "Qi" therapy reduced the HR and increased HRV as indicated by a reduced LF/HF power ratio of HRV. "Qi" therapy had a higher capacity to stabilize the sympathovagal function compared to placebo.
Yang et al. (2005) [434]	The "qi" therapy participants experienced improvements in mood and psychological variables over the four-week program compared to the control group. Pain and psychological benefits remained significantly improved after two weeks of follow-up.
Lee et al. (2007) [381]	All RCTs on external "Qigong" demonstrated more significant pain reduction in "Qigong" groups than control groups, including general care for treating chronic pain.
Cohen et al. (2010) [435]	No clinical changes were detected in breast cancer tumor measurements from pre- to post-"external qi" therapy, no suggestion of a change in tumor size by physical breast examination, and no changes in quality of life.
Pike et al. (2014) [436]	An enhancement of the left-anterior activation of the cerebral cortex relative to placebo and no-treatment controls was seen during the first 100 s of biofield treatment, indicating a higher overall reduction in state anxiety relative to baseline measures.
Gaillard et al. (2021) [437]	Non-contact biofield therapy could not reduce the number of warts three weeks after intervention (0/64). No significant differences were found between the experimental and placebo groups concerning warts disappearance three weeks after intervention (p = 0.49), nor at six weeks (p = 0.40); however, reduction in size at week 3 was more promising for biofield therapy but, even so, was not significant (p = 0.27).

Abbreviations: premenstrual syndrome (PMS); heart rate (HR); low frequency (LF); high frequency (HF); low frequency-high frequency ratio (LF/HF); heart rate variability (HRV); randomized controlled trial (RCT).

During a biofield-based intervention based on practices such as “Reiki” and healing touch, the practitioner might use contact, non-contact, or a combination of both techniques. Whatever the approach used, biofield practices are often related to an evident reduction of stress patterns, as shown by Reeve et al. (2020), while evaluating the effects of healing touch as an intervention in treating posttraumatic stress disorder. These authors found a significant mean reduction of symptom severity of about 18.11 points in the experimental group, comparable to a change of 5.57 points for the control group. In addition, those exposed to biofield treatment reported a range of positive physical and psychological effects [438]. Most of these biofield interventions share several aspects related to the practitioner mindset, focus, and modus operandi. The primary outcomes might be associated with a compensation of stress’s adverse effects via sympathetic activation of recipients’ left-anterior cerebral cortex, as shown in the study carried out by Pike et al. (2014). The results of that study point towards an enhancement of the left-anterior activation of the cerebral cortex relative to placebo and no-treatment controls (as indicated by significantly higher and significantly positive alpha asymmetry index scores) during the first 100 s of treatment, indicating a higher overall reduction in state anxiety relative to baseline measures [436]. Other stress-related physiological variables are also responsive to biofield treatments, as Lee et al. (2004) show. In that crossover study, “external qi” therapy was proved to induce significant changes accessed by encephalography and circulating cortisol concentrations in the real intervention compared to the placebo control. In addition, subjects reported improved emotions of satisfaction, relaxation, and calmness during the real intervention compared to placebo treatment [430]. “External qi” therapy positively affected sympathovagal function compared to placebo, reducing the heart rate and increasing the heart rate variability [432, 433]. These physiological mechanisms might be common to studies reporting beneficial effects of biofield practices in burnout [439], anxiety, and depression [440-443].

The previous studies support some of the findings of a systematic review by Jain et al. (2010) to synthesize the best evidence examining whether such modalities positively affect health and reduce disease symptoms. That review included 66 clinical studies encompassing several biofield therapies in different patient populations. The authors found strong evidence for reducing pain intensity in pain populations and moderate evidence in hospitalized and cancer populations. Additionally, moderate evidence points to decreased negative behavioral symptoms in dementia and anxiety in hospitalized populations. This study points to reducing fatigue, improved quality of life in cancer patients, and decreased cardiovascular patients’ anxiety [307].

Although the results of some studies seem promising and capable of leaving a clue about possible involved mechanisms, other studies with good experimental designs did not seem to reveal any significant effects of these practices. To understand the underlying physiological mechanisms of how “Reiki” might have therapeutic effects on subjective measures of stress, pain, relaxation, and depression/anxiety, Bat (2021) conducted a pilot randomized, double-blinded, and placebo-controlled study accessing the effects of this biofield modality on heart rate, diastolic and systolic blood pressure, body temperature, and stress levels. The changes in pre- and post-treatment measurements for each outcome measure were analyzed through an analysis of variance (ANOVA) posthoc multiple comparison test, which found no statistically significant difference between any groups. Thus, even though the significance level for comparing “Reiki” and sham groups for heart rate was 0.053, a definitive conclusion cannot be made based on this pilot study alone, demanding a study with a larger sample size [444].

While some researchers explore the effects of biofield practices on physiological parameters, others look for structural changes in the body, such as tumors or warts, to evaluate these structures’ remission effect. For example, the single-blinded, assessor-blinded, placebo-controlled, randomized trial conducted by Gaillard et al. (2021) aimed to evaluate if one session of non-touch biofield therapy with an experienced practitioner could treat warts in the hands and feet in adults. The authors found that no original wart had disappeared three weeks after intervention (0/64). As well, there were no significant differences between the experimental and placebo groups concerning wart disappearance three weeks after intervention (p = 0.49), nor at six weeks (p = 0.40); however, a reduction in size at week 3 was more promising for biofield therapy, but was not significant (p = 0.27). Unfortunately, this study had a short follow-up time to measure the clinical outcome, making it harder to verify the hypothesis [437].

Chronic pain is a common condition in the elderly population. In 2005, 43 elderly adults with chronic pain were randomly assigned either to an intervention or a general care group. The intervention group was given four weeks of “qi” therapy, whereas the control group was given standard care. The “qi” therapy participants experienced improvements in mood and psychological variables over the four-week program compared to the control group. Furthermore, pain and psychological benefits remained significantly improved after two weeks of follow-up. These findings suggest that “qi” therapy may help the elderly to cope with pain and associated mood disturbances [434] and are in agreement with the systematic review conducted by Lee et al. (2007). In that review, 141 potentially relevant randomized clinical trials (RCT) on the effects of “external Qigong” in pain conditions were identified; however, only five RCTs were included due to the study excluding criteria. All

RCTs on external “Qigong” demonstrated a higher significant pain reduction in “Qigong” groups than control groups, including general care for treating chronic pain [381].

More recently, studies involving pain populations have been published, constituting a robust body of evidence on these practices’ beneficial effects. Some conditions with positive outcomes include multifactorial pain [381,434], carpal tunnel syndrome [445], palliative care [446], fibromyalgia [447, 448], knee arthroplasty, postoperative pain [449], knee osteoarthritis [450, 451], pain during hospitalization for cesarean [452], and premenstrual symptoms, including pain [431].

Biofield therapies have also been studied in cancer populations. Cases of improvement and the effectiveness of “qi” therapy in managing advanced cancer symptoms have been reported. For example, in one study, the subject had beneficial effects on pain, vomiting, dyspnoea, fatigue, anorexia, insomnia, daily activity, and psychological calm. These improvements were maintained over the two-week follow-up phase. After the first “qi” therapy session, the patient discontinued medication and could sit by himself, and after the fourth session, the patient was able to walk and use the toilet without assistance [210]. In two different case studies, the authors found that after 20 min of “qi” therapy, both patients experienced improvements in mood and alertness and reduced pain, anxiety, depression, discomfort, and fatigue, on both the first and last days of the interventions. Furthermore, the scores recorded on the last day for most symptoms were improved compared to the first day [453].

The cytotoxic activity of natural killer (NK) cells is positively correlated to survival in cervical cancer patients. These cells target and lyse tumor cells and perform tumor cell surveillance. In 2010, Lutgendorf et al. conducted a study to assess how healing touch may affect immunity, depression, and treatment side effects in patients receiving chemoradiation for cervical cancer. The authors observed a marked reduction of NK cell activity in both the relaxation and usual care groups, in contrast to a mild decrease of NK cell activity in the healing touch group. In addition, the healing touch group showed a more significant reduction in two indicators of depressed mood compared to the other groups of patients [454].

Jain et al. (2012) evaluated the effect of a biofield healing intervention over fatigue and cortisol variability in breast cancer survivors. The authors compared the intervention with mock treatment and wait-list groups and found statistically significant reductions in total fatigue for the biofield group compared to the wait-list group. Additionally, biofield treatment significantly increased diurnal cortisol variability to healthy levels compared to the mock treatment and wait-list groups [455]. Even though the reported improvements in breast cancer patients, this tendency is not always observed, which, in some cases, might be due

to sampling size effects and study design. For example, Cohen et al. (2010) studied whether “external qi” therapy could shrink breast cancer tumors and improve women’s quality of life with pathologically confirmed breast cancer awaiting surgery. The authors found no clinical changes in tumor measurements from pre- to post- “external qi” therapy, no suggestion of a change in tumor size by physical breast examination, and no changes in quality of life [435].

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Chapter 3. Can the electrical potential of acupoints be used to assess the functional state of channels and the effects of therapeutics? An exploratory data analysis

The contents of this chapter were adapted from Matos LC, Lopes LT, Freire VA, Machado JP, Monteiro FJ, Greten HJ. Can the electrical potential of acupoints be used to assess the functional state of meridians and the effects of therapeutics? An exploratory data analysis. *Journal of Bodywork and Movement Therapies*. 2021; 26: 309-317.

3.1 Abstract

Background: Acupoints have bioelectrical properties distinct from common skin. Besides the higher electrical conductance and lower resistance, acupoints show capacitor-like properties, which can be related to their endogenous electrical potential. Traditional Chinese medicine postulates that channels are physiological structures connecting acupoints and working as a conduit for the flow of two essential "substances" known as "qi" and "xue". **Objectives:** This pilot study was focused on evaluating whether the electrical potential of acupoints can be correlated objectively to the functional properties as described by ancient Chinese medical theories, such as the theories of coupled channels of the same phase ("elements") and the principle of coupled points. **Methods:** Direct needle moxibustion on LU5 and needle dispulsion of LI4 were performed in 21 subjects. The electrical potential of each acupoint was measured with a high-resolution data acquisition system taking to reference the acupoint SP6 of the Spleen conduit. **Results:** The results may indicate a functional relationship between the therapeutics and the electrical potential response on the selected acupoints. These effects seem to be explainable considering the specific properties of each acupoint, the relationship between TCM phases, and the dynamics between coupled conduits**. Conclusion:** The evaluation of the endogenous electrical potential of acupoints and the changes caused by an external stimulus might contribute to understanding TCM concepts, mechanisms, and the effects of associated therapeutics. The observed phenomena encourage the systematic assessment of the functional vegetative status via skin electrophysiology and objective measurements.

3.2 Introduction

For many years researchers have claimed that acupuncture points are unique locations on the body surface at which the skin's electrical conductance is higher than neighboring spots [1, 2]. Moreover, the electrical properties of these “bioactive” points are also characterized by a reduced impedance and resistance, an increased capacitance, and higher electrical potential compared with non-acupuncture points [3]. Once the conductivity between two points along the same channel (or conduit) is higher than that between points not sharing this relationship, researchers have postulated that channels are reflections of superconducting-like pathways of least electrical resistance throughout the body [4, 5]. Structurally this may represent fascial cleavage planes where extracellular ionic fluids can spread electrical potentials over great distances without needing to overcome the resistances of cellular membranes [6]. It is even conceivable that these low-resistance extracellular fluid pathways might have branches connecting them to the internal organs, thus providing a theoretical basis for the traditional Organ-Channel associations [7]. Indeed, TCM holds that homeostasis depends on a balance of these functional tissues in the interior, which is reflected by the functional properties of skin regions coincident with acupoints. Therefore, specific stimulation of acupoints can influence the interior functional tissues via perpendicular connections. As well, it can also influence, via horizontal connections, the tissues, muscles, joints, and organs along the course of the channels [8, 9].

Nowadays, several devices can measure the electrical resistance (or the reverse quantity, the conductance) in specific skin areas related to the so-called acupuncture points [10]. Bioelectrical impedance analysis has been used to estimate the acupoint composition according to its physiological state [11]. Some authors have shown that it is possible to distinguish conduit from non-conduit tissue using low-frequency electrical stimulation of the skin [11-14]. Based on this principle, several electrodermal screening techniques were developed, not only for point location but also for diagnostic and therapeutic purposes [12, 15-19]. However, the development of this kind of technology has to deal with some critical technical issues that contribute to the final electrodermal reading and may cause doubts about the validity of those devices. These include, among others, the electrode polarizability, the stratum corneum impedance, the presence of sweat glands, the contact medium, and the electrode geometry [3].

As Pontarollo et al. (2010) have shown, acupoints state can change under the effect of a specific stimulus, inducing physiological changes and modifying the endogenous electrical potential and current in the tissue [20]. In this field, Kim et al. (2013) proposed, with success, a method based on the bioelectrical impedance of an acupoint to measure

the channel energy potential and to establish an objective channel diagnosis. The method was tested while assessing the changes in the electrical properties of acupoints from the bladder and stomach conduits after cupping and taking a meal, respectively [21].

An acupoint's electrical potential is a relative quantity that estimates its energy capacity compared to a reference. This physiological measure is commonly used to study bioelectricity related to low-level endogenic currents and could be helpful to access functional effects and particularities along conduits. Indeed, this methodology was used by Lee et al. (2005) while studying the effects of acupuncture on the potential along the stomach conduit of healthy and unhealthy patients suffering from gastritis. These authors found that a diagnosis can be made by comparing the potential differences in the conduit [15]. Similarly, Xu et al. (2015) have shown that those differences can aid in monitoring changes in the functional state of acupoints and conduits [22].

The main goal of this pilot study was to evaluate if the electrical potential of acupoints, measured continuously by a data acquisition system developed for the purpose, correlates with the functional properties as described by ancient Chinese medical theories, such as the theories of coupled channels of the same phase (“elements”), and coupled points.

3.3 Methods

3.3.1 Study design and recruitment

This exploratory nonrandomized controlled pilot study was designed to guide further research on the subject. The study enrolled 23 volunteers above 18 years old, capable of following basic instructions in terms of Portuguese language skills. Subjects with psychological or physical dysfunctions that could not follow instructions, pregnant, under medication, skin irritations, and bleeding disorders were excluded. Considering the mentioned criteria, 23 volunteers were eligible; however, 2 of them dropped out, one male and one female. The final sample included six Caucasian males and fifteen Caucasian females aged between 25 and 65. The intervention was explained in detail, granting anonymity and destruction of all personal data at the end of the study. A demonstration was performed to show the simplicity and harmlessness of the measurement equipment and the involved techniques. A qualified TCM practitioner executed all the invasive techniques. With reference 2019/CE/PO024(P302/2019/CETI), this study was approved by the Ethical Commission CHUP/ICBAS, and according to the Helsinki Declaration, each participant signed the informed consent, keeping one copy.

3.3.2 Instrumentation and data collection

Electrical potential measurements were performed with a high-resolution data acquisition card from National Instruments (DAQ), model NI USB 6215, 16 bits, with eight differential or sixteen single-ended analog input channels. The card was connected to a laptop and the electrodes to the analog input channels. Electrical connections were made in single-ended mode, sharing the reference (ground) in both lower limbs at the SP6 acupoint of the spleen conduit. The wiring diagram is shown in Figure 3.1b.

Single-use sterile stainless-steel acupuncture needles, brand Huanqiu, 0.3 mm diameter and 30 mm length, were used as invasive electrodes. The needles were connected to the data acquisition card through electrical crocodile clips and multifilament cables of tinned copper with PVC insulation. When required, direct needle moxibustion was performed by igniting moxa roll pieces of Artemisia vulgaris placed on the top and embracing the tail and handle of the acupuncture needles.

A data acquisition program was developed in LabVIEW, version 8.2, to acquire and save real-time data with a configurable acquisition frequency. The user interface allowed the direct visualization of the electrical potentials, and the acquisition sub-routine on the block diagram was set to multichannel reading with one sample on demand, which gave the system's maximum acquisition capacity.

The control group was composed of the same subjects, in which the required baseline measurements were performed before each intervention. In addition, a second TCM practitioner evaluated the participants establishing a diagnosis based on the Heidelberg model of TCM, whose guidelines are well described in specific literature [23-25].

Each participant was seated with the left arm resting on the table and the wrist turned laterally during electrical potential measurements. The needles were inserted in the selected acupoints and further connected to the data acquisition system.

Acupoints were chosen from the primary coupled Lung and Large Intestine conduits, considering the five inductories or antique transport points approach (Figure 3.1a). Due to its unfavorable location, the puteals (Well) of both conduits were not selected in this study. LI4 and LU7 are two acupoints frequently used in daily practice. This study included those points to test the effects of needle manipulation in LI4 and its connection to LU7. Therefore, the following points were considered from distal to proximal: LU10, LU9, LU8, LU7, LU5, from the Lung conduit; LI2, LI3, LI4 LI5, and LI11 from the Large Intestine conduit. All acupoints were connected in single-ended mode, sharing the SP6 as the reference point in both limbs (Figure 3.1b). SP6 is considered the three-“yin” intersection, or the meeting point of the Spleen, Liver, and Kidney conduits, and for this reason, it was selected as the reference point.

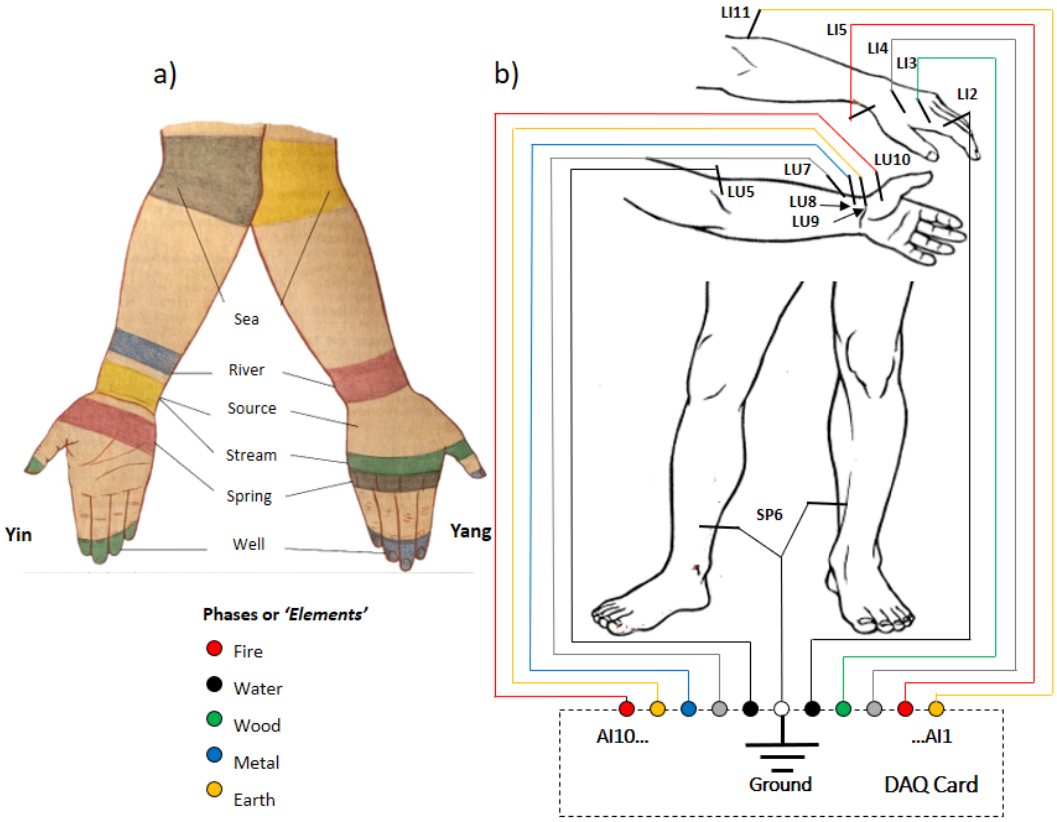

Figure 3.1. a) Areas of the five antique transport points or inductories (adapted from ref. [26]). b) Wiring diagram showing the selected acupoints connected to the analog input channels of the data acquisition card (DAQ) (body illustration adapted from ref. [27]).

After the insertion of the needles, data was automatically saved into text files to set the baseline. This procedure was adopted before all the experiments. The dispulsion of LI4 was performed without insulation between the subject and practitioner, which is the closest to real-life clinical practice. Many theories on needle manipulation are well described in the literature [28]. Much of these techniques are based on subtle variations of lifting and thrusting, twisting and rotating the needle, to which is attributed a reinforcement or reducing power as a function of the frequency and displacement. In this work, to ensure practical reproducibility, dispulsion was performed by bidirectional high-frequency rotation of the needle.

3.3.3 Statistical analysis

The process of finding patterns and testing hypotheses was facilitated by the graphical arrangement of data in scatterplots. Because nothing was known about the variables of interest in the population, the Wilcoxon matched-pairs test, a nonparametric method, was

used when two groups of observations were compared. The t-test for dependent samples was also used because the observations to be compared were based on the same subjects tested sequentially (e.g., baseline, dispulsion, and moxibustion), and a considerable part of the within-group variation in each assessment can be attributed to the individual differences between subjects. The outputs of both nonparametric and parametric tests were evaluated. Simple linear correlation (Pearson r) was used to understand if the values of two variables were somehow proportional to each other and to find causality effects. The Wilcoxon matched-pairs test, the t-test for dependent samples, and the Pearson correlation analysis were performed with Statistica for Windows, version 7.0.

3.4 Results

3.4.1 Effects of dispulsion of LI4

As shown in Figure 3.2, the dispulsion of LI4 induced a sudden decrease in its potential.

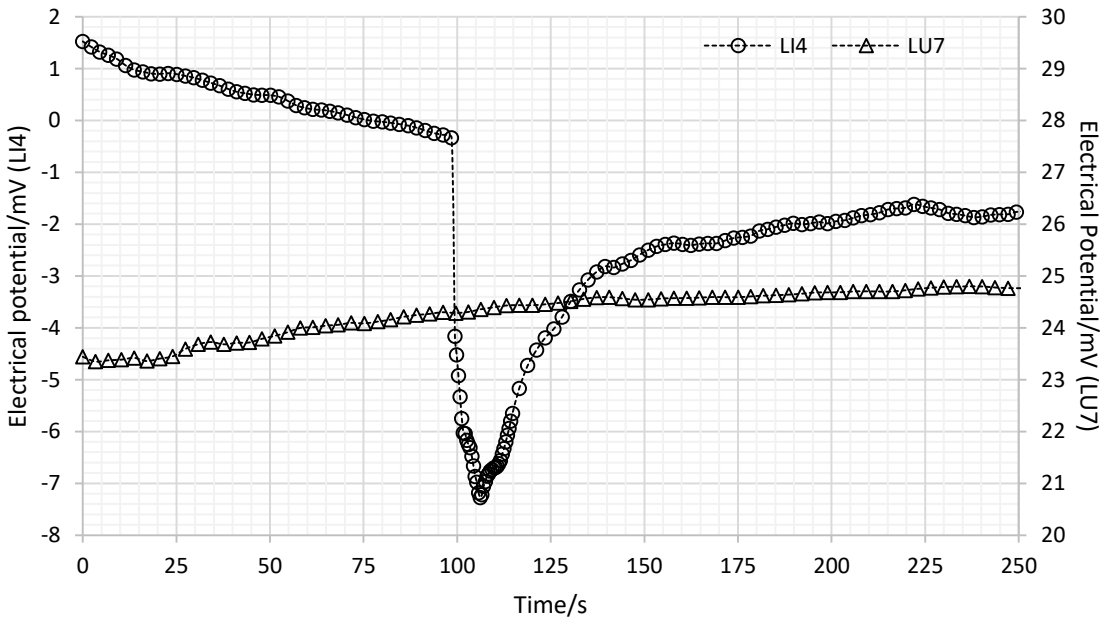

Figure 3.2. Average electrical potential in LI4 and LU7 during the dispulsion experiment.

The drop in the electrical potential during dispulsion was due to a mixed effect of the manipulation itself and a lack of insulation between the practitioner's fingers and the inserted needle. Before manipulating the needle, the electrical potential in LU7 raised continuously during the baseline, making it harder to understand the direct relationship between this tendency and the dispulsion technique. To overcome this limitation, the slopes, *m*, were

calculated for each time increment (equation 3.1). These values were compared before and after each intervention.

$$m = \frac{\mathrm{d}\varphi}{\mathrm{d}t} = \frac{\varphi_2 - \varphi_1}{t_2 - t_1}, \quad (3.1)$$

were φ_2 and φ_1 are the electrical potential for time t_1 and time t_2, respectively.

Special attention was given to this analysis, as the results are influenced by the time intervals considered to compute data. The duration of the dispulsion technique determined those time intervals and the exact moment to perform the calculation. When the values were computed before and after 100 seconds, which marked the beginning of the dispulsion technique, then the differences between the slopes in the baseline and after dispulsion failed to have statistical significance for LU7 (p^* = 0.077 and p = 0.1408 for Wilcoxon matched pairs test and t-test for dependent samples, respectively). However, as shown in Figure 3.2, the dispulsion took, on average, 8 seconds to be entirely performed, and, in this case, if data is computed after releasing the needle, then the differences between the slopes are significant (p* = 0.0196 and p = 0.0393). Indeed, as seen in Figure 3.3, this opposite-effect relationship between LI4 and LU7 is clear while comparing the average slopes in baseline and after dispulsion.

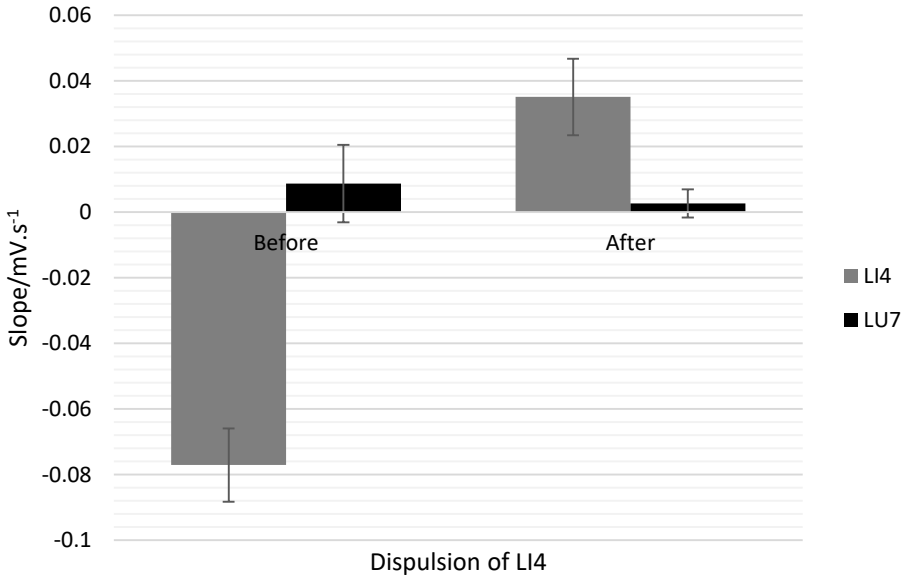

Figure 3.3. Average slopes of LI4 and LU7, before and after dispulsion of LI4.

The decreasing tendency on the electrical potential was also observed in LI2, LI5, LU8, LU9 and LU10, while in LI3, LI11 and LU5 the potential raised (Figure 3.4 and Figure 3.5). The slopes in the baseline and after the intervention were significantly different for LU5 (p^* = 0.0198 and p = 0.0122), LU10 (p^* = 0.0475 and p = 0.0523) and LI2 (p^* = 0.0056 and p = 0.0070).

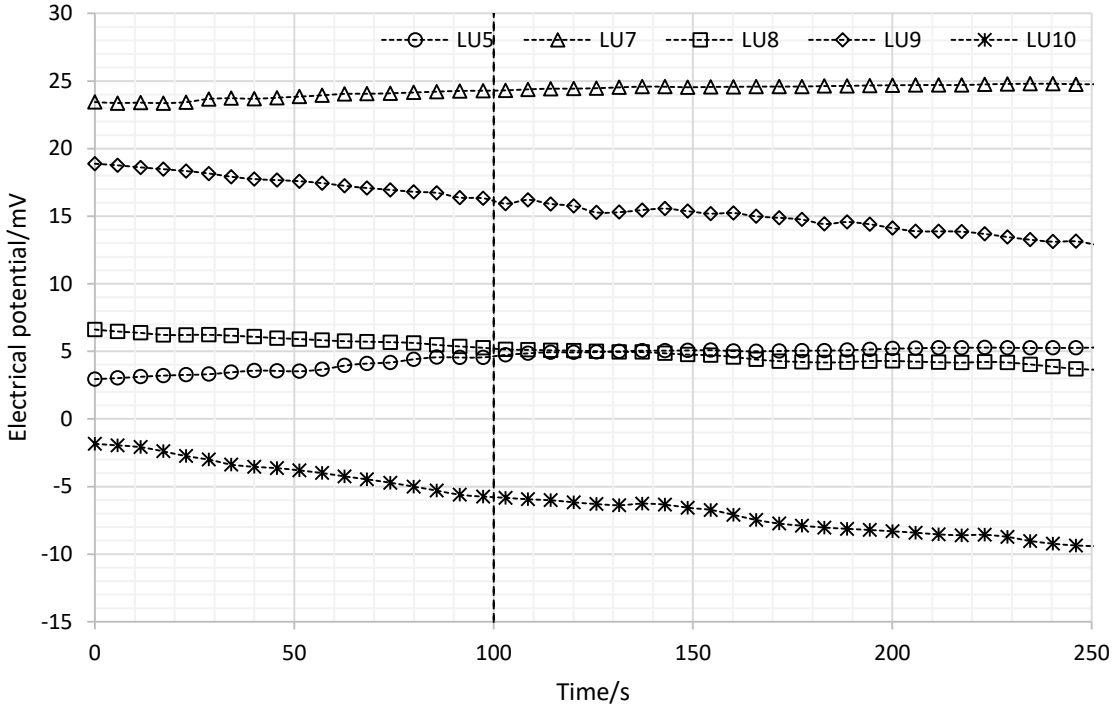

Figure 3.4. Average electrical potential in acupoints of the Lung conduit before and after the dispulsion experiment (the dashed vertical line marks the moment of dispulsion).

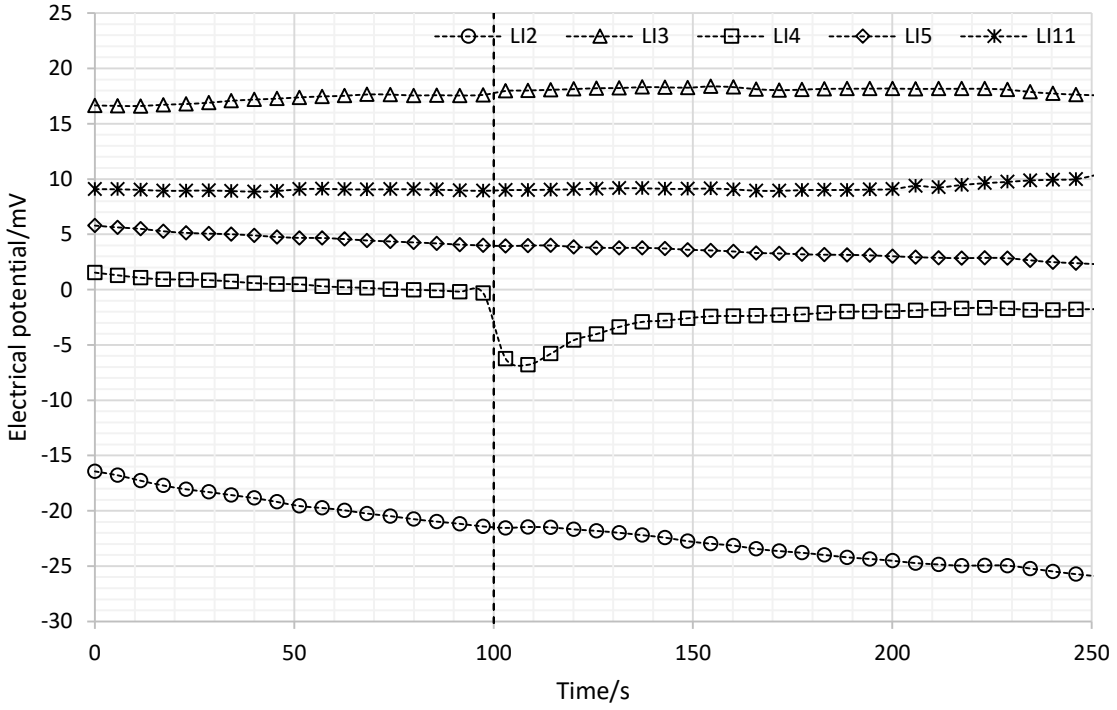

Figure 3.5. Average electrical potential in acupoints of the Large Intestine conduit before and after the dispulsion experiment (the dashed vertical line marks the moment of dispulsion).

3.4.2 Effects of moxibustion on LU5

In this study, a roll of moxa was placed around the handle of the needle inserted in LU5. After the ignition, moxa was let to burn, and data was saved for about 7 minutes (Figure 3.6 and Figure 3.7).

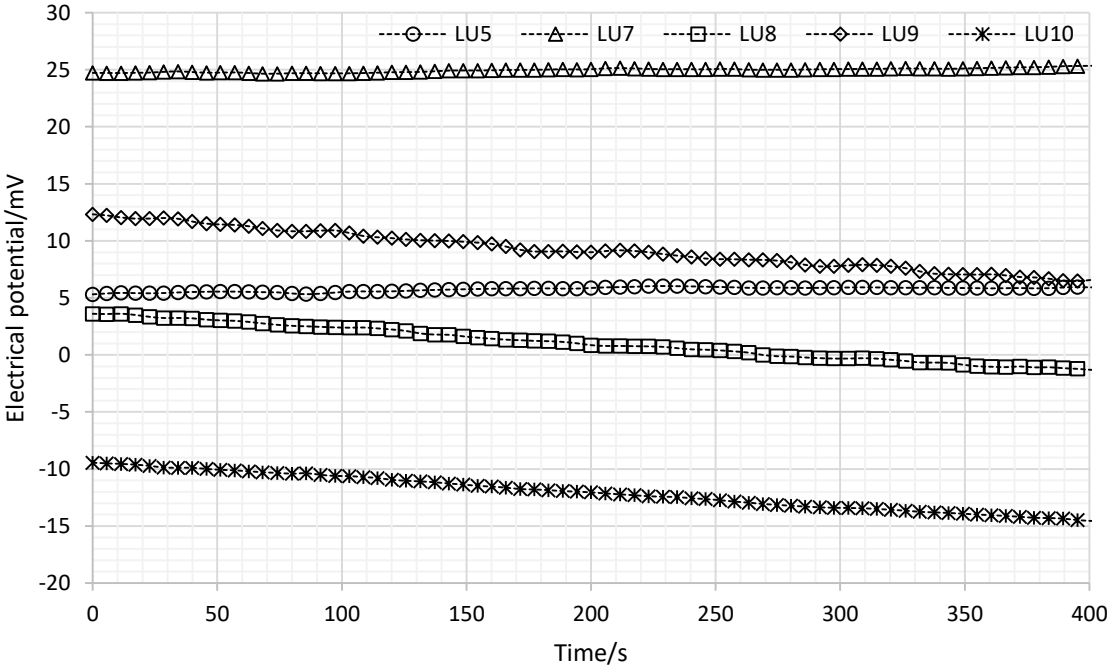

Figure 3.6. Average electrical potential in acupoints of the Lung conduit during moxibustion.

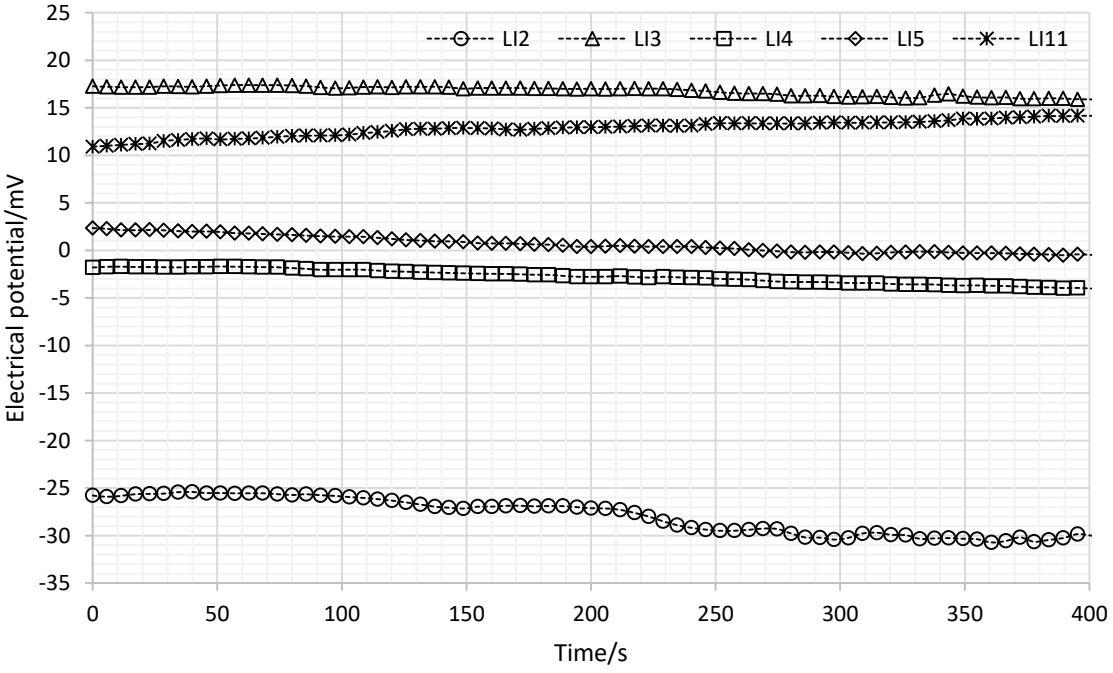

Figure 3.7. Average electrical potential in acupoints of the Large Intestine conduit during moxibustion.

Although the potential in LU5 presented a small increase along with the moxa experiment, this tendency was negligible, and the slopes were not significantly different from the baseline (p^* = 0.7366 and p = 0.6963). Indeed, only LU10 and LI2 showed significant differences between the slopes during the baseline and the moxa experiment (p^* = 0.0198 and p = 0.01863 for LU10, and p^* = 0.0016 and p = 0.0006 for LI2).

3.4.3 Effects of the intervention on the relationship between coupled conduits

The dynamics of the Lung and Large Intestine conduits, believed to be coupled according to TCM theory, was evaluated during the treatment. As previously explained in the methods section, this analysis considered the five inductories (five Antique "Shu" acupoints), except for the puteals (Well) of both conduits, due to their unfavorable location. First, the steady-state average potential of each acupoint was calculated in the baseline, in the dispulsion and moxibustion experiments. Then, those values were plotted as a function of the relative position of each acupoint in both conduits (Figures 3.8 to 3.10).

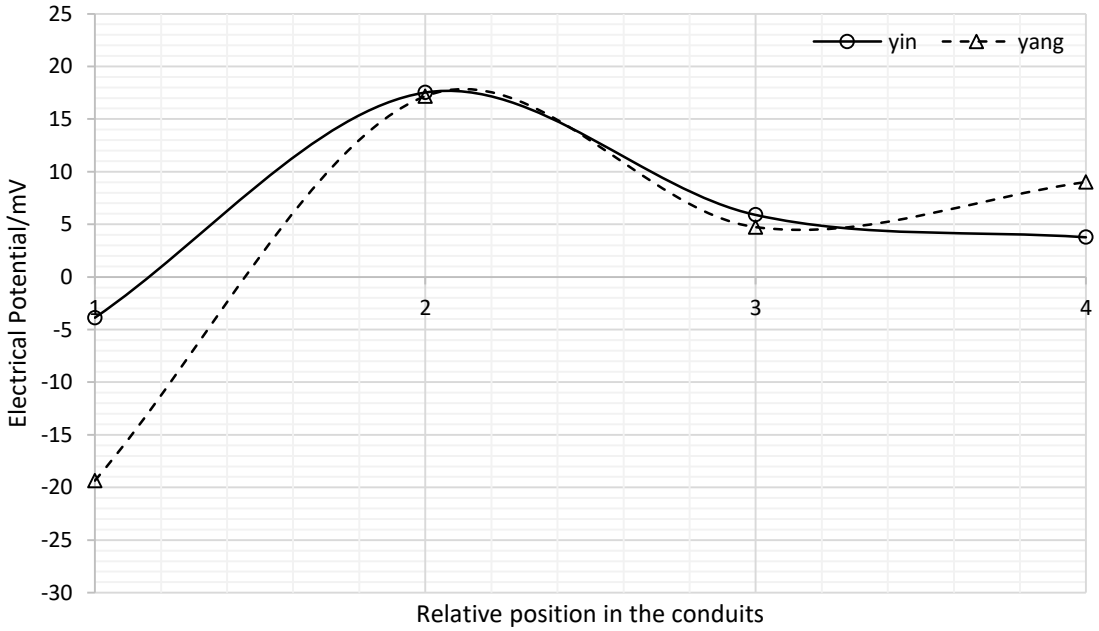

Figure 3.8. Baseline measurements of the electrical potential in the Lung ("yin") and Large Intestine ("yang") conduits as a function of the relative position of each acupoint.

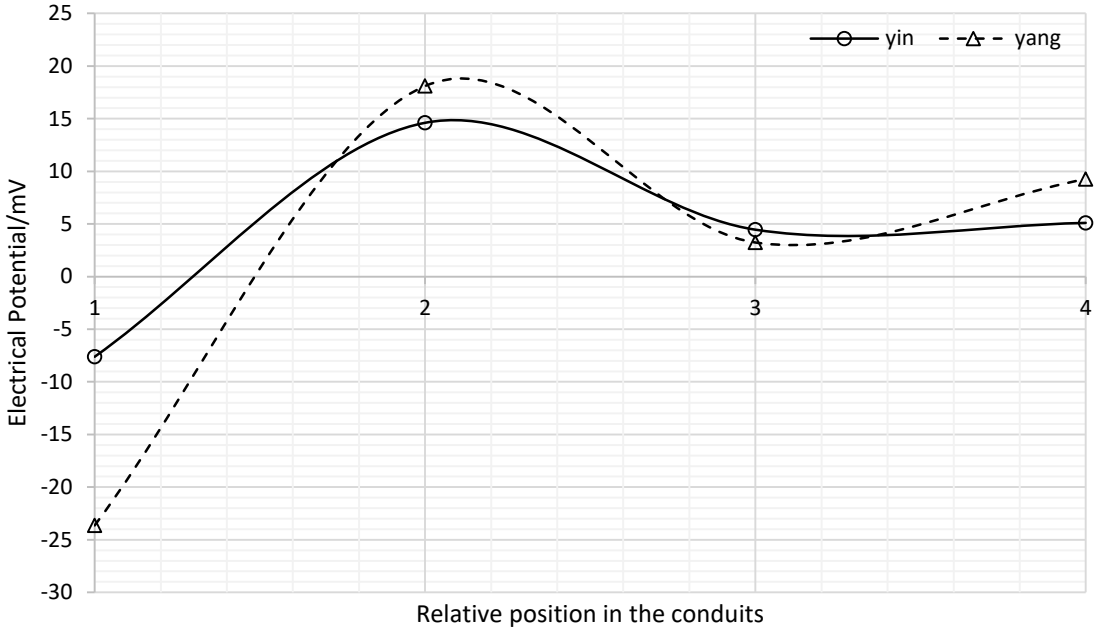

Figure 3.9. Electrical potential in the Lung ("yin") and Large Intestine ("yang") conduits as a function of the relative position of each acupoint after dispulsion of LI4.

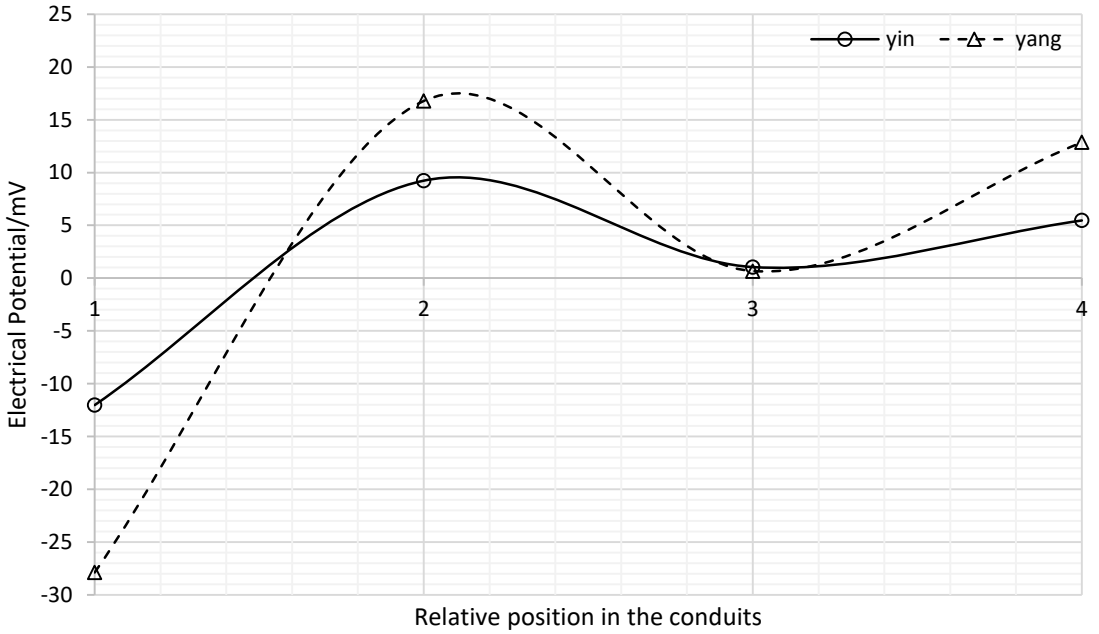

Figure 3.10. Electrical potential in the Lung ("yin") and Large Intestine ("yang") conduits as a function of the relative position of each acupoint after moxibustion on LU5.

The conduit relative position was established from proximal to distal, where position one was set to those points near the elbow, LU5, and LI11. As shown in Figures 3.8, 3.9, and 3.10, the electrical potential along the conduits presented a sine wave-type pattern,

both in the “yin” (Lung) and “yang” (Large Intestine) conduits. Simple linear correlation (Pearson r) was used to determine if these two conduits were somehow related. The analysis showed that the patterns of variation tended to be positively correlated, with a significant increase in this relation as the intervention proceeded (Table 3.1).

Table 3.1. Simple linear correlation between the potentials on the Lung (“yin”) and Large Intestine (“yang”) conduits for each intervention.

Variable	Correlation Factor (*r*)	Level of Significance (*p*)
“yin” vs “yang” (baseline)	0.8879	0.112
“yin” vs “yang” (dispulsion of LI4)	0.9713	0.029
“yin” vs “yang” (moxibustion of LU5)	0.9962	0.004

3.5 Discussion

Acupoint LI4, valles coniunctae (IC4) in the Heidelberg model terminology, is a “yuan”-source point or a source of original “qi” (“qi” originale). It is thought to have a high energetic effect, acting simultaneously on the Lung and Large Intestine conduits. LI4 is coupled with LU7, the “luo”-connection acupoint of the Lung conduit. Dispulsion of LI4 should open the coupled conduit and promote the “flow of qi”. Besides the regulation of defensive “qi”, this point is also used against the pathogenic agent “ventus” (wind) and to release the “extima” (exterior), having a noticeable effect on the regulation of the face, eyes, nose, mouth, and ears, restoring the “yang” and alleviating pain [23, 27]. Moreover, the well-known theory of the “coupled conduits and coupled effects” postulates the existence of junctions between the exterior (“yang”) and the interior (“yin”) conduits of a phase. Thus, an acupoint dispulsion should induce suppletion in the linked point, while suppletive techniques should have the opposite effect.

Hypothetically, the simple act of puncturing LI4, which originated a decrease in its potential, might have increased LU7 potential. This hypothesis requires further experiments, for example, by firstly puncturing LU7 to get the baseline and then, after, puncturing LI4. Despite the need for further sequential tests, these results point towards a decreasing tendency on the potential of LI4 and an increasing tendency in the coupled acupoint, LU7. The stimulation of the phase Metal might affect the surface of the body (both skin and psychic surfaces) and, therefore, might explain the slight increase in the potential of LI11. Indeed, LI11 is known to cool the “xue” (similar to blood) on the “extima”. The “xue” deals with the effects of the microcirculation and the expression of the phase Fire. In TCM, cooling is understood as a decrease of Fire patterns and, considering that LU10 belongs to the phase Fire, it might explain the decrease of its electrical potential.

Acupoint LU5 belongs to the phase Water and is often used to nourish the “yin” (structure) and descend the “qi” in the Lung conduit. It is an excellent point to clear all forms of heat in the Lung, whether from an excess or a deficiency. The use of moxibustion in this point is allowed but not often used. Moxibustion is a strengthening technique frequently used to remove the agent “algor” (cold) and to enhance the flow of “qi” and “xue” in the conduits. Even though no significant differences were found on LU5 during moxibustion, the strengthening effect of this technique and the relation between phases could, eventually, explain the relative decrease in the potential of LU10. This Fire acupoint is connected through the system of phases to LU5 and LI2, two Water acupoints.

In this study, the intervention was sequential, which means, firstly, acupuncture was performed, then dispulsion of LI4, and finally moxibustion on LU5. As the treatment proceeded, the correlation between the two coupled conduits increased. This behavior might indicate a strengthening effect on the “yin-yang” balance. The electrical potential profiles and the Five-“Shu” relative position was similar for the “yin” and “yang” conduits, resembling a sine wave pattern, even if each coupled acupoint was positioned in different anatomical zones of the arm. Such results suggest an electrophysiological relationship between the Lung and Large Intestine conduits.

We understand this study's limitations concerning the sample size and inherent heterogeneity of gender, age, or even physiological status distribution. Further studies with larger samples should minimize those aspects and consider the possibility of grouping subjects as a function of their functional vegetative status assessed by standardized diagnosis strategies. Nevertheless, considering these factors and using a convenience sample, the output of this pilot study might contribute to the discussion on the electrophysiological properties of acupoints and shed light on the design of experiments dealing with this subject. Moreover, the use of invasive electrodes, the needles themselves, instead of skin' surface electrodes, might have originated a different physiological response, not only in the chosen acupoints but also in the whole body. Nevertheless, we choose to follow this strategy, as this procedure is the closest to real-life clinical practice. Further studies might consider non-invasive electrodes, such as pediatric ECG electrodes used with success in similar research [29]. As well, instead of invasive techniques, acupressure might be chosen as the primary intervention.

3.6 Conclusions

This exploratory nonrandomized controlled pilot study explored the changes in the electrical potential of some acupoints of the Lung and Large Intestine primary conduits while

using typical TCM therapeutic stimulations. These included the use of acupuncture and moxibustion, often used together during a single treatment. The simultaneous and continuous measurement of the electrical potential in the selected acupoints, considering SP6 as the reference, was not published elsewhere. The results of this study may indicate a functional relationship between the therapeutics and the electrical potential of acupoints. These effects seem to be explainable considering the specific properties of each acupoint, the relationship between phases, and the dynamics between coupled conduits. Thus, the simple act of puncturing a point might have initiated an innate reflex electrophysiological response, not only on that point but also on others. This behavior was observed, for example, in LI4 and LU7 during baseline measurements immediately after puncturing those points. In this case, the electrical potential profiles had opposite tendencies, following the theoretical concept of coupling these two acupoints.

The slope analysis based on the derivative of the electrical potential for each time increment allowed us to observe significant shifts along with the intervention. Indeed, during the dispulsion of LI4, the potential dropped, and the slope increased after releasing the needle. However, an opposite tendency was noticed in the LU7 slope.

The use of moxibustion on LU5 seems to act on the phases Water and Fire. Although the changes on LU5 were not significant during moxibustion, the slope analysis allowed us to observe relevant changes in the electrical potential of LI2 and LU10, two acupoints belonging to the phases Water and Fire, respectively. These results might indicate that, by strengthening the phase Water, a cooling or descending effect can be seen on the phase Fire, oppositely connected to Water through the phases system.

The results of this work encourage the study of skin electrophysiology and the use of objective measurements to systematically assess TCM vegetative functional manifestations observed before and after therapeutic interventions. In addition, these findings encourage further research to develop non-invasive equipment that might aid the automatic physiological analysis of TCM practices and diagnosis.

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Chapter 4. Changes of skin electrical potential in acupoints from “Ren Mai” and “Du Mai” conduits during “Qigong” practice: documentation of a clinical phenomenon

The contents of this chapter were adapted from Matos LC, Machado JP, Monteiro FJ, Greten HJ. Changes of skin electrical potential in acupoints from Ren Mai and Du Mai conduits during “Qigong” practice: Documentation of a clinical phenomenon. *Journal of Bodywork and Movement Therapies*. 2019; 23(4): 713-20.

4.1 Abstract

“Qigong” is a traditional Chinese medicine therapeutic method that combines slow, soft movements and postures with breath control and a particular mental state of “awareness”. TCM holds that the practice of “Qigong” promotes the “circulation of qi” in the human body, the “flow” of upwards “yang qi” and downwards “yin qi” to establish “balance”. In Western terms, this may generally be equivalent to vegetative homeostasis and the emotionally balanced state induced thereby. Researchers have often attempted to evaluate the functional movements of “qi” using measurements of the skin’s electrical resistance. However, these methodologies have proven challenging to gauge, validate, repeat and interpret. We aimed to overcome these limitations by measuring the skin electrical potential between two points of the same system. The main goal of this study was to assess the skin electrical potential changes in acupoints from the “Ren Mai” and “Du Mai” conduits, or meridians, as well as in other points of interest during “Qigong” practice. While participants performed a specific “Qigong” exercise called “White Ball”, we observed significant changes in the skin electrical potential on “Mìngmén” (GV4), “Shèndáo” (GV11) and “Baihuì” (GV20), from the “Du Mai” conduit, as well as on “Huiyin” (CV1), “Qìhai” (CV6), “Zhongwan” (CV12) and “Dànzhong” (CV17), from “Ren Mai”. These observations agree with TCM theory and may help explain the vegetative physiological changes associated with “qi flow” in TCM.

4.2 Introduction

“Qigong” is a traditional vegetative biofeedback therapy used in Chinese medicine. It comprises concentrative motion and postures combined with breathing exercises [1]. In fact, the “qi activation” is achieved with breath control and a particular mental state of “awareness” [2, 3]. TCM holds that the “qi” cannot be seen and is immaterial, whereas qi's effects may be seen in the functional so-called organ patterns, including functional changes of the conduits or “meridians”. Thus, the practice of “Qigong” promotes the “circulation of qi” in the human body, the “flow” of upwards “yang qi” and downwards “yin qi” to establish “balance”, thereby improving and strengthening the overall health state (homeostasis) [4-6]. From a Western standpoint, these exercises may be understood as vegetative feedback promoters in which “yin”, “yang”, and the Phases are cybernetic elements of a circular process of physiological regulation. This process is ruled by transmitters, and neuronal pathways, where sympathetic functions are more active in “yang” phases and parasympathetic (vagal) activity is more present in “yin” phases [7].

The Heidelberg model of TCM, which is a model of vegetative systems biology centered on the theory of physiological regulation [8], sees strong analogies between the effects of “xue” (“blood”), as described by the classical scriptures, and the clinical effects of microcirculation in Western medicine. Moreover, the classical theoretical foundations of TCM dictate that intention (“yi”) directs the movement of “qi”, which in turn directs the flow of “xue” in the body [9, 10]. Imagination and intention that is focused thinking, which have been studied for the hypothetical ability to exert effects on the physical reality [11, 12], are capacities of “Shen” (mind), which rules, limits, and controls emotions and associations in order to create a mental and emotional state called presence, an ideal, balanced state of mind [7].

As shown by Matos et al. (2012) in a study assessing “Qigong”-related effects using infrared thermography, an increase in the fingers’ temperature, associated with an increase of microcirculation, was observed during the practice of a particular system of “Qigong” known as “White Ball”. However, during the experiments, temperature changes were detected only when the subjects felt the subjective “qi” sensation that results from the combined action of imagination and awareness (see Figure 4.1). “Qi” sensations during “Qigong” practice, also known as “Ba Chu” or “Eight Touches”, are well described and may include pain, itching, cold, warmth, lightness, heaviness, astringency, and slipperiness [13-15].

Preliminary control interventions in which the same physical posture was adopted, but without the mental attitude and imagination associated with “Qigong”, resulted in no

significant vegetative activation nor temperature changes [16]. These results corroborate the thesis that the “mind” activates the “qi”, which itself moves the “xue”.

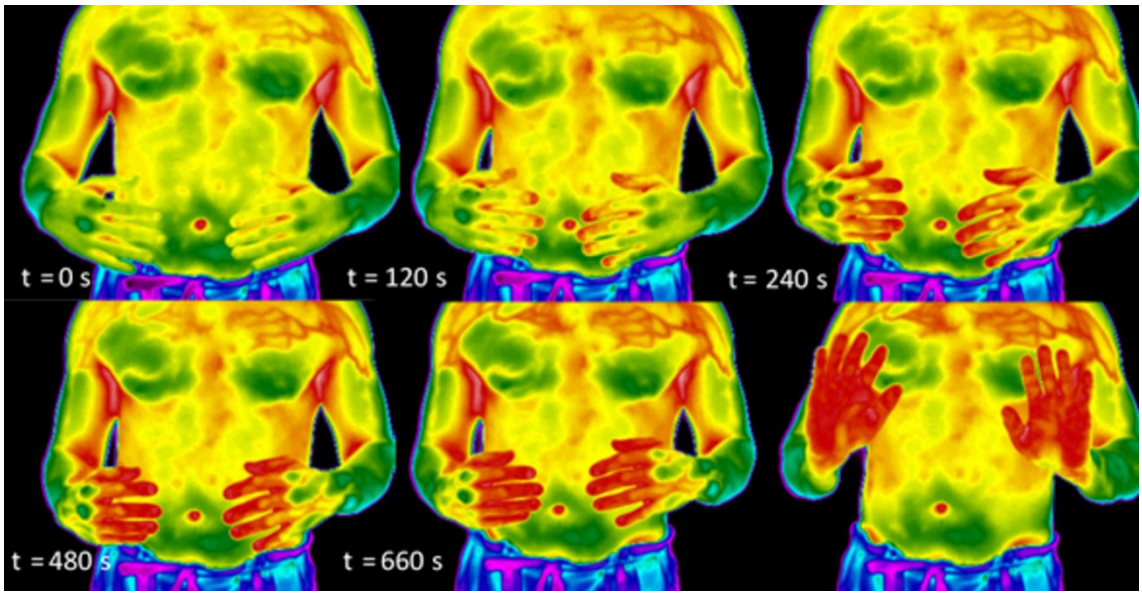

Figure 4.1. Infrared thermography measurements during “Qigong” practice (adapted from ref. [16]).

Blood flow perfusion, fluid balance, and accumulation and dispersal of substances may be related to increased or decreased electrical activity in specific areas of the body [9, 17, 18]. Moreover, unique locations on the body’s surface at which the skin's electrical conductance, capacitance, and potential are higher than neighboring spots have often been found to coincide with the classical acupoints [19-23]. It has also been claimed that electrical conductance is more significant between two points along the same conduit than between points not sharing this relationship, suggesting that acupuncture structures constitute particular pathways for electrical signals [23].

Electrodermal screening techniques have been used for decades, not only for point location but also for diagnostic and therapeutic purposes [24]. These devices and approaches vary in terms of instrumentation and the parameters they measure, such as electrical resistance, impedance and potential, and the number and type of acupoints they use. However, all of them are based on the principle that acupoints have unique electrical properties [25]. For example, electroacupuncture, according to Voll (EAV), the Ryodoraku mechanism, and similar techniques are based on the measurement of electrical resistance (or its inverse quantity, electrical conductance). They have been reported to be successful corroborating tools in diagnosing specific pathologies [26-28]. Nevertheless, most of the findings in this research field are difficult to replicate or evaluate critically due to the lack of methodological standards and reporting protocols [24]. In fact, several factors, such as the use of alternating or direct current stimulation, the electrode polarization, the stratum

corneum impedance, the presence of sweat glands and skin moisture, the contact medium and electrode geometry, and the pressure, angle, and duration of electrode probe application may contribute to the final electrodermal reading; the presence of such factors has raised doubts about the validity of these devices [25, 29].

An acupoint's electrical potential is a relative quantity that measures how much energy capacity it possesses compared to a reference [25]. It is a measure commonly used to study bioelectricity related to low-level endogenous currents and has been shown to enable the assessment of functional effects and particularities in acupoints as well as along conduits [25, 30-32]. The properties of acupoints may be altered by different stimuli, which induce physiological alterations and shifts in the endogenous electrical potential and current in the tissue [31-35]. Acupuncture and “Qigong” studies that measure the electrical potential difference between two points of the same system, without any external electrical load, may overcome or minimize the limitations mentioned above regarding electrodermal readings. Moreover, the measured signals are endogenous due to the body's natural state and the biophysical effects of the practices under investigation.

Considering TCM’s dialectical view of human anatomy and physiological regulation, and by focusing on the principle of the “yin”/negative–“yang”/positive polarity, we conducted this pilot study in order to assess the changes of the skin electrical potential in acupoints from the “Ren Mai” and “Du Mai” conduits, as well as in other points of interest, during “Qigong” practice.

4.3 Methods

4.3.1 Sample and study design

Two healthy Caucasian males, Subject A and Subject B, aged 37 and 33 years old, respectively, with previous experience in “Qigong”, were selected for this study. On different days, infrared thermography and electrical potential measurements were taken. Infrared thermography methodology was well described in a previous publication [16]. The electrical potential measurements were taken using the acupoint “Yongquán”, KI1 as a negative reference point. “Mìngmén”, GV4, “Shèndáo”, GV11 and “Baihuì”, GV20, from the Governing Vessel, “Huiyin”, CV1, “Qìhai”, CV6, “Zhongwan”, CV12 and “Dànzhong”, CV17 from the Conception Vessel, “Yìntáng” (EX-HN3), “Laogong”, Pc8 and the tip of the index and middle finger of both hands were measured. Points were located using the traditional relative measurement system and the “cun” proportional unit [36].

Control experiments were conducted on the same day, with the same subjects, and under the same environmental and instrumentation measurement conditions. Therefore,

two consecutive measurements were performed, the control and, immediately after, the “Qigong” exercise, both with the same duration. In these two runs, the physical posture adopted was the same; however, the intention and mental focus (i.e., the endeavor to achieve a particular mental state of awareness) were active only during “Qigong” (see Figure 4.2).

In order to verify whether the changes in electrical potential were related to the selected acupuncture points and not expressed indifferently all over the skin, two additional experiments were performed. These experiments were conducted on Subject A, precisely the same way as previously described, with both control and “Qigong”. Subject A was chosen because of the higher electrical potential differences measured during the initial tests. In the first experiment, the electrical potential was continuously measured on CV6, and in the second, it was continuously measured in a non-acupuncture point nearby; in both experiments, the measurements were performed with reference to KI1. The non-acupuncture point was horizontally aligned with CV6, at a distance of 3 cun to the right side of the body.

4.3.2 Electrical potential measuring system

Experiments were performed with Ag/AgCl ECG pediatric electrodes (Ewemed) connected through wires to a National Instruments NI USB 6015 high-resolution data acquisition card. Pediatric electrodes were used because their small size facilitated their placement over the selected acupoints and other skin zones and minimized adhesive material around the measured points. Connections to the analog input channels were made in single-ended mode, considering the acupoint KI1 as the negative pole, or ground, shared with all channels. The data acquisition interface was developed in Labview 8.2 from National Instruments. The program was built in order to acquire and save real-time data with a configurable acquisition frequency. In addition, the user interface allowed direct visualization of the electrical potentials, and the acquisition subroutine on the block diagram was set to multichannel reading with one sample on demand, which enabled the system to operate at its maximum acquisition capacity. Figure 4.2 shows the wiring diagram with the selected acupoints connected to the analog input channels of the data acquisition card.

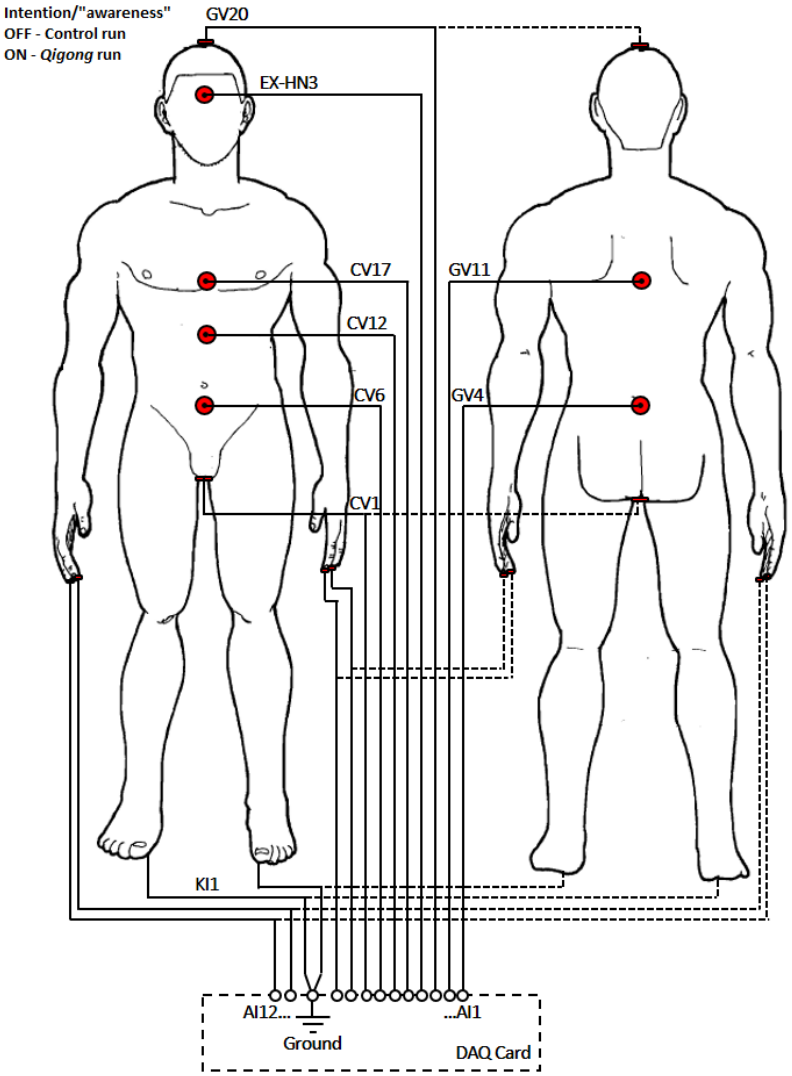

Figure 4.2. Wiring diagram showing the selected acupoints connected to the analog input channels of the data acquisition card (DAQ) and the two possible intention/awareness states (body illustration adapted from ref. [10]).

4.3.3 "Qigong" system and training

The "Qigong" exercise selected for this study was the "White Ball" standing exercise, performed according to the Heidelberg model of TCM. It is a nondynamic, basic "Qigong" posture, similar to the "Wu Chi" posture in the "Zhan Zhuang" system, in which the participant imagines holding a rice-paper ball in front of the lower "dantian", thus excluding the effects of physical movement. The main aspects of this exercise have been well described by Greten [2], Johnson et al. [10], and Jin et al. [37]. Both subjects had at least three years of experience practicing this "Qigong" system.

4.3.4 Statistical analysis

Electrical potential values were submitted to t-tests for independent samples and Pearson's correlation analysis to evaluate the statistical significance of the observed differences and detect relationships between variables. The analysis was performed with Statistica for Windows version 7.0.

4.4 Results

Thermography indicated an increase in the subject's skin temperature while performing the "Qigong" exercise. This change resulted from the increase of local microcirculation in the hands of both subjects. During the experiments, the "qi" sensation was reported only when microcirculation increased.

Electrical potential measurements on the tip of the middle finger (RMF – right middle finger; LMF – left middle finger), on the tip of the index finger (RIF – right index finger; LIF – left index finger), and on Pc8 R, right hand, and Pc8 L, left hand, with reference to KI 1, were significantly different ($p < 0.01$) between the control and "Qigong" runs. Comparing the two subjects, the tendencies and magnitude of variation were also significantly different (see Figure 4.3) but not correlated with each other (r = 0.1509, $p = 0.7750$).

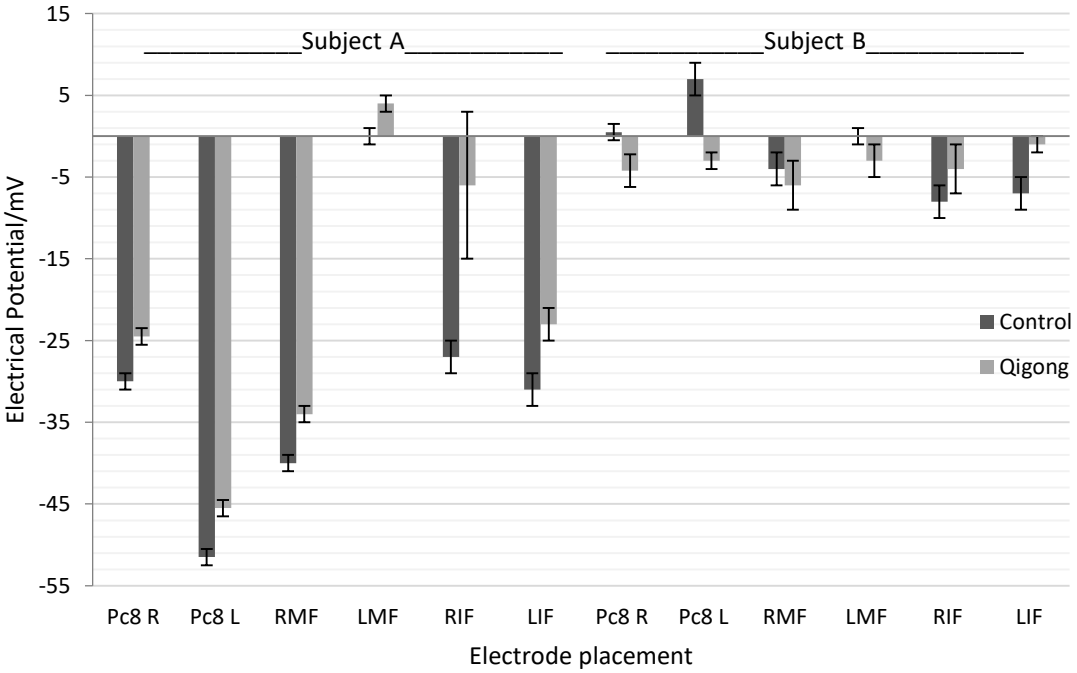

Figure 4.3. Average electrical potential in selected points of the subjects' hands during control and "Qigong" experiments. Legend: RMF – right middle finger, LMF – left middle finger, RIF – right index finger, LIF – left index finger, Pc8 R – pericardium 8 right, Pc8 L – pericardium 8 left.

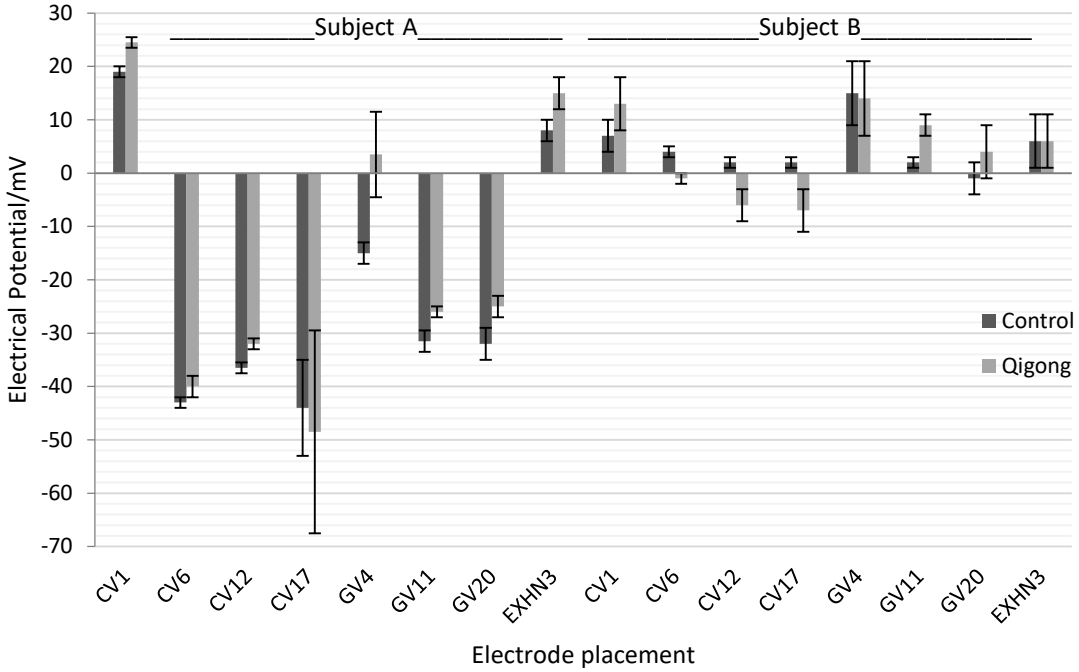

Figure 4.4. Average electrical potential on selected points from the “Ren Mai” and “Du Mai” conduits and EX-HN3 during control and “Qigong” experiments.

The comparison between the electrical potential on acupoints from the “Ren Mai” and “Du Mai” conduits enabled the detection of the expression of a more substantial electronegative potential in “Ren Mai” than in “Du Mai”, both in control and during “Qigong” for Subject A, and only during “Qigong” for Subject B. These changes were positively correlated between the two subjects ($r = 0.7966$, $p = 0.0180$).

Real-time electrical potential measurements on CV6 and in a non-acupuncture point nearby, with reference to KI1, were taken during control and “Qigong” runs. As shown in Figures 4.5 and 4.6, the potential profiles had different tendencies. In the non-acupuncture point, during both the control and “Qigong” runs, the potential remained almost stable around a mean value (see Figure 4.6), whereas, in CV6, the potential tended to increase significantly during “Qigong” (see Figure 4.5).

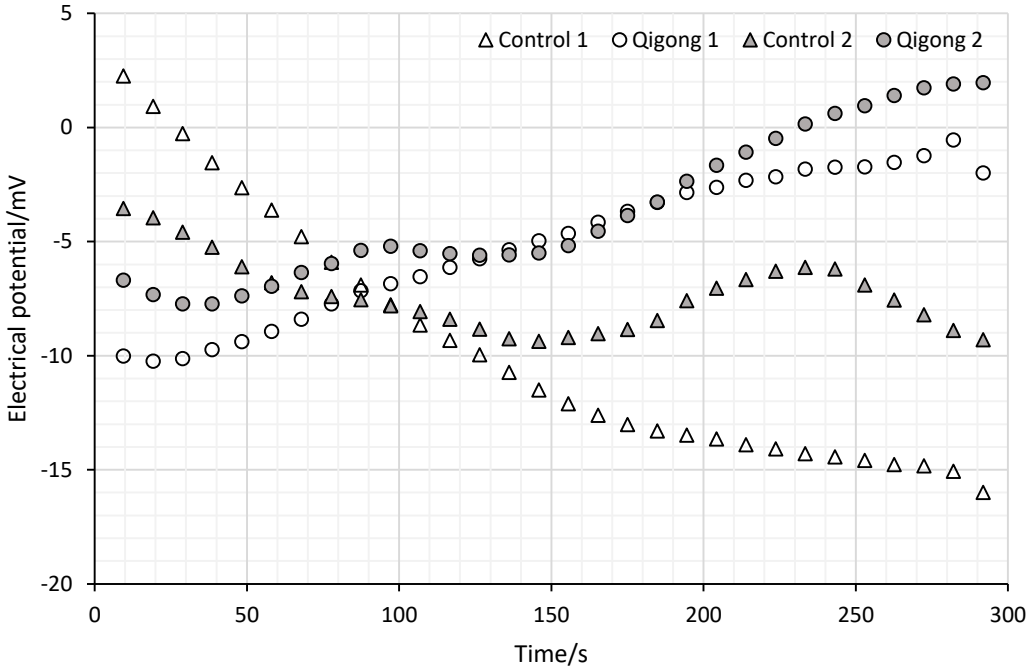

Figure 4.5. Electrical potential measured on CV6 with reference to KI1 (Subject A) during control and "Qigong" experiments.

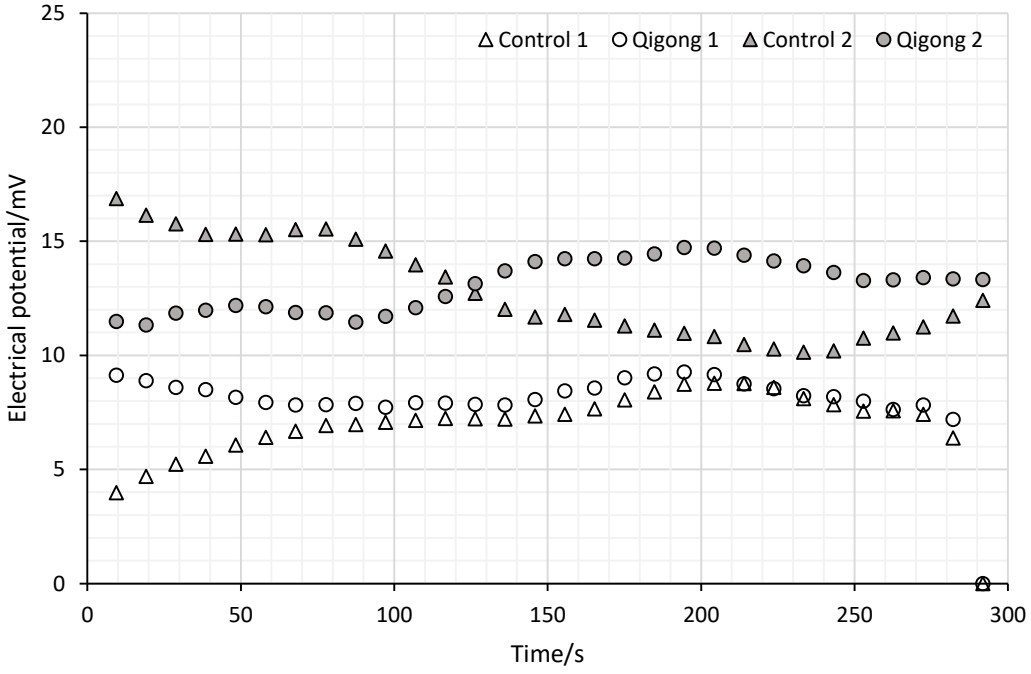

Figure 4.6. Electrical potential measured on a non-acupuncture point near CV6 with reference to KI1 (Subject A) during control and "Qigong" experiments.

In fact, in the first set of two experiments, when the electrode was placed on CV6, the measured differences between control and "Qigong" runs were highly significant ($p < 0.001$),

in contrast to the low level of significance found, for example in experiment 2, when the electrode was placed on the non-acupuncture point (p = 0.5961). A statistically significant level was achieved regarding experiment 1 of the second set of experiments; however, this value lacked practical significance because the graphical analysis discarded it.

4.5 Discussion

TCM's dialectical view of human anatomy posits that the human body is an organic, interconnected, and functional whole based on the union of opposites, in which every tissue or organ can be assigned to either "yin" or "yang" [38]. This principle is also applied to physiological regulation and pathology, in which it could be understood as a directional norm convention, able to describe circular functions within a cybernetic regulatory context, such as "yin" (descending/downregulation) and "yang" (rising/upregulation). Moreover, "yin" could be understood as "less qi" and "yang" as "more qi" from a medical perspective. Particularly relevant to the interpretation of our results is TCM's relative-polarity view of the body, according to which the upper part and back of the body are "yang", and therefore positively charged, or less electronegative, and the lower part and front of the body are "yin", and therefore negatively charged, or more electronegative. The same applies to "yin" and "yang" conduits and can, hypothetically, be related to the driving force of the so-called 'flow of qi'. These considerations have been supported by the work of Robert O. Becker, who showed that the body surface has a differential electrical polarity and the ability to generate a direct current electrical charge involved, for example, in healing processes [39].

Few published studies have investigated changes in the electrical properties of acupoints during "Qigong" practice. To the best of our knowledge, there are only two published studies of the changes in electrical conductance measured before and after the practice of "Qigong" [40, 41]. Although both studies showed that the practice resulted in significant differences, neither presented a real-time measurement profile of the exercise.

Our results show that electrical potential changes occurred during the exercises, a phenomenon documented for the first time during "Qigong" practice. The changes were generally compatible with certain ancient theoretical assumptions of TCM. The observed potential tendencies were not equal within the "Ren Mai" and "Du Mai" conduits. In fact, as shown in Figure 4.4, there was a tendency toward more negative potential within the (downwards) "Ren Mai" conduit or Conception Vessel and toward less negative potential in the (upwards) "Du Mai" conduit or Government Vessel.

In a particular point of the "Ren Mai" conduit, CV1, both subjects exhibited a relatively high positive potential, which increased during "Qigong". CV1, located at the perineum,

midway between the anus and the scrotum in men, is the meeting point between the “Ren Mai” and “Du Mai” conduits and is directly beneath and opposite to GV20. This point is crucial in “Qigong” practice and on the so-called small heavenly circuit rotation, or microcosmic circulation, in which the “qi” is focused and felt in the lower “dantian”, directed to CV1 and then to “Changqiang” (GV1), before being directed up by the “Du Mai” to GV20, and then down the “Ren Mai” to return to the lower “dantian” [10, 42]. EX-HN3, another critical point in “Qigong”, exhibited a relatively high positive potential in both subjects. This acupoint, located at the middle of the forehead, between the eyebrows, is the front point of the upper “dantian”, traditionally known as the “entrance of the spirit” and often associated with intuition, “energy” projection, wisdom and enlightenment [10]. These theoretical particularities can hypothetically be related to the increased electrical potential measured in CV1 and EX-HN3.

As noted above, several factors may influence the electrical potential of the selected acupoints. These include the stratum corneum impedance, the presence of sweat glands and skin moisture, blood flow perfusion, fluid balance, and accumulation and dispersal of substances, to mention just a few. Moreover, changes in electrodermal measures are often indicators of sympathetic nervous system activity during emotional manifestations [43, 44]. Indeed, sweat glands are innervated by postganglionic fibers of the sympathetic nervous system because their functioning is highly influenced by emotional states [45]. In this process, the central nervous activity related to affective and cognitive states triggers sweat secretion by the action of catecholamine neurotransmitters such as noradrenaline [46]. Moreover, variations in sweating, activated by acetylcholine, are a function of environmental temperature and humidity [47-49]. Nevertheless, at temperatures below the threshold of sweating, the electrical potential of the skin seems to provide a measure of the epidermal ion concentration gradient associated with physiological regulation [48, 50].

Considering that all the measurements were performed at stable room temperature; that all elements of distraction, such as other persons in the room, mobile phones, and disturbing external noises, were avoided during the measurements; that the studied subjects were healthy, experienced “Qigong” practitioners capable of achieving a particular state of awareness and controlling their thoughts and balance emotions; the results show that the changes in the electrical potential of acupoints may result from the “Qigong” exercise and may be triggered by intention and imagination, which, as reported by the subjects, was felt like a unique state of awareness. In this particular state of mind, the perception of “qi” resulted from the vegetative activation of physiological mechanisms. This is compatible with the Heidelberg model of TCM, which defines “qi” as a tissue or organ’s vegetative capacity to function, which may be felt as tearing, pressure or flow when the

tissue is activated. In the present study, this activation was seen as induction of microcirculation and changes in electrical potential. These results agree with the principle that the mind activates the “qi” and that the latter moves the “xue”.

Both subjects' electrical potential measured in the fingers and “Laogong” changed during “Qigong”. These tendencies were not correlated. Whereas Subject A exhibited an increased potential in all points, Subject B exhibited an opposite, decreasing tendency in “Laogong” and the middle fingers of both hands. Thus, although thermography indicated an increase of blood perfusion in the hands of these individuals, which could explain the increased potential, other variables may have influenced the electrical properties of some points, thus requiring more research and leaving us, at this point, without a conclusive explanation.

As shown in Figures 4.5 and 4.6, the electrical potentials measured in the acupuncture and non-acupuncture points had different tendencies during the practice of “Qigong”. Whereas in “Qìhai”, the changes in potential were noticeable and could be related to the exercises, in the non-acupuncture point, those changes seemed to be negligible. Therefore, “Qìhai” exhibited a higher electricity load, and this load shift may eventually be related to some electrical current (bioelectricity). If the changes in bioelectricity and the related bioelectric flow can be explained in physiological terms, such an explanation could contribute to understanding the vegetative physiological changes associated with “qi” flow in TCM. Moreover, if the “qi” flow changes with the practice of “Qigong”, and these effects can be measured, it is likely that “qi patterns” associated with an individual’s constitution and disease can also be detected, quantified and related to TCM diagnoses.

We are aware of the limitations of this study, particularly the small sample size and the lack of published material on this specific subject and the related assessments. A more extensive body of research would help mitigate errors and misunderstandings, which may eventually be detected in follow-up studies. It is also important to remember that subjects experienced in the “Qigong” system investigated in this study are not abundant. Moreover, we do not know if the changes have any relationship with the practitioner’s level of experience or are triggered by a natural skill. These issues require further studies that include both experienced and inexperienced subjects. Also, to measure the differences in electrical potential, we choose KI1 as the ground, or negative pole, shared with all acupoints. We did so because the renal conduit belongs to the “yin” and because this point is in perfect contact with the biggest “yin” that exists, the Earth itself. However, we cannot ensure that the acupoint state is the same for all subjects, which may induce variability in both polarity and signal magnitude. Therefore, further studies employing electrical potential measurements in acupoints should consider choosing other reference points.

4.6 Conclusions

The biophysical effects of “Qigong”, as vegetative biofeedback therapy, can be measured and quantified using various approaches, including measurements of the electrical potential of the skin. The changes in the electrical properties of acupuncture points and the possible association with the bioelectrical flow of charges during “Qigong” practice seem to be related to the practitioner’s intention and consistent with the theoretical foundations of TCM. The “xue” is moved by the “qi” and guided by the intention of the mind, the “yi”. Therefore, the activation of the “qi” flow depends on the practitioner’s particular mental state of awareness, which triggers the manifestation of vegetative physiological changes, such as the increase of the microcirculation and changes in the electrical potential of the skin. On the other hand, the main changes in electrical potential during “Qigong” practice occurred in acupuncture points. Such points, when linked together, form a meridian or conduit, in our case the “Ren Mai” and “Du Mai”, in which the relative polarity was following TCM’s dialectical view of the human body.

4.7 References

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Chapter 5. Instrumental measurements of water and the surrounding space during a randomized, blinded controlled trial of focused intention

The contents of this chapter were adapted Matos LC, Santos SC, Anderson JG, Machado J, Greten HJ, and Monteiro FJ. Instrumental Measurements of Water and the Surrounding Space During a Randomized, Blinded Controlled Trial of Focused Intention. *Journal of Evidence-Based Complementary & Alternative Medicine*. 2017; 22: 67586.

5.1 Abstract

This work's main goal was to assess measurable interactions induced by focused intention, frequently used in biofield practices such as Healing Touch and "Reiki". As the main component of the human body, water was chosen as a model. Intention experiments were performed over four different days at a scheduled interval, during which 286 trained biofield practitioners from several countries were instructed to meditate to change the molecular vibrational state of water samples selected by a blinded operator. The experimental protocol was randomized, blinded, and controlled; the measured variables included water's Raman spectra, pH and electrical conductivity, and the magnetic field and UV-VIS radiation near the experimental spot. Although a direct causal relationship cannot be established, some measurements of the water samples and the magnetic field and radiation near the experimental spot were responsive during the experimental period.

5.2 Introduction

Paradigms are determined by cultural differences and perceptions of reality and often define the borderline between science and pseudoscience. Indeed, science's history is full of challenging anomalies ignored by the scientific mainstream by defying the dominant paradigm until explained [1, 2]. Over the last several decades, researchers have been interested in the effects and potential mechanisms of certain energy-healing practices or biofield therapies such as "Qigong", Healing Touch, and "Reiki" [3, 4]. As a result, traditional medicine practitioners and so-called "energy healers" have been involved in many studies [5-15]. Philosophically, each of these biofield therapies relies on a "vital force" as the primary driving mechanism of health, pathogenesis, and healing. This ancient shared concept is understood as "Qi", "Ki", "Prana", "Ankh", and "Pneuma" in Chinese, Japanese, Hindu, Egyptian, and Greek cultures, respectively [16].

"Qigong", used in Chinese medicine as traditional vegetative biofeedback therapy, considers the existence of a differential external protective field known as "Wei Qi", which acts on the physical, emotional, and spiritual levels [17]. The hypothetical existence of such a complex and dynamic biologic field within and around the body, which is involved in homeostasis, [18, 19] could be partially based on the electromagnetic field theory, [20-30] on acoustic and thermal related effects, [5, 9, 31, 32] and possibly other subtle energy fields, which, in some cases, seem to generate physical changes that are measurable with current technological methods [3, 18, 33, 34]. However, some practices appear to act in a manner described as nonlocal, thus acting at a distance, possibly compromising consciousness or even transpersonal realities, transcendental or spiritual experiences, [18, 35] defying mainstream scientific concepts [36, 37]. Nevertheless, the first approach while studying this phenomenon is often to correlate it with physical aspects such as light, electricity, heat, sound, and magnetism. For that, researchers have been using various instruments and methods, including magnetometers, voltmeters, photometers, gamma radiation counters, sound equipment, and gas discharge visualization, among others [5, 9, 27, 28]. Indeed, proper and reliable instrumentation is crucial to document the phenomena and potentially calibrate biofield practitioners. This represents a challenge in research given that the involved mechanisms remain unknown, and the ability to trigger these effects could be a natural skill or the result of continuous practice.

Within this field of study, intention, which could be defined as a directed thought to elicit a particular response, [38] seems to play an essential role in the process [39]. Although the biophysics of intention is still under debate, research has shown that an intended thought appears to generate physical effects over inanimate objects and living things, from unicellular organisms to human beings [37, 38, 40-43]. The nonlocality feature of this phenomenon is often associated with the concept of entanglement [37, 42, 44, 45] and aspects of consciousness and quantum physics in which mental processes are referred to as a triggering element [42, 46, 47]. In the case of distant healing, the healer who directs his/her thought or intent to the patient comprises a single system even while physically separated. Thus, the concept of entanglement is used to describe a connection between two elements existing even though separated across space [48].

This phenomenon has apparent implications and requires clinical and preclinical studies in humans and proper research with objective models exempt from expectation, belief, and psychosocial factors, such as models using animals, plants, biomolecules, tissue samples, and cell cultures [49]. Accordingly, as the main component of the human body, water stands as an obvious choice to avoid the interactions mentioned above and generate hypotheses to explicate the subsequent effects and relationships within complex biological

systems. Water has been used as a model in several studies with outcomes that suggest some of its properties, such as the cooling rate, the molecular bonding as reflected by changes in the infrared spectra, the vibrational state as measured by Raman spectroscopy, scattered laser light, and the pH level may be affected by intention [30, 38, 40, 43, 50-53].

Given these arguments, the question of whether the mind may or may not influence matter is of relevance, especially within a dialogue of conflicting cultural, religious, and scientific concepts. Therefore, we established a rigorous experimental protocol based on the available literature and used several instrumental methods to detect water physical properties changes. This work's main goal was to assess measurable interactions hypothetically induced by focused intention, frequently used in Healing Touch and "Reiki" practices.

5.3 Materials and methods

5.3.1 Study design

The experimental protocol, schematically represented in Figure 5.1, used a randomized, blinded, and controlled design. Experiments were conducted over four consecutive days, from the 8th to the 11th of September 2015 (ED1 to ED4). The intentional meditation source (IMS) was 286 trained practitioners affiliated with two non-profit organizations: Healing Touch International (dba Healing Beyond Borders) and Reiki's Portuguese Association. Members of these organizations were invited to participate in the study via email. Potential participants used a Google form to provide limited information (email address, level of training, city, country) to maintain anonymity. None of the participants was aware of the experimental measures used to collect data.

The sample of participants included 254 Healing Touch students, practitioners, and instructors with an average level of expertise of 7.2 years of practice (SD 7.1 years, median five years with a range of 0.25 to 40 years of practice) who were located in several countries according to the following distribution: the United States = 223; Canada = 24; Australia = 3; Peru = 3; and The Netherlands = 3. The 32 "Reiki" practitioners with an average level of expertise of 8.4 years of practice (SD 5.7 years, median seven years with a range of 3 to 23 years of practice) were located in Portugal, from North to South. Twelve of the "Reiki" practitioners held the level of "Shinpiden" (Master or third level) and 20 the level of "Okuden" (second level), from the systems "Usui Reiki Ryoho", Traditional Tibetan, and Essential.

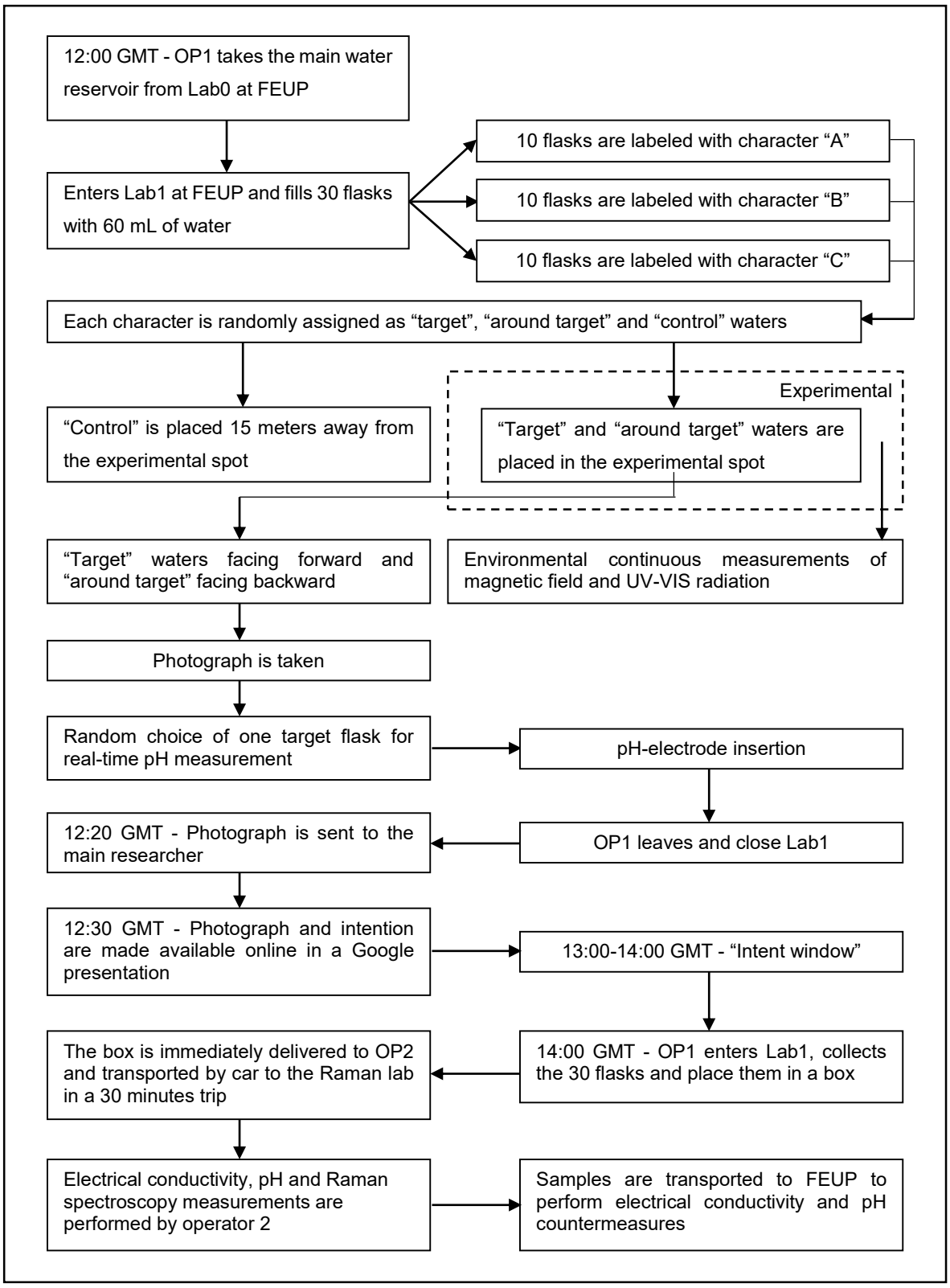

Figure 5.1. Daily experimental protocol.

Two independent experimental operators (operators 1 and 2), blinded to the study and without any knowledge of and connection to these biofield practices, were instructed and trained to perform all required laboratory assessments systematically. An educational

pilot plant laboratory (Lab1) located in the Department of Chemical Engineering of the Faculty of Engineering at the University of Porto was used during the experimental period. The laboratory was closed, kept in twilight without artificial light, and prohibited from any additional activity during the experiments. This laboratory was chosen because of the dimensions (7 m high, 7 m depth, 20 m length), which maintained an average constant temperature of 24 ºC. In addition, operator 1 (OP1) was the only person allowed to enter the lab to dispose of and collect the water samples after each experiment.

Commercial purified water was used and stored in a different laboratory in the same building. Each day, around 12:00 hours GMT, OP1 took the main water reservoir and entered Lab1 to fill the single-use 60 mL sterilized flasks (brand Deltalab). A total of 30 flasks were prepared: 10 of these were marked with the character “A”, 10 with “B”, and 10 with “C”. Randomly, OP1 chose one of the characters as the control and placed the respective flasks 15 meters away from the experimental spot within the same lab. The other 20 flasks were randomly arranged on the experimental spot, and again, OP1 chose one of the characters to face forward (corresponding to the flasks with the target samples) and the other to face backward (corresponding to the flasks around the target); the random choice of characters is shown in Table 5.1.

Table 5.1. OP1 random choice of characters.

Experimental day	Target	Around target	Control
ED1	A	B	C
ED2	C	A	B
ED3	B	C	A
ED4	A	C	B

Flasks placed around the target samples were used to verify whether the intention was selective. All experimental design conditions were kept constant as the lab bench was marked with specific locations for the flasks and the measurement instrumentation. A photograph of the 20 experimental flasks was taken, and a pH electrode connected to a data acquisition system, which saved data with a frequency of one data point every 5 seconds, was vertically inserted into one of the flasks with the character facing forward. A magnetic field sensor and a spectrometer were installed near the experimental spot and configured for continuous acquisition of the magnetic field strength and radiation in the range of 175 to 954 nm. Following this procedure, OP1 exited and closed Lab1, and around 12:20 hours GMT, and sent the photograph of the flasks with the target identified to the principal researcher.

The photograph was published using a Google document made available online at 12:30 hours GMT on the day of the experiment; a link to the document was emailed to all

286 practitioners enrolled in this study. Below the photograph, a defined intention was included: “to change the vibrational state of the water molecules contained in the flasks marked with the character … placed in the lab …, FEUP, Portugal”. The concept described (i.e., “to change the vibrational state of the water molecules”) was understood among the practitioners as the action of “energizing the water”, for example, by allowing the imagination of molecular movement or structure dynamics. Although the target’s identification was available at 12:30 hours GMT, the practitioners were instructed to meditate during a defined “intention window” set between 13:00 and 14:00 hours GMT. Each of the Healing Touch participants meditated for 10 minutes per day during the intention window, while the “Reiki” practitioners were free to meditate for the time they felt reasonable. “Reiki” practitioners were instructed to register the time spent in meditation; a mean meditation time of 15 minutes was achieved, with a minimum of 2 minutes and a maximum of 45 minutes.

At 14:00 hours GMT, OP1 entered Lab1 to collect the flasks with the water and placed them in a box immediately delivered to operator 2 (OP2). Then, OP2 transported the water samples by car from the Faculty of Engineering (FEUP) to the Raman lab at the Institute of Material Physics - Department of Physics and Astronomy - Faculty of Sciences (approximately a 30-minute drive). OP2 performed Raman spectroscopy, pH, and electrical conductivity measurements. The following day, the samples were transported back to FEUP to perform pH and electrical conductivity countermeasures. The described protocol was repeated each day of the experimental period. At the end of the study, the collected data were delivered to the principal researcher.

In addition to the measurements made from the 8th to the 11th of September 2015, magnetic field strength, radiation, and real-time pH measurements were taken on control days. On those days, the laboratory conditions, the experimental spot arrangement, procedures, and timings were kept the same, differing only in the absence of intention between 13:00 and 14:00 hours GMT.

5.3.2 Instrumentation and data collection

Variables such as magnetic field strength, ultraviolet and visible radiation (UV-VIS wavelength range - 175 to 954 nm), and real-time pH of the target water samples were measured by equipment set to continuous acquisition during the experimental period each day. Magnetic field strength was measured in the 0.32 mT range with a resolution of 0.0002 mT with a Vernier Magnetic Field Sensor using a Hall-effect transducer connected to a Vernier LabPro interface. Data were collected using the Logger Pro 3.8.4 software. A ScanSpec UV-VIS spectrometer from Sarspec, equipped with a Sony ILX511 linear charge-

coupled device (CCD) array of 2048 pixels and an entrance aperture of 50 μm, was used to measure the radiation spectra between 175 and 954 nm. Real-time pH was measured using a JUMO ecoLine glass pH electrode, with a ceramic diaphragm in the glass shaft, connected to a Hanna Instruments 209 pH Meter equipped with a proportional DC analog output. The signal was collected by a NI DAQ card USB-6008 with 12-bit resolution and analyzed with a virtual interface programmed in LabVIEW 8.2 from National Instruments.

Momentary pH and electrical conductivity measurements were performed for each sample with a HI8424 pH Meter from Hanna Instruments equipped with a HI1230 electrode and a GLP31 Conductimeter from Crison equipped with a 5293 conductivity cell. Countermeasures were performed with a Hanna Instruments 209 pH Meter coupled to a glass membrane electrode and a RE 388 TX conductimeter from EDT Instruments equipped with a glass dip cell. The equipment used for countermeasures was checked daily for calibration using standard buffers.

Unpolarised Raman spectra were obtained at room temperature, with a spectral slit width better than 1.5 cm^{-1} in the 1300-3900 cm^{-1} spectral range. The excitation was ensured by a 514 nm line of an argon laser with a power of 1.6 W. The conditions were kept constant for all scattering measurements. The scattered light was analyzed by a T64000 Jobin-Yvon triple spectrometer operating in triple subtractive mode and equipped with liquid nitrogen-cooled CCD. Data were collected and analyzed using LabSpec5 software.

5.3.3 Statistical analysis

Pearson's correlation analyses and t-tests for independent samples were performed with Statistica for Windows release 7.0 to detect the relationships between variables and evaluate the observed differences' statistical significance.

5.4 Results and discussion

The detected changes in the magnetic field strength and radiation measured near the experimental spot coincided with the experimental period's activities. The magnetic field strength profiles for each experimental day and the day before the beginning of the study are shown in Figure 5.2. From the 7th to the 28th of September, mean values per day were calculated and plotted in Figure 5.3.

An increase in the magnetic field strength was observed immediately after the first day. Specifically, on the 7th of September (CD0), the day before the first experimental day, the mean value was 0.0336 ± 0.0004 mT; the value increased to a maximum of 0.03644 ±

0.0005 mT on the 9th of September, followed by a slight decrease and remained constant until the 15th of September. The second part of this study was conducted under specific conditions between the 15th and 24th of September (data not shown). This time and data gap are represented by the dashed vertical lines in Figure 5.3. From the 24th of September, the magnetic field strength decreased to 0.0338 ± 0.0003 mT. With the beginning of educational activities in the lab, the experimental conditions were compromised, and no further measurements were possible. Nonetheless, from the 30th of October to the 6th of November, we performed new measurements during a period of inactivity and found a mean magnetic field strength of 0.0339 ± 0.0005 mT, similar to the values obtained at the beginning of the study.

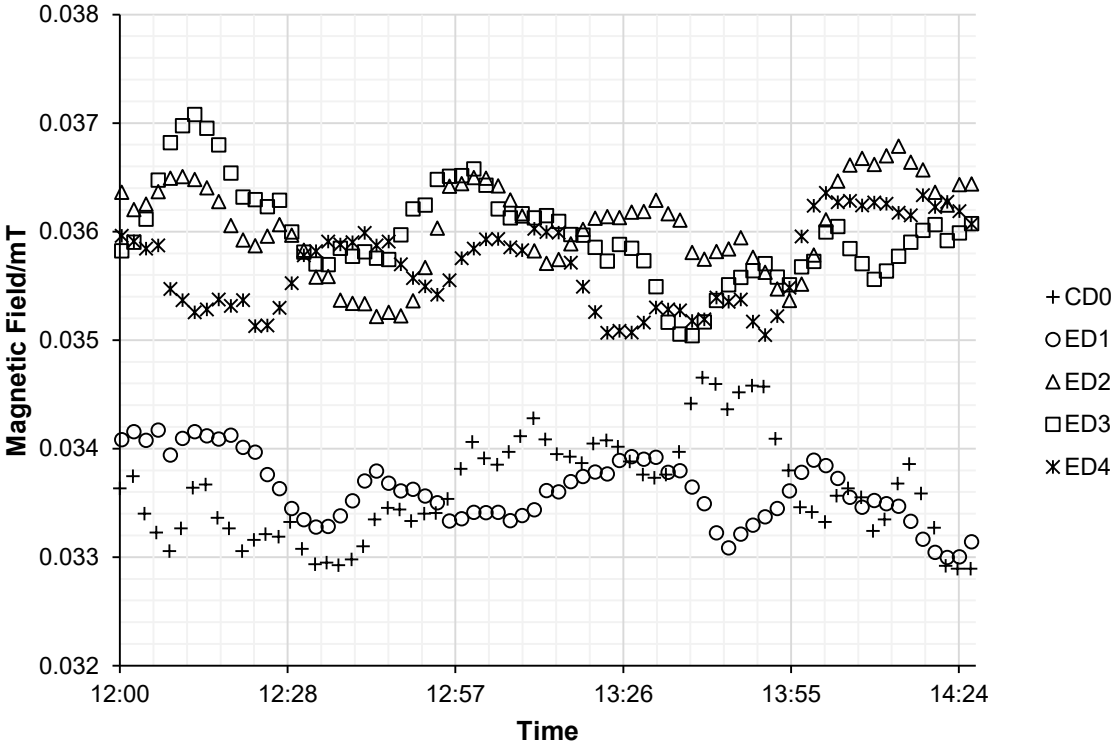

Figure 5.2. Magnetic field strength near the experimental spot during the experimental week.

None of the 286 practitioners was in the laboratory's vicinity during the experimental activities. Additionally, none knew that magnetic field strength would be one of the studied variables. Because the magnetometer and probe were kept in the same position during all experiments and no inductive equipment was working nearby, we cannot point to a clear explanation for this kind of change and correlations.

According to William A. Tiller, Professor Emeritus from the Department of Material Sciences and Engineering at the University of Stanford, laboratory space can become changed or "conditioned" when submitted to a continuous intentional stimulus. Tiller and his

colleagues claim that the fundamental symmetry state of the space can be altered by activating the indwelling-consciousness of that space to a higher level of physical reality, thus changing the electromagnetic gauge symmetry state of the experimental space, which in turn allows human intention to change the properties of materials significantly [45, 50, 54-58]. Obviously, this explanation is based on a paradigm-challenging model. In the present experiment, we observed a change in the magnetic field strength that followed a pattern and points to hypothetical conditioning of the laboratory; however, we do not have causal data to support this argument.

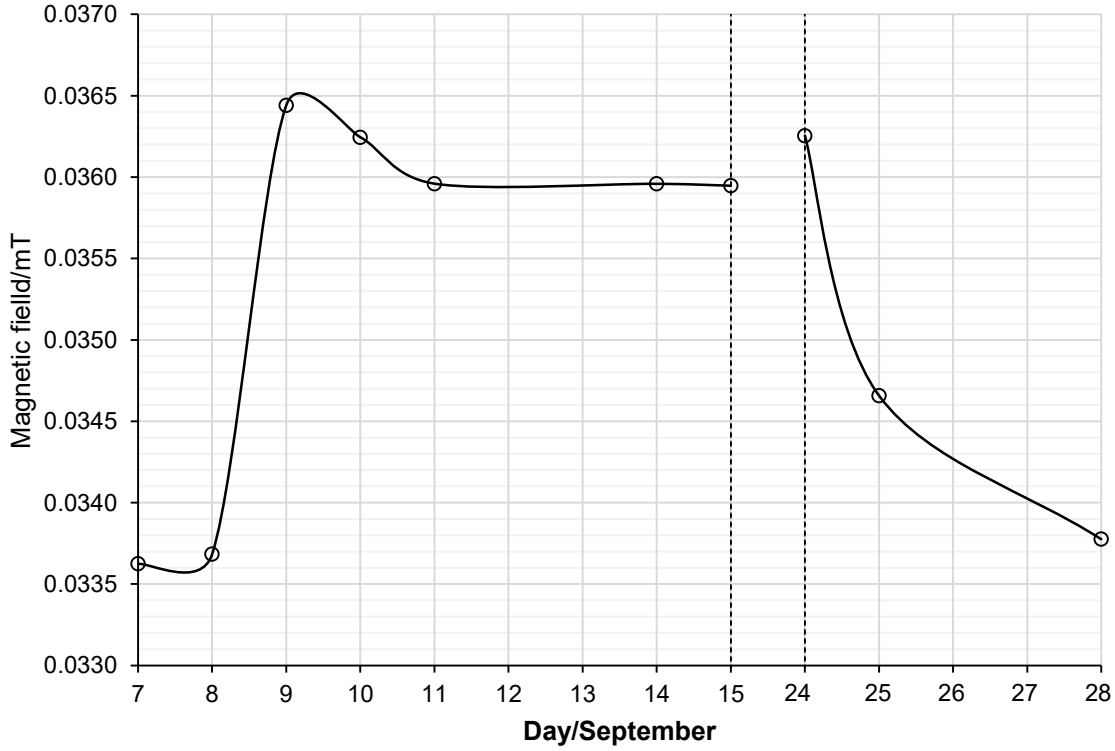

Figure 5.3. Mean magnetic field strength recorded from 7 to 28 of September.

A spectrometer measuring the spectra between 175 and 954 nm was used to collect the maximum information possible. This equipment was located 10 cm away and pointed toward the experimental spot where the target water samples were placed. The spectra were collected between 11:00 and 16:00 hours GMT with a frequency of one spectrum every 2 minutes. Two critical moments were considered to evaluate any spectral changes during the experiments: between 12:25 and 12:35 hours GMT when the waters samples' photographs were available online, and between 12:55 and 13:05 hours GMT when the "intention window" began. Measurements were taken both during control and experimental days, and the mean values and dispersion of each critical moment were calculated (Table 5.2).

Table 5.2. Intensity mean values and dispersion data of the UV-VIS spectrum in the 1st and 2nd critical moments.

Wavelength Interval (nm)		ED1		ED2		ED3		ED4		CD1		CD2	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
175 – 375	MI	3.3	2.4	2.4	3.2	2.8	2.8	2.2	4.2	2.7	2.7	3.0	2.9
	MD	2.4	2.0	1.6	1.8	1.8	2.3	1.5	2.4	1.6	1.4	1.8	1.9
	MaxD	3.4	3.7	2.7	3.1	3.0	3.3	2.2	3.4	2.4	2.3	3.0	2.7
	MinD	1.6	1.2	0.6	0.8	1.1	1.6	0.6	0.9	0.9	0.5	1.1	0.9
375 – 575	MI	16.5	15.8	13.0	11.0	14.8	11.0	14.9	16.3	15.6	15.5	13.9	14.5
	MD	2.7	8.2	2.2	4.6	3.1	6.3	3.3	6.8	1.8	2.6	2.7	2.6
	MaxD	3.8	11.3	3.8	6.9	4.7	8.7	4.8	9.5	2.7	3.5	3.8	3.3
	MinD	1.7	3.7	0.9	2.1	1.9	3.4	2.1	2.6	0.9	1.4	1.8	1.8
575 – 775	MI	4.8	4.6	7.6	5.0	4.4	4.6	4.2	6.5	5.3	4.6	5.3	3.4
	MD	4.0	3.7	3.3	4.7	2.4	4.3	2.5	2.8	2.4	2.9	3.2	2.9
	MaxD	5.3	5.5	4.1	5.4	5.2	5.6	3.9	5.5	3.5	4.4	4.4	4.6
	MinD	1.6	2.8	2.3	3.1	1.1	2.3	1.6	0.9	1.5	1.8	1.9	1.6
775 – 954	MI	2.0	0.6	1.6	2.3	0.0	2.3	1.5	3.1	1.1	0.6	3.2	1.4
	MD	4.4	3.4	2.5	4.7	3.6	3.0	3.8	3.2	2.5	2.8	3.0	3.2
	MaxD	6.6	5.2	7.3	6.4	8.4	4.5	7.2	5.2	4.9	4.4	4.4	4.7
	MinD	3.2	2.3	1.3	3.1	1.6	2.1	1.9	1.9	1.1	1.2	1.8	1.6

Legend: MI – mean intensity; MD – mean dispersion; MaxD – maximum dispersion; MinD – minimum dispersion.

Figures 5.4 to 5.7 show the mean spectra and dispersion of two control days (CD1 and CD2) and two experimental days (ED1 and ED4). This analysis allowed for evaluating the light scattering properties around the experimental spot. We found a higher frequency of spectral changes with increased intensity during both critical moments on the experimental days. Specifically, this variability was more expressive during the critical moment set between 12:55 and 13:05 hours GMT, when the “intention window” began and during which all practitioners were instructed to meditate with the established intention.

This behavior is easily observed in the wavelength interval of 375-575 nm during the 2nd critical moment by comparing the mean and maximum dispersion values between experimental and control days. Nevertheless, again, because the experimental conditions were kept constant, we do not have a plausible explanation for the changes outside of a hypothetical interference of the equipment or a specific higher instability of the overall light-scattering effects located around the experimental spot.

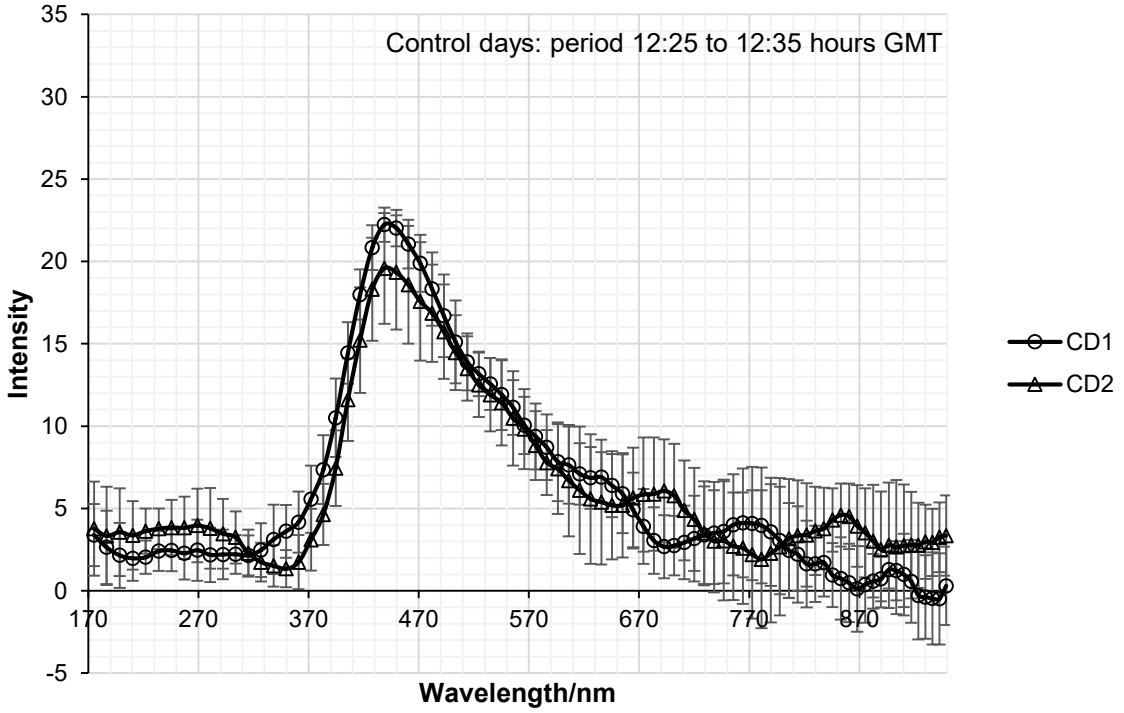

Figure 5.4. Ultraviolet and visible spectrums of the environment near the experimental spot (control days: period 12:25 to 12:35 hours GMT).

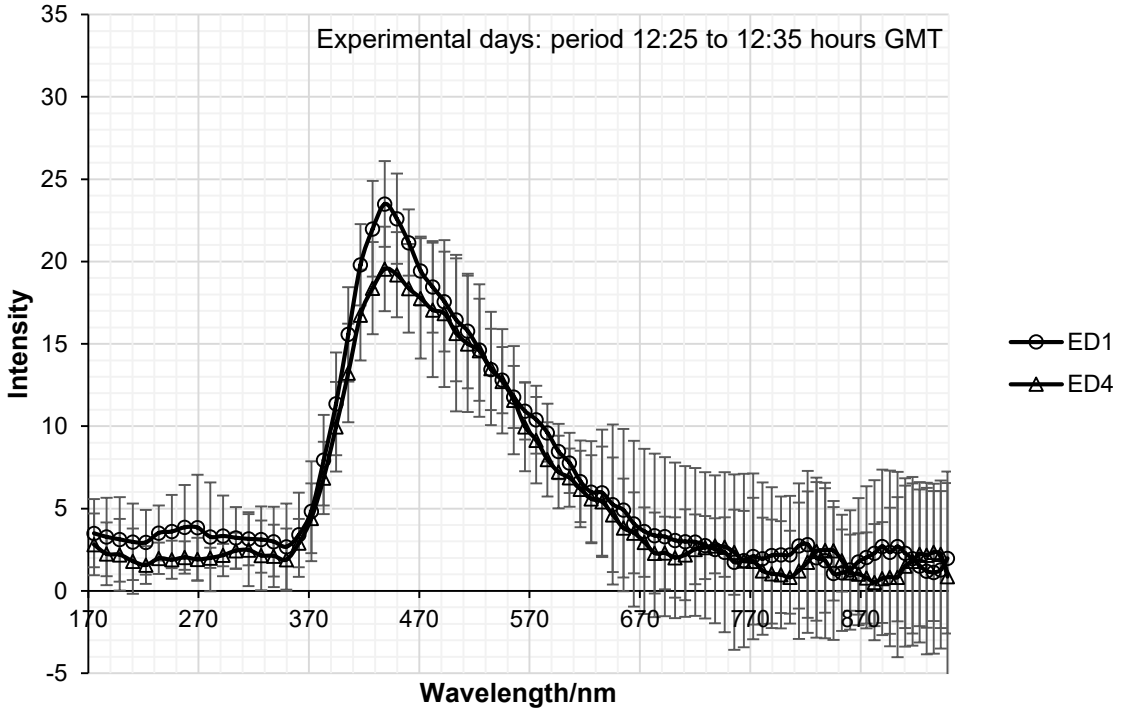

Figure 5.5. Ultraviolet and visible spectrums of the environment near the experimental spot (experimental days: period 12:25 to 12:35 hours GMT).

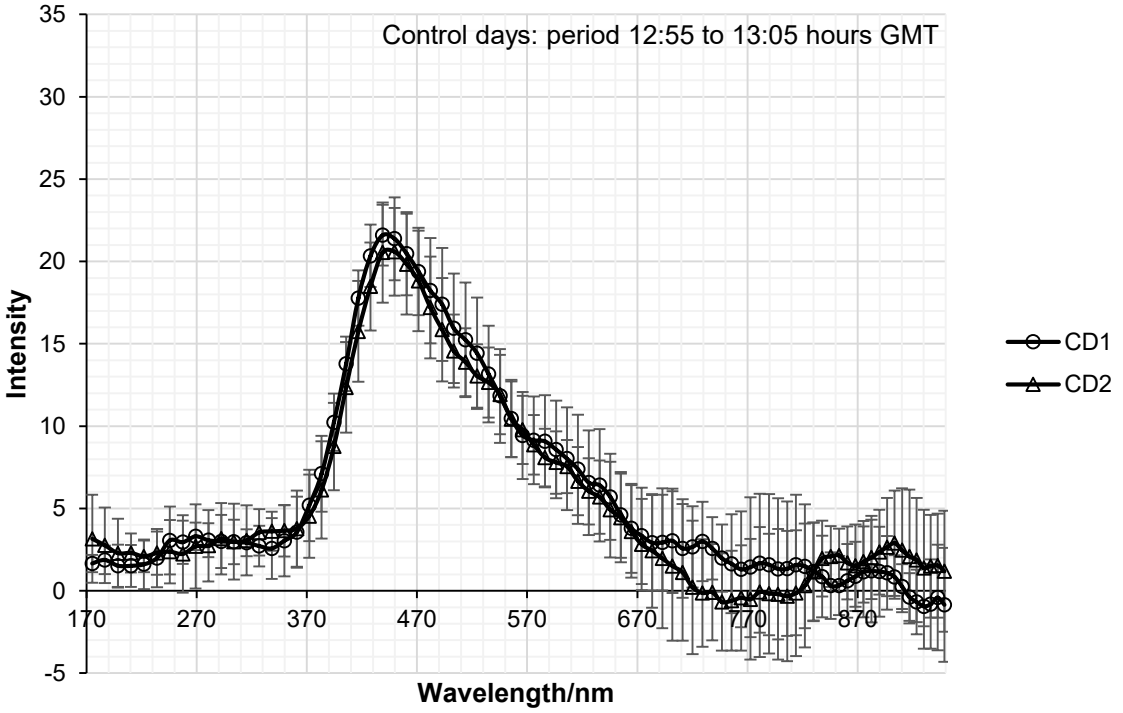

Figure 5.6. Ultraviolet and visible spectrums of the environment near the experimental spot (control days: period 12:55 to 13:05 hours GMT).

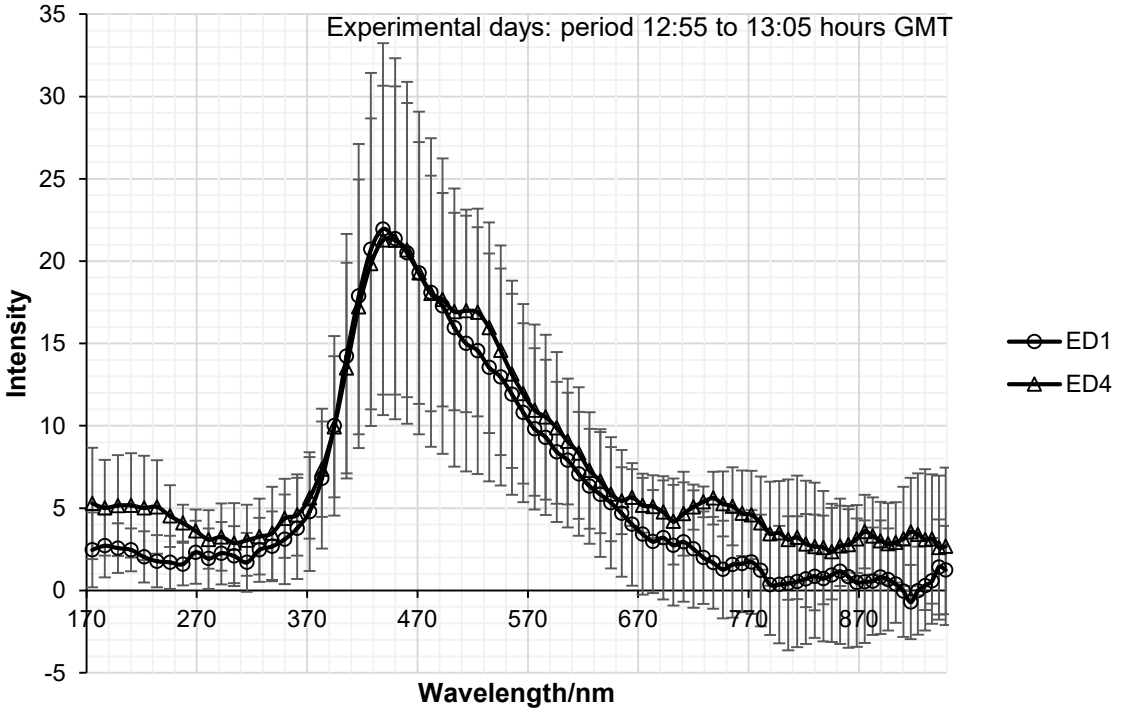

Figure 5.7. Ultraviolet and visible spectrums of the environment near the experimental spot (experimental days: period 12:55 to 13:05 hours GMT).

The sensitivity of pH to intention has been reported by other authors [45, 50, 54-57]. We used a real-time data acquisition system tested for sensitivity and stability during long periods and, therefore, able to detect any eventual changes during the experiments. We found that the instability mentioned above and the relationship with both critical moments was also noticed using real-time pH measurements. Figure 5.8 shows the pH profiles on three experimental days (ED1 – data not shown). On ED2, the pH remained stable until 13:00 GMT; from this point on, we noticed an increase followed by shifts in the tendency, reaching a higher value around 14:00 GMT. Similar results were observed on the other days. After 12:30 GMT, we detected a slight variability in all profiles that were evident on ED4. All the involved practitioners were instructed to meditate during the "intention window", as this was set as a premise during the enrollment process. Nevertheless, because the practitioners could see the target at 12:30 GMT, we cannot guarantee that some may have started the intention earlier.

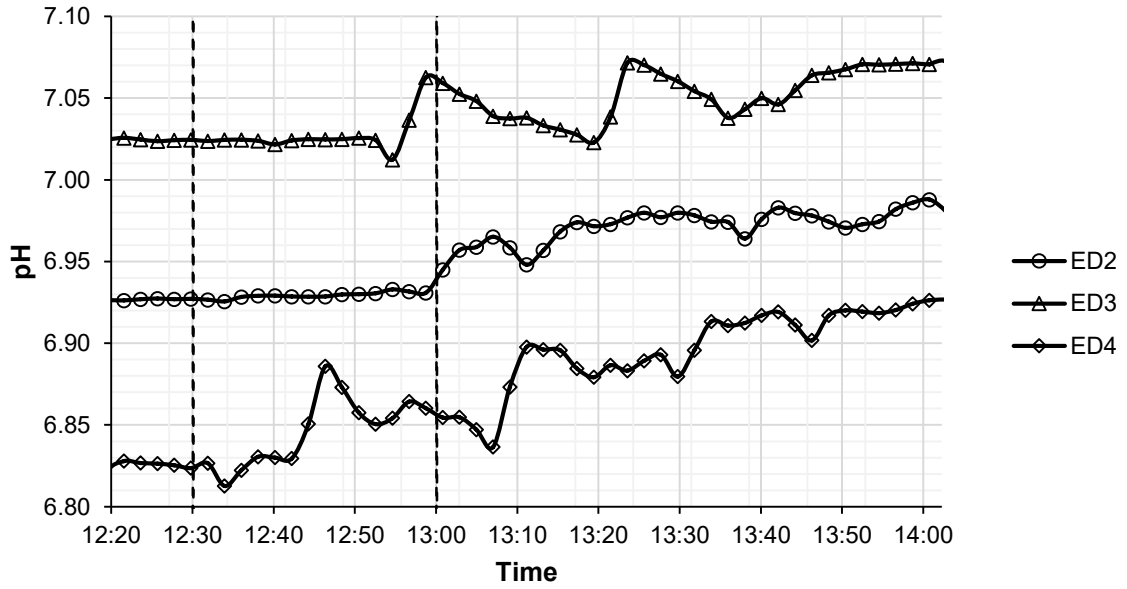

Figure 5.8. Real-time pH of the targeted water during the experiments.

Both pH and electrical conductivity measurements were performed before Raman spectroscopy. The measurements were made under adequate stirring conditions and automatic temperature compensation. A stable pH value should be obtained under normal conditions when the electrolyte-electrode system achieves the equilibrium electrochemical potential. In our work, OP2 reported difficulties during pH measurements, with statements such as: "I did not understand why but in some samples the pH shoots to high values and then decreased… I thought that the pH meter had a malfunction". This is visible in Table 5.3 regarding the pH mean values and dispersion of the target water samples. Target water

samples presented higher pH values and higher variability during these measurements, suggesting a higher electrode sensitivity in those samples. Although we cannot point to any reasonable explanation for these differential changes, some authors suggest that such an increase in pH could be related to a higher level of thermodynamic free energy [59].

Statistical methods were used to analyze our results, taking into account probability and the potential for statistically significant results related to chance alone. Statistically significant changes in pH were observed on ED1 (A vs C, p = 0.0011), ED2 (A vs B, p = 0.0220), and ED4 (A vs C, p = 0.0280 and B vs C, p = 0.0017). Although the average electrical conductivity of the target water samples tended to be higher than the electrical conductivity of each control, those differences were not statistically significant. Nevertheless, with the exception of ED2, these changes were statistically correlated with pH changes, as follows: ED1, r = 0.56, p = 0.039; ED3, r = 0.48, p = 0.009; and ED4, r = 0.60, p = 0.001. On these days, an increase in pH was directly related to an increase in the electrical conductivity. As shown in Table 5.3, countermeasures confirmed blinded measurements and, in the majority of cases, were positively correlated as follows: ED1, pH, r = 0.73, p = 0.003; ED2, electrical conductivity, r = 0.48, p = 0.010; ED3, pH, r = 0.45, p = 0.015 and electrical conductivity, r = 0.42, p = 0.022; and ED4, pH, r = 0.43, p = 0.019.
Although we cannot pinpoint a direct cause for the apparent differences, we can hypothetically relate these changes with variables that were also responsive during the experiments, such as the magnetic field strength. Research has shown that electric and magnetic fields have opposite effects over hydrogen-bonded clusters of water. Suppose electromagnetic fields, even shallow ones, weaken water clustering by reducing the amount of hydrogen bonding and strength, acting as a “disorder-maker” and encouraging reactivity in chemical processes [60]. In that case, static magnetic fields may seem to strengthen hydrogen bonding, promoting structural coherence [61-63]. On the other hand, even tiny magnetic and electromagnetic fields may affect gas solubility in water, perturbing the gas/liquid interface and producing reactive oxygen species [64]. Changes in hydrogen bonding may also affect carbon dioxide hydration resulting in pH changes [65] or even promote the gradual decrease of electrical resistivity [66].

Table 5.3. The water's pH and electrical conductivity (mS·cm-1) at 25 ºC (blinded measurements and * countermeasures).

	ED1		ED2		ED3		ED4	
	pH	**Conductivity**	**pH**	**Conductivity**	**pH**	**Conductivity**	**pH**	**Conductivity**
A	7.27 ± 0.12	27.65 ± 0.13	7.09 ± 0.07	27.11 ± 0.54	7.12 ± 0.02	27.59 ± 0.13	7.20 ± 0.08	27.44 ± 0.30
A*	7.26 ± 0.03	26.85 ± 0.24	7.11 ± 0.04	27.36 ± 0.26	7.08 ± 0.02	27.57 ± 0.53	7.15 ± 0.06	28.16 ± 0.55
B	7.03 ± 0.17	27.54 ± 0.11	7.03 ± 0.05	27.23 ± 0.53	7.17 ± 0.08	27.56 ± 0.18	6.98 ± 0.08	27.14 ± 0.42
B*	7.00 ± 0.02	26.74 ± 0.15	7.07 ± 0.02	27.45 ± 0.55	7.14 ± 0.07	27.99 ± 0.50	7.06 ± 0.02	27.83 ± 0.43
C	6.90 ± 0.11	27.50 ± 0.10	7.03 ± 0.14	27.51 ± 0.27	7.10 ± 0.08	27.47 ± 0.33	7.11 ± 0.08	27.36 ± 0.34
C*	6.90 ± 0.01	26.64 ± 0.21	7.15 ± 0.04	28.42 ± 0.97	7.12 ± 0.04	27.53 ± 0.45	7.14 ± 0.06	27.78 ± 0.48

We also used Raman scattering spectroscopy as a tool to assess hypothetical changes in the molecular structure of the water samples. This technique relies on detecting inelastically scattered light with an origin in the molecular optical vibrations. The frequency and profile of Raman bands are highly specific to both molecular structure and normal vibrations of the chemical species [67]. In a standard Raman spectrum, the main double-peak can easily be found in the range of 2900-3700 cm^{-1}, known as the OH stretching band, and a smaller, broader band around 1640 cm^{-1} related to the OH bending mode. Usually, the mode around 3200 cm^{-1} is related to strongly hydrogen-bonded water molecules and the mode around 3400 cm^{-1} with loosely bonded ones [68]. These two bands are thought to reflect the dynamic microstructure of water and its interactions with solutes, polymers, or biological molecules [69]. The dynamic equilibrium of water involves changing the proportions of different oligomers and polymer species. This cluster structuring process is sensitive to temperature, pressure, composition, magnetic and electric fields, and, as referred to by others, the “subtle energies” of biofield therapies [70].

As shown in Figures 5.9 to 5.12, all of the Raman spectra presented the dominant bands related to the vibrational modes known as bending and stretching, and those were coincident with frequencies typically described in the literature. Nevertheless, we noticed different absolute intensities, with a higher expression in the double-peaked OH stretching band. Except on ED2, target water samples presented the highest values. On those days, the intensity followed a specific pattern described as follows, from the highest to the lowest: target water > water around target > control water. Even though the described pattern, discarding the hypothesis of polarization and changes in the concentration, shifts in absolute intensities are often related to the laser’s source stability and temperature changes. Thus, to counter these limitations, we decided to evaluate the results considering the relative intensities between the two dominant modes of the OH stretching band.

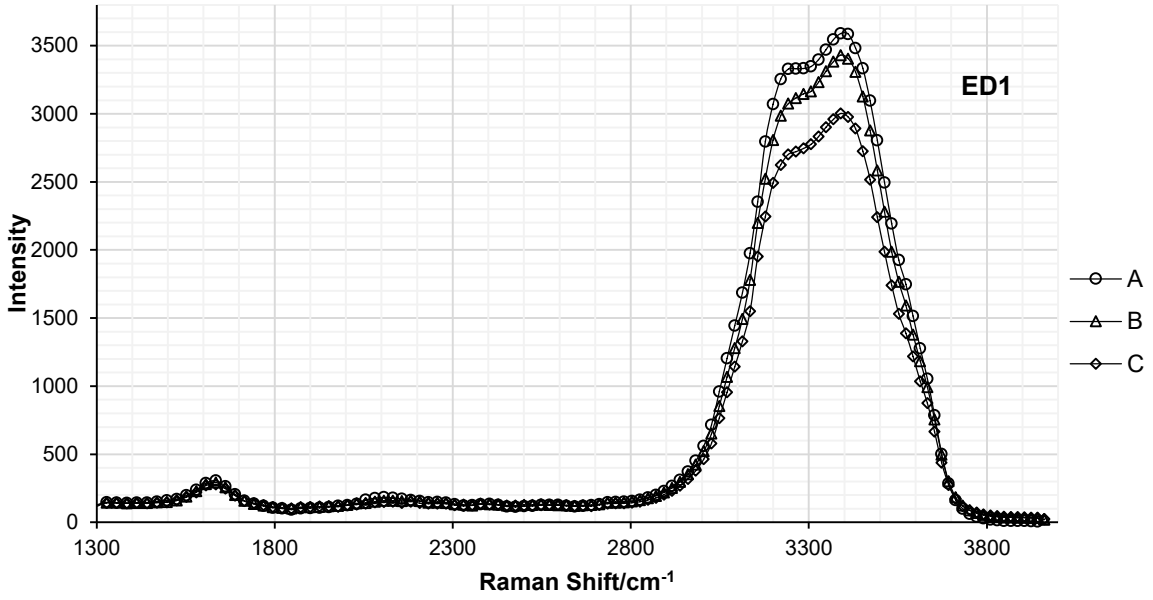

Figure 5.9. Raman spectra of the water in experimental day one (ED1).

As previously mentioned, we focused our attention on the dominant OH stretching band to evaluate any eventual change that could be related to a shift in the water structure. Peak deconvolution was performed using the Lorentzian and Gaussian functions for two peaks centered at 3230 and 3440 cm^{-1} (an example of this procedure is shown in Figures 5.13 and 5.14). The Solver function was used as an optimization method to find the minimum fitting error between the set of experimental data and the proposed model. This procedure allowed us to find the optimal width of the two peaks within the OH stretching band.

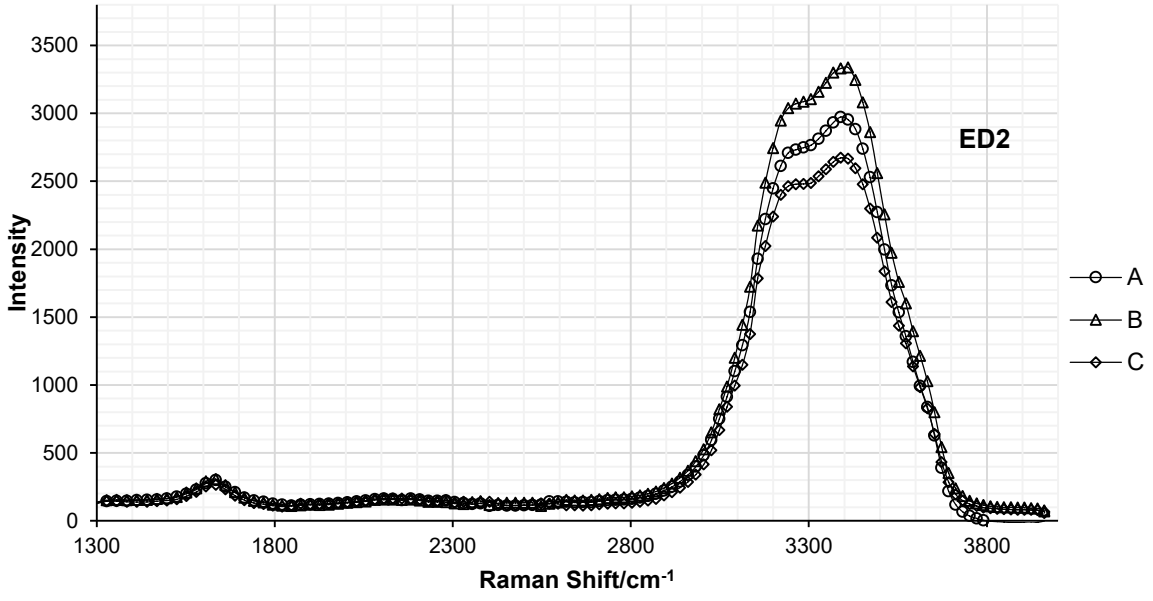

Figure 5.10. Raman spectra of the water in experimental day two (ED2).

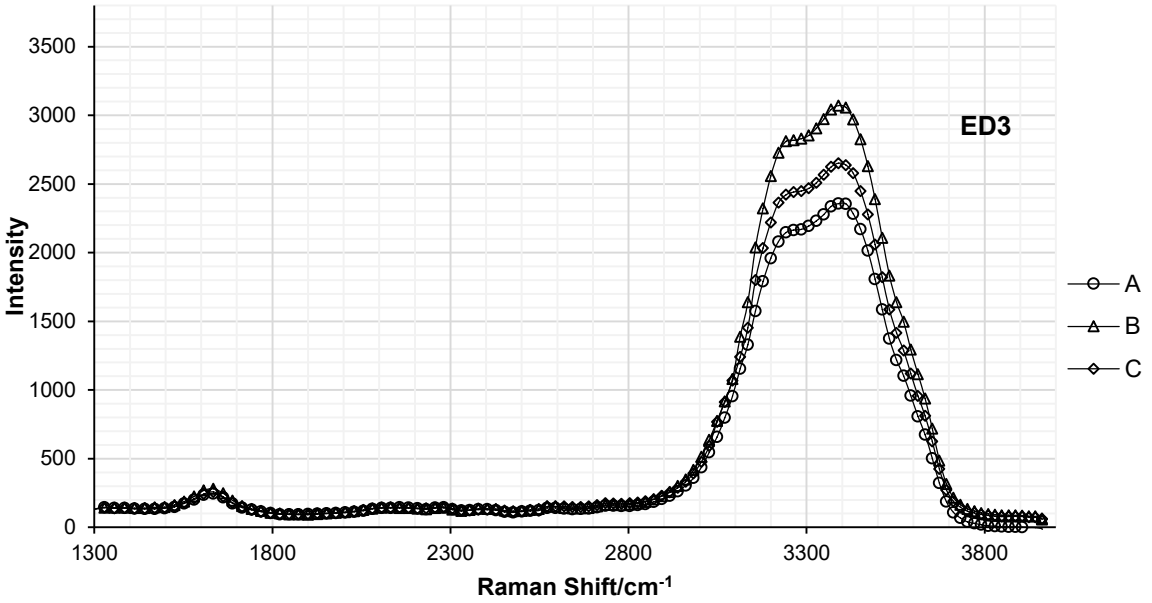

Figure 5.11. Raman spectra of the water in experimental day three (ED3).

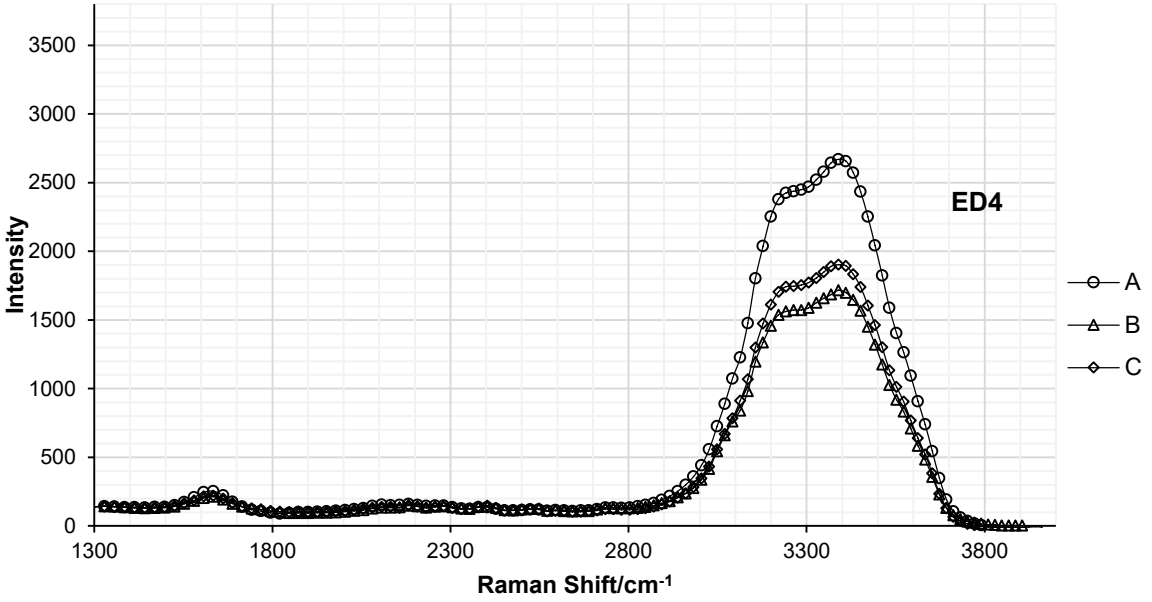

Figure 5.12. Raman spectra of the water in experimental day four (ED4).

Both models provided similar results yielding minor fitting errors and high Pearson's correlation coefficients. Bands 1 and 2 for each model and sample were numerically integrated with the trapezoidal rule, and the ratios were calculated and compared (Table 5.4).

Although slight differences in the intensity ratios were observable on ED1, ED2, and ED3, these were not statistically significant. Nevertheless, on ED4, we found significant differences ($p < 0.05$) between the control and target water samples (deconvolution with the

Lorentzian model) and between the control and both the target and around the target water samples (deconvolution with the Gaussian model).

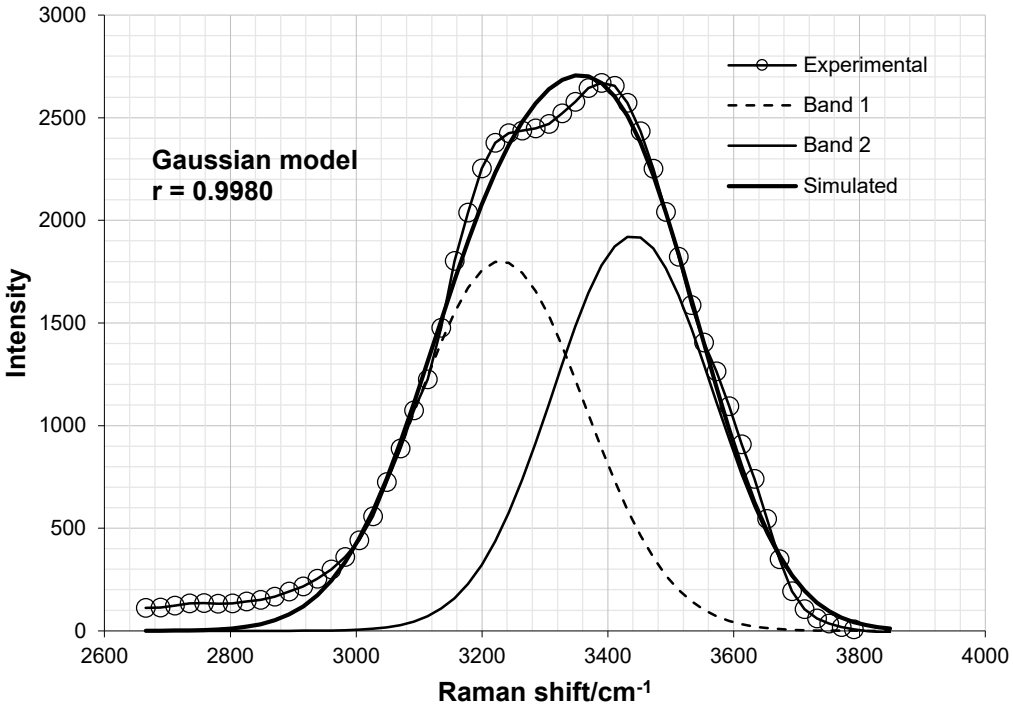

Figure 5.13. Peak deconvolution using the Gaussian model of the OH stretching band (target water [A] on the ED4).

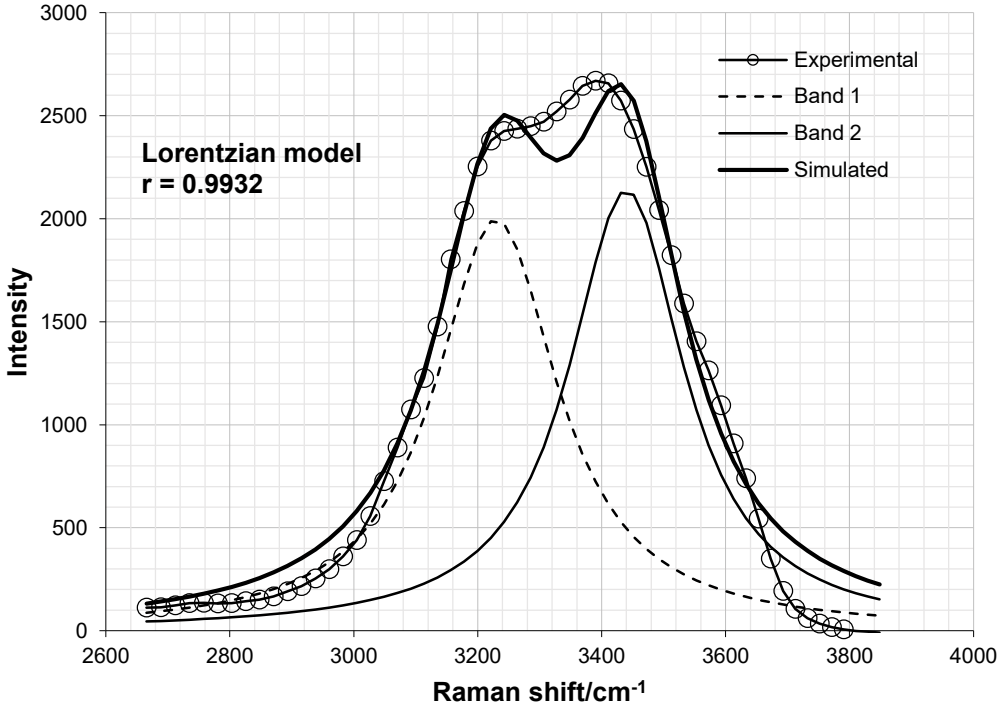

Figure 5.14. Peak deconvolution using the Lorentzian model of the OH stretching band (target water [A] on the ED4).

Table 5.4. Peak area ratios on the double-peaked OH stretching band (Lorentzian and Gaussian models).

Peak area ratio	Experimental Day	Water sample					
		A	A*	B	B*	C	C*
$\frac{\int I_{band1}}{\int I_{band2}}$	ED1	0.93 ± 0.05	0.93 ± 0.05	0.90 ± 0.05	0.89 ± 0.01	0.92 ± 0.00	0.92 ± 0.00
	ED2	0.95 ± 0.24	0.95 ± 0.24	0.89 ± 0.05	0.88 ± 0.06	0.88 ± 0.05	0.88 ± 0.05
	ED3	1.05 ± 0.09	1.05 ± 0.10	0.87 ± 0.04	0.87 ± 0.03	0.95 ± 0.05	0.96 ± 0.05
	ED4	0.99 ± 0.02	0.99 ± 0.03	1.11 ± 0.02	1.14 ± 0.01	1.06 ± 0.02	1.07 ± 0.02

5.5 Conclusions

In science, the results of a study often generate more questions than answers. Our findings are an excellent example of this statement. Although other researchers have studied the phenomenon of intention, the mechanisms behind the most reported outcomes are still unclear or unknown. In our work, we cannot further explain such interactions but only report that the measurements' results and the combined analysis of the variables point to changes that coincided with specific moments of the experimental period. Given that coincidence does not equate with causality, we can offer no conclusive explanation for the observed changes. Nonetheless, the questions regarding the effects of intention remain relevant and warrant more research.

We can also suppose that this phenomenon, if confirmed, could hypothetically affect neighboring targets. Thus, considering a hypothetical scenario in which a person asks for a "distant healing intervention", we do not know if the effects could affect other persons sharing the same space unaware of what is going on. This might raise some ethical issues regarding "distant healing interventions".

The time dependence of the eventual effects is also of importance. How long are the changes measurable? Is there any proportional decreasing tendency in the changes as a function of time? Shelf-time experiments should be done to clarify this issue.

Finally, we are aware of the difficulties to reproduce the study, given that it is complicated, if not impossible, to recruit the same 286 practitioners and ensure the same conditions. Moreover, this high number of participants was based on availability rather than on the knowledge of any proportional effects. Therefore, further studies must be conducted to clarify if effects are dependent on the number of practitioners, their levels of expertise, or the duration of the meditation time.

5.6 References

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Chapter 6. Can measurements be physically conditioned by thought? Further observations following a focused intention experiment

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6.1 Abstract

Background: Biofield is a controversial concept among the scientific community. Some aspects of this phenomenon relate to measurable factors of mainstream science, such as electromagnetics. In contrast, others, involving nonlocal interventions, intention, and consciousness, seem to produce physical changes through mechanisms that are still unknown, making the outcomes of many studies not fully explained by our current state of scientific understanding. The present study explored the hypothetical effects of intention on conditioning a pH system with continuous data acquisition for real-time measurements. As a follow-up study, those effects were related to changes in the physicochemical properties of water samples chosen as a target in a previous large-scale intervention of focused intention. **Methods**: The intention experiments were conducted under controlled conditions from the 8th to the 11th of September 2015. During this period, 286 qualified biofield therapy practitioners meditated at a distance with the intention of changing the vibrational state of the water molecules contained in specific flasks. Several variables were evaluated, including the magnetic field and UV-VIS radiation from 175 to 954 nm near the experimental spot, Raman spectra, pH, and electrical conductivity of all the water samples. After this period, real-time pH measurements of water samples were taken with the same equipment and under the same experimental conditions, except for the practitioners' awareness of those experiments, without their focused intention. Real-time pH, electrical conductivity, and the concentration of cations and anions measured by ion chromatography in the water samples were used to test the proposed hypothesis. **Results**: Real-time pH was responsive during the intention experiments and after this period. Further continuous measurements after the 11th of September showed that the pH variations over time kept a systematic and consistent tendency similar to those observed during the experimental activities involving focused intention. After the electrode internal electrolyte replacement, this behavior was no

longer verified, and the pH was stable as the initial tests to evaluate the equipment sensitivity. **Conclusions**: After the experimental period involving focused intention, the pH system maintained a systematic and consistent behavior while measuring the pH of new water samples. An eventual intention-mediated conditioning of the pH measurement system might hypothetically have occurred because of changes in the properties of the electrode internal electrolyte.

6.2 Introduction

Energy medicine modalities have been categorized in the United States using two main classes: the veritable, which must be measurable using conventional technology, and the putative or subtle, which have not been definitively scientifically measured [1-3]. This classification is no longer included on the website of the National Center for Complementary and Integrative Health (NCCIH); however, its foundation considers that external “Qigong”, Healing Touch, and “Reiki”, which are known as traditional healing modalities, are all based on the concept that human beings are infused with a subtle form of energy, often referred to as the biofield [4, 5]. Despite the common use of this term, the biofield’s physical nature remains uncertain. Some researchers claim that the phenomenon could be related to mainstream science-based factors such as electromagnetic [6-15], acoustic, and thermal-related effects [16-20], while others point toward subtle energy fields that, hypothetically, seem to generate physically measurable changes and may be related to physiological aspects of homeostasis [20-27].

The controversy around this subject is considerable as there is no consensus regarding the mechanisms through which these practices seem to have measurable effects on physical reality, as these effects often appear to act in a manner described as nonlocal [28-32]. The eventual involvement of altered states of consciousness [22, 33] has been suggested as a process in which imagination and the use of intention seem to trigger changes in the physical reality, affecting inanimate objects and living things, from unicellular organisms to human beings [30, 34-37]. Nevertheless, several studies have produced astonishing results [38-43], defying conventional scientific concepts and contravening the materialistic view of human existence [11, 30, 44, 45].

The sensitivity of pH to intention has been reported by other authors [46-51]. Among them is William A. Tiller, who has devoted much of his research to this subject, suggesting science-based models in which matter, energy, and aspects of consciousness could be involved and may be able to induce physical effects. Tiller and his colleagues claim that the fundamental symmetry state of a space can be changed by activating the indwelling-consciousness of that space to a higher level of physical reality. This might alter the

electromagnetic gauge symmetry state, which allows human intention to significantly change the properties of materials [46-52].

The main goal of this study was to verify the hypothetical physical conditioning of a pH measurement system used in a previous large-scale study of focused intention [53] by measuring the real-time pH of new water samples, without the practitioners' awareness of those experiments and without their intention of affecting the target. This study considered the hypothesis that the pH measurement system became physically conditioned after the focused intention experiment, maintaining a systematic measuring behavior after that experimental period. Therefore, to test the hypothesis mentioned above, which, if confirmed, would generate a measuring tendency, real-time pH profiles were compared on different regular days, i.e., without the focused intention procedure. In addition, the system´s behavior was evaluated considering the changes in the physicochemical properties of water samples chosen as a target in that study.

6.3 Materials and methods

6.3.1 Study design

The present work is a follow-up study to verify if a pH measurement system used in a previous trial of focused intention became physically conditioned after that experiment [53]. The findings reported in this manuscript are concerned with further sequential measurements of real-time pH and electrical conductivity of new water samples from the same source used in that study. These control samples were tested with the same equipment under the same laboratory conditions; however, they were not submitted to focused intention. The water was poured into single-use 60 mL sterilized flasks, and the pH electrode was vertically inserted. The data were saved over time. Besides the real-time pH and electrical conductivity, the present study considered the concentration of cations and anions measured by ion chromatography in the water samples selected for real-time pH measurements during the period of focused intention.

Because some of the results analyzed in this paper deal with the experimental activities involving focused intention [53], that study's design will be described below.

From the 8th to the 11th of September 2015 (experimental day 1 to experimental day 4, ED1 to ED4), 286 qualified biofield therapy practitioners affiliated with two non-profit organizations, Healing Touch International, Inc. (dba Healing Beyond Borders) and the Portuguese Association of Reiki, were instructed to meditate with a well-defined intention. During a daily scheduled "intention window" set between 13:00 and 14:00 hours GMT, each enrolled practitioner had access to a photograph published online of the target water

sample. Below the photograph, the intention was written as follows: “to change the vibrational state of the water molecules contained in the flasks marked with the character… placed in the lab…, FEUP, Portugal”. This intention was based on an idea commonly understood among the practitioners enrolled in this study as an act of “energizing the water”, allowing the imagination of molecular movement or structure dynamics.

To set the target and take a photograph daily, a blinded operator unaware of the study goals and without any knowledge of biofield therapy practices entered the restricted access laboratory to fill the single-use 60 mL sterilized flasks with commercial purified water and randomly chose a character from “A” to “C” to set as the target water samples. A total of 30 flasks were prepared, 10 for each character, representing flasks with target water, flasks with water around the target aimed to verify whether the intention was selective, and flasks with control water that were placed 15 meters away from the target. A photograph of the 20 flasks (target and surrounding water samples) distributed in the experimental spot was taken. Afterwards, the technician randomly inserted a pH electrode in one of the ten selected flasks of the target water, which remained in place during the “intention window”, as displayed in Table 6.1 (ED1 data not shown).

Table 6.1. Random choice of target and flask with the pH electrode.

Experimental day	Target	Flask with electrode
ED2	C	C2
ED3	B	B4
ED4	A	A2

Because the electrode was connected to a data acquisition system, the pH of the sample was continuously monitored during the period of focused intention (“intention window”). This system was previously tested to detect minimal changes and ensure signal stability during long periods. The real-time pH measurements aimed to detect patterns of variation. The device resistance conditions were kept constant by not adjusting the slope and offset potentiometers. Further momentary pH measurements were taken with other equipment to know the exact pH value of all samples.

In addition to real-time pH measurements of the target water samples, other variables were evaluated, including the magnetic field and UV-VIS radiation from 175 to 954 nm near the experimental spot and Raman spectra, pH, and electrical conductivity of all the water samples.

6.3.2 Instrumentation and data collection

Real-time pH was measured using a JUMO ecoLine glass membrane electrode, with a ceramic diaphragm in the glass shaft, connected to a Hanna Instruments 209 pH Meter equipped with a proportional DC analog output. The signal was collected using a NI DAQ card USB-6008 with 12-bit resolution and analyzed with a virtual interface programmed in LabVIEW 8.2 from National Instruments. In addition, momentary electrical conductivity measurements were performed using a GLP31 Conductimeter from Crison equipped with a 5293 conductivity cell.

Fluoride (F^-), chloride (Cl^-), nitrite (NO_2^-), sulfate (SO_4^{2-}), bromide (Br^-), nitrate (NO_3^-), and phosphate (PO_4^{3-}) were quantified by ion chromatography using a Dionex ICS-2100 apparatus equipped with an IonPac® AS11-HC (4 × 250 mm) column at 30 ºC and an anion self-regenerating suppressor (ASRS® 300, 4 mm), under isocratic elution of 30 mM NaOH at a flow rate of 1.5 mL·min^{-1} for 12 minutes. Sodium (Na^+), ammonium (NH_4^+), potassium (K^+), magnesium (Mg^{2+}), and calcium (Ca^{2+}) were determined by ion chromatography using a Dionex DX-120 device equipped with an IonPac® CS12A (4 × 250 mm) column at ambient temperature and a cation self-regenerating (CSRS® Ultra II, 4 mm) suppressor, under isocratic elution of 20 mM methane sulfonic acid at a flow rate of 1.0 mL·min^{-1} for 12 minutes. All samples were filtered through a 0.45 mm Nylon membrane filter before analysis.

6.3.3 Statistical analysis

Pearson's correlation analysis and t-tests for independent samples were performed to detect relationships between variables and evaluate the statistical significance level. In addition, one-Way ANOVA was used to evaluate the differences between means by comparing the variances of each real-time pH run. The normalized pH profiles as a function of normalized time were used in this analysis. All statistical methods were performed with the software Statistica for Windows release 7.0.

6.4 Results

The main objective of this study was to verify if a pH measurement system used in a previous large-scale study of focused intention became physically conditioned by measuring the real-time pH of new water samples, without the practitioners' awareness of those experiments and without their intention of affecting the target.

This work considered the electrical conductivity and ionic composition of water samples placed at the experimental spot during the intention experiments and the electrical conductivity and pH profiles of new water samples measured after the 11th of September 2015. After further continuous real-time pH measurements, the research team observed a systematic, unusual, and consistent result regarding the pH measurement system. The consistency of these results led us to suspect and report the eventual conditioning of the pH measurement system, coincident, by proximity, with the period of focused intention experiments.

Under normal conditions, a stable pH value should be obtained when the electrolyte-electrode system achieves the equilibrium electrochemical potential. Thus, according to the H^+ concentration in the sample, the system reacts until equilibrium is reached. During the intention experiments conducted from the 8th to the 11th of September 2015, the changes in the pH of the water samples were positively correlated with changes in the electrical conductivity. Additionally, systematic shifts in the real-time pH tendencies were also observed and coincided with two critical moments: the online publication of the target photograph at 12:30 hours GMT and the beginning of the “intention window” at 13:00 hours GMT (both local time in Portugal). A second blinded operator performed electrical conductivity measurements under adequate stirring conditions and automatic temperature compensation (Table 6.2).

Table 6.2. Electrical conductivity (mS·cm^{-1}) of the target water at 25 ºC.

	ED2	**ED3**	**ED4**
Target	27.51 ± 0.27	27.56 ± 0.18	27.44 ± 0.30
Control	27.23 ± 0.53	27.59 ± 0.13	27.14 ± 0.42

The values shown in Table 6.2 (ED1 data not shown) do not take into consideration the measurements made on the samples that were in continuous contact with the pH electrode during each experimental “intention window” (referenced in Table 6.1). Actually, these samples presented a higher electrical conductivity as follows: C2 = 45.00 mS·cm^{-1}; B4 = 36.10 mS·cm^{-1}; and A2 = 37.70 mS·cm^{-1}. Given the ion chromatography results (Table 6.3), we concluded that these higher electrical conductivity values resulted from electrolyte leaking into the water. As is commonly known, to close the electrical circuit in the glass membrane electrode during normal measurements, the KCl electrolyte solution comes into contact with the sample through a porous junction. Consequently, the electrolyte ions diffuse into the sample at rates prone to be affected by the experimental conditions.

Table 6.3. Concentrations of cations and anions ($mg \cdot L^{-1}$) in the water measured by ion chromatography.

	Lithium	Sodium	Ammonium	Potassium	Magnesium	Calcium	
Control	0.024	5.094	< 0.01	0.348	0.137	1.832	
A2	0.023	5.098	< 0.01	3.097	0.142	3.046	
B4	0.023	5.053	< 0.01	2.682	0.128	2.361	
C2	0.024	5.045	< 0.01	5.355	0.126	2.729	
	Fluoride	Chloride	Nitrite	Sulphate	Bromide	Nitrate	Phosphate
Control	0.118	4.153	0.149	0.092	< 0.01	0.061	< 0.05
A2	0.099	6.598	0.150	0.105	< 0.01	0.029	< 0.05
B4	0.115	6.153	0.145	0.057	< 0.01	0.188	< 0.05
C2	0.116	8.476	0.123	0.010	< 0.01	< 0.010	< 0.05

Although all of the water samples had the same origin, the composition of those samples submitted to real-time pH measurements differed from the controls in terms of the K^+, Ca^{2+}, and Cl^- concentrations. Because a three molar KCl solution was used as the probe internal electrolyte, the increase in the K^+ and Cl^- concentrations were justified by the porous junction's leaking effect, which was extensible to calcium that, even if less abundant, diffused from the internal solution into the sample.

After the 11th of September and following an overall evaluation of the measured variables, which included the Raman spectra, the pH, and electrical conductivity of the water, as well as the magnetic field and UV-VIS radiation near the experimental spot, the research team concluded that these were responsive to and coincident with the periods of focused intention. Indeed, with particular attention to the OH stretching band that is thought to reflect the dynamic microstructure of water, different absolute intensities were noticed regarding the Raman spectra. In three of the four experimental days, those intensities followed a specific pattern described as follows, from the highest to the lowest: target water > water around target > control water. After peck deconvolution using the Lorentzian and Gaussian functions for two spectral peaks centered at 3230 and 3440 cm^{-1}, slight differences in the intensity ratios were observable from ED1 to ED3, and on ED4 significant differences ($p < 0.05$) were found between the control and target water samples (deconvolution with the Lorentzian model) and between the control and both the target and around the target water samples (deconvolution with the Gaussian model). An increase in the magnetic field strength was observed immediately after the first experimental day, increasing to a maximum of 0.03644 ± 0.0005 mT on the 9th of September, followed by a slight decrease and remaining constant until the 15th of September. From the 24th of September, the magnetic field strength decreased to 0.0338 ± 0.0003 mT, similar to the values obtained at the beginning of the study. Changes in UV-VIS radiation near the

experimental spot were also noticeable, with a higher frequency of spectral fluctuations characterized by an increase in intensity during both critical moments, but more expressive during the critical moment set between 12:55 and 13:05 hours GMT, when the “intention window” began and during which all practitioners were instructed to meditate with the established intention [53].

Because of the observed changes in the real-time pH during those experiments, with shifts that coincided with the critical moments mentioned above, further pH tests were conducted to ensure that the system worked correctly. Thus, several measurements were performed on different days with the same equipment and under the same laboratory conditions without any focused intention.

Figures 6.1 to 6.4 show that real-time pH measurement patterns were not stable, as expected in a control measurement. If the shifts resulted from a hypothetical intention-related phenomenon, a stable behavior similar to the one obtained during the initial tests would be expected without the focused intention. As shown in Figures 6.5 to 6.8, the systematic irregular behavior (with differences from the relative stability period that were highly significant, $p < 0.001$) was relatable between different runs. In those figures, we can observe the normalized pH as a function of the normalized time (dimensionless analysis) and the linear correlation between the pH of the water samples on both days.

Linear correlation analysis provided high correlation coefficients for both pairs of days ($r = 0.81$, days 1 and 2; $r = 0.82$, days 3 and 4). These high values were confirmed using Pearson’s correlation analysis: days 1 and 2, $r = 0.85$, $n = 1315$, $p < 0.001$; and days 3 and 4, $r = 0.77$, $n = 1252$, $p < 0.001$.

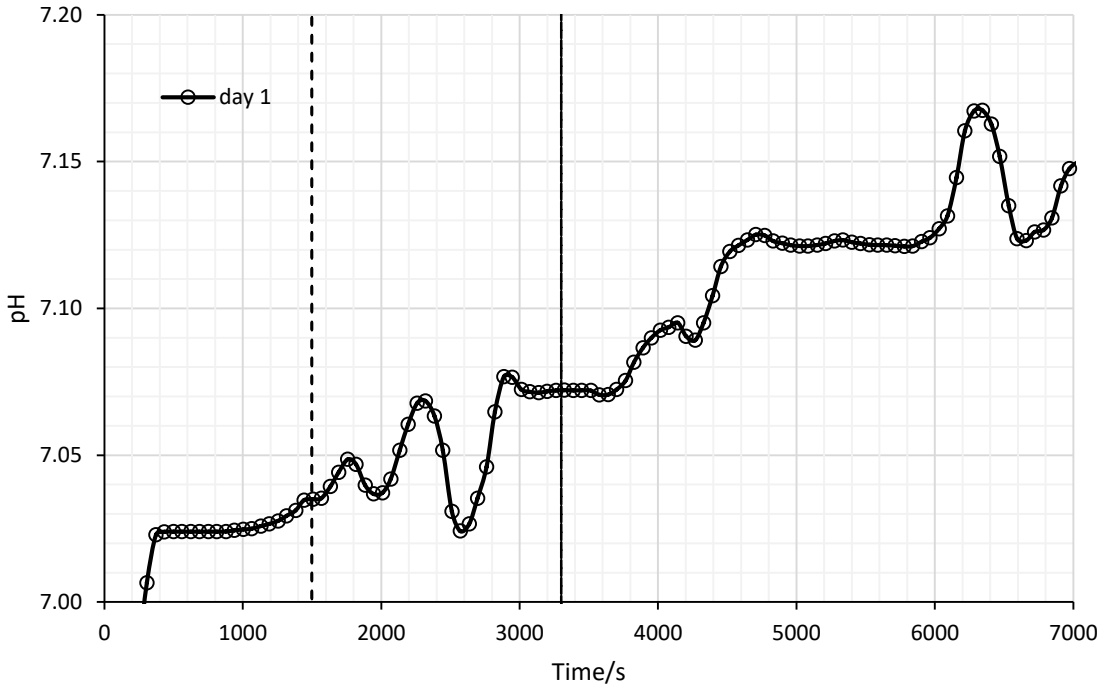

Figure 6.1. Real-time pH profile on day 1.

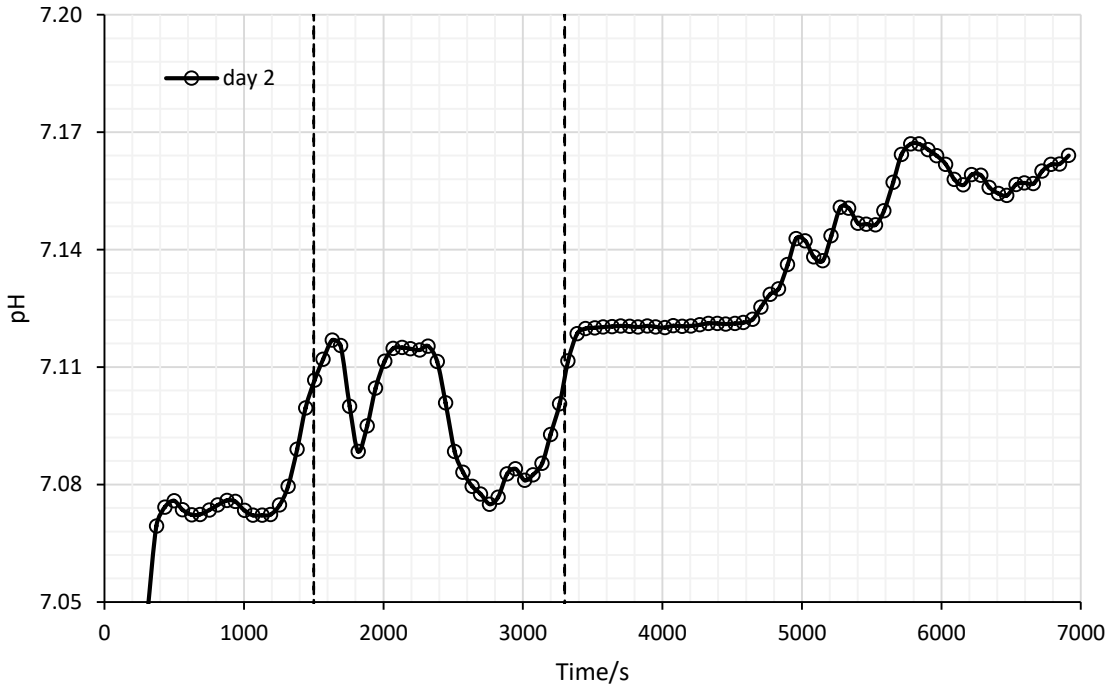

Figure 6.2. Real-time pH profile on day 2.

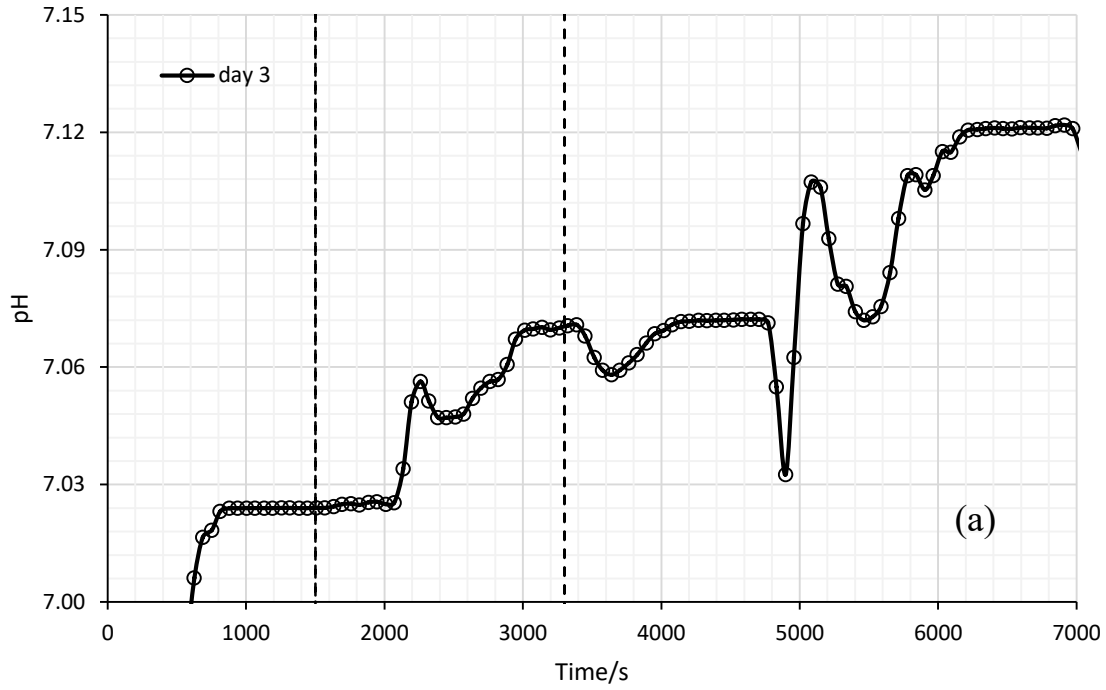

Figure 6.3. Real-time pH profile on day 3.

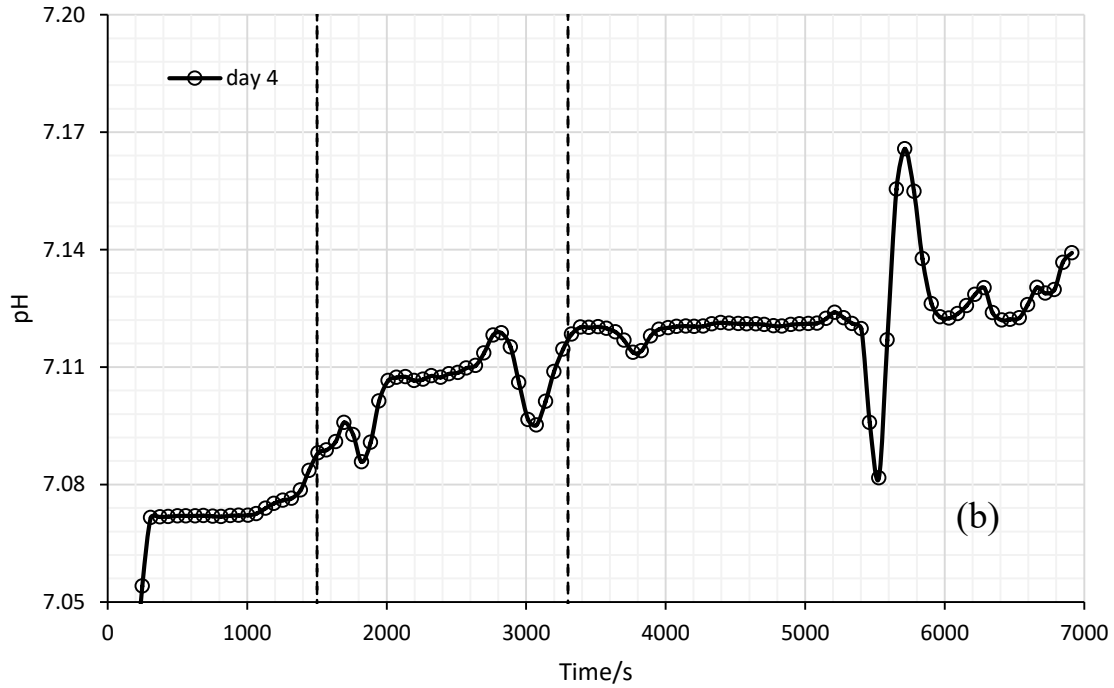

Figure 6.4. Real-time pH profile on day 4.

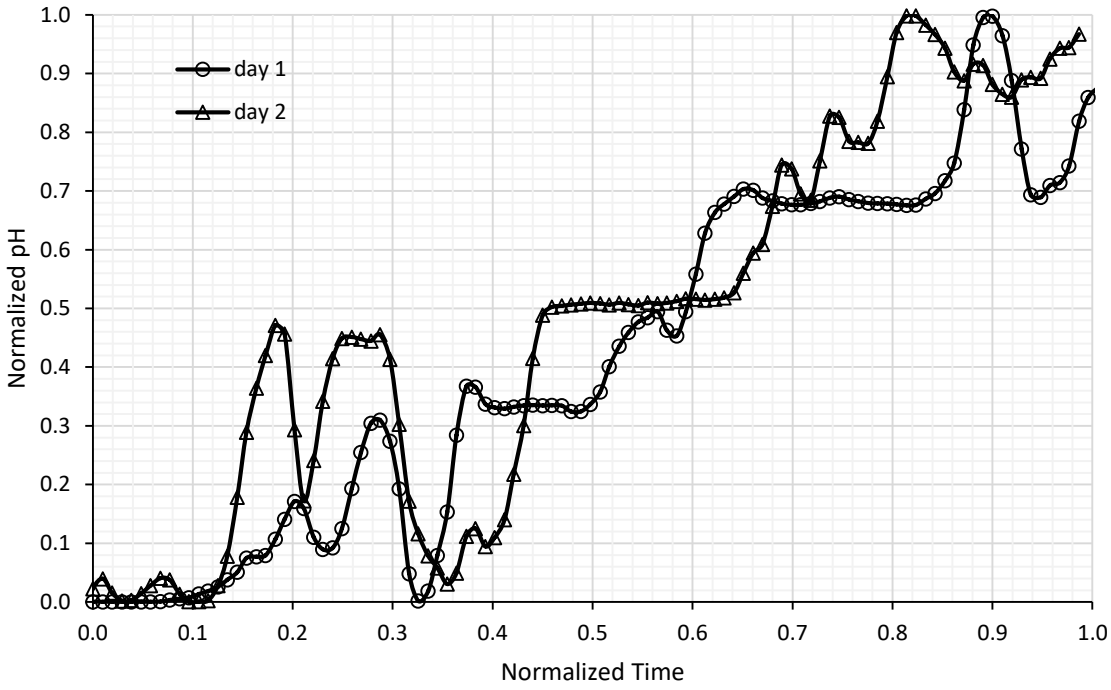

Figure 6.5. Dimensionless analysis of pH profiles on days 1 and 2.

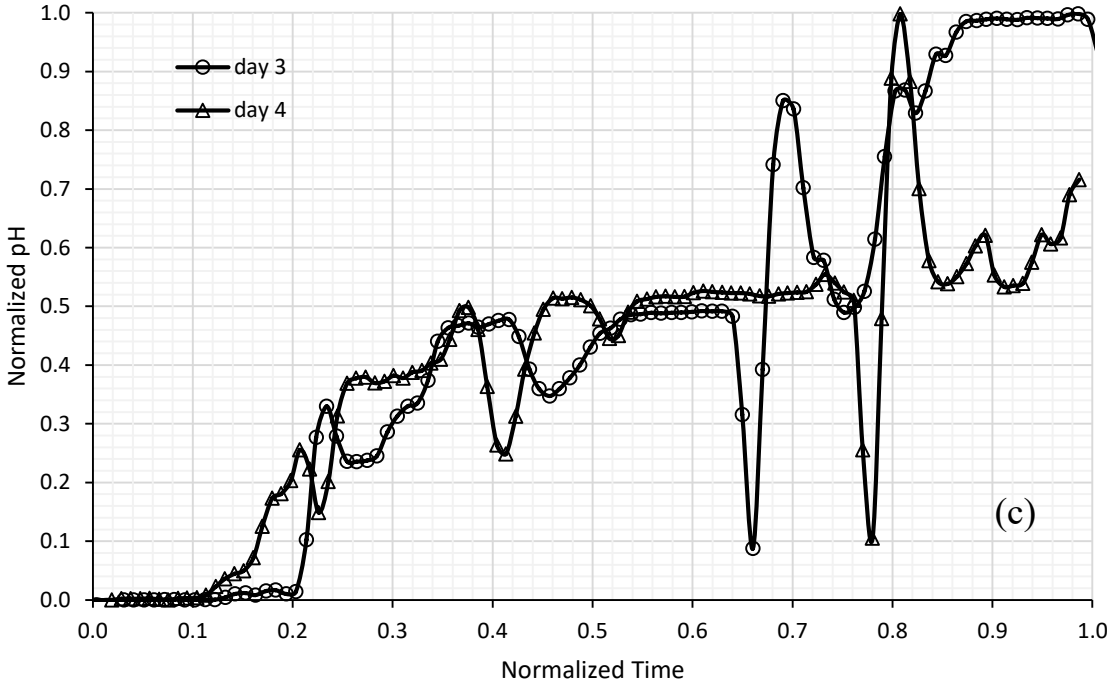

Figure 6.6. Dimensionless analysis of pH profiles on days 3 and 4.

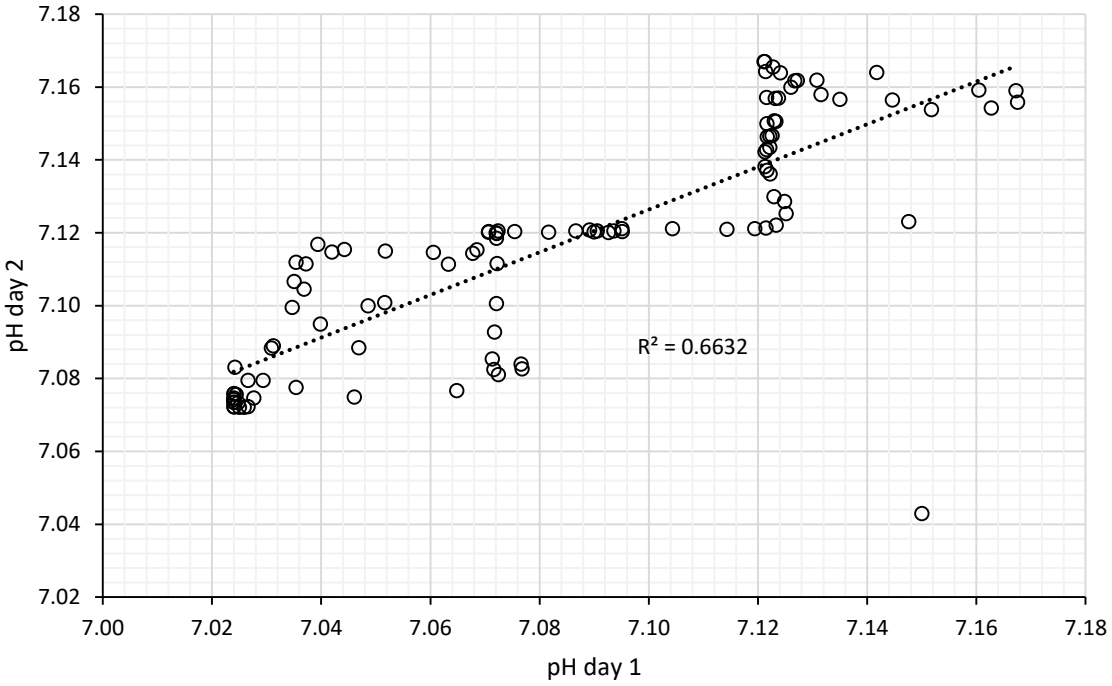

Figure 6.7. Correlation analysis of pH profiles on days 1 and 2.

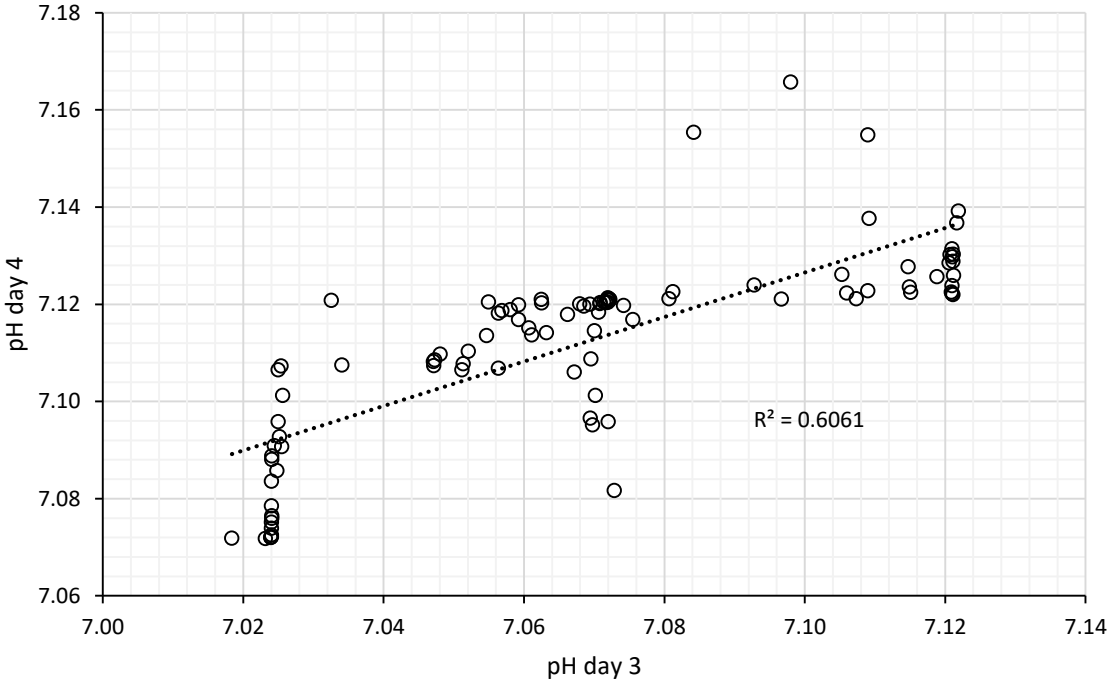

Figure 6.8. Correlation analysis of pH profiles on days 3 and 4.

These results suggested that the equipment was conditioned, giving a similar output when submitted to the same stimulus. Because the system was composed of an electronic device and a glass membrane electrode, it was decided to test the most susceptible

component, in this case, the electrode that was in contact with the target water samples. The primary research study showed that the target water samples and adjacent non-target water samples, within a radius of 8 cm of each flask, were affected, though the non-target water samples were affected to a lesser degree [53]. This observation led the authors to hypothesize that the electrolyte inside the probe could also be susceptible to changes, inducing a specific ionic gradient and output different from those under normal conditions.

Electrical conductivity was also measured after each run (Table 6.4). A closer analysis of these results may indicate a time dependence of the ionic diffusion phenomena related to the time dependence of the KCl solution properties. Indeed, this is observed by comparing samples in contact with the pH electrode during 2 hours and those in contact during 4 hours (referred to as 2-hour and 4-hour periods). Thus, the diffusion of electrolyte ions into the sample, confirmed by the ionic chromatography, was the main reason for the observable increases in electrical conductivity reported both from the 9th to the 11th of September 2015 (ED2 to ED4) and after this period (Day 1 to Day 6).

Table 6.4. Electrical conductivity (mS·cm^{-1}) of the water submitted to real-time pH measurements.

Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
2-hour period	2-hour period	4-hour period	4-hour period	2-hour period	2-hour period
45.40 ± 0.14	40.20 ± 0.14	57.85 ± 0.78	33.95 ± 0.35	33.25 ± 0.07	32.40 ± 0.14

Considering that the control water samples had an average electrical conductivity of 27.32 mS·cm^{-1} and that the average on days 1 and 2 was 42.80 mS·cm^{-1} for 2 hours if there were a linear relationship between the ionic diffusion and the induced increase of the electrical conductivity, a value around 58.28 mS·cm^{-1} after 4 hours would be expected, corresponding to a 15.48 mS·cm^{-1} increase per every 2 hours. This was confirmed on day three after a 4-hour run during which the electrical conductivity reached 57.85 mS·cm^{-1}, slightly below the calculated value. Nevertheless, on day 4, even with a similar pH profile, the linear relationship was not reproduced, and a value of 33.95 mS·cm^{-1} was found after 4 hours.

Aiming to test the hypothesis regarding the electrolyte conditioning, the internal solution of the electrode was replaced with a new solution from the same origin, and new measurements were performed on days 5 and 6 (Figure 6.9).

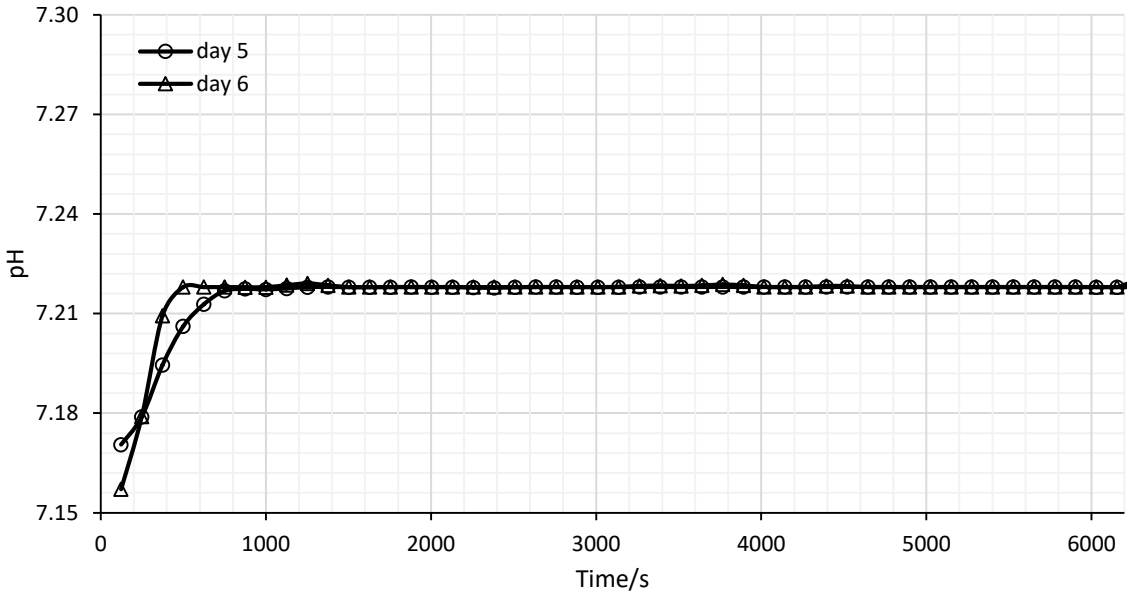

Figure 6.9. Real-time pH profiles on days 5 and 6.

As shown in Figure 6.9, stable pH profiles were obtained on both days 5 and 6. These measurements were very similar to those from the initial stability tests, thus indicating that the electrolyte state after the main experimental period was different and could induce a systematic conditioned response on the pH measurement system. This observation is strengthened considering the lower electrical conductivity measured after these two runs (Table 6.4), which pointed to a decrease in the ionic diffusion rate through the porous junction.

In addition to observing the similarities between the real-time pH profiles shown in Figures 6.1 to 6.4 and the statistically significant correlation coefficients, the results were submitted to analysis of variance. Thus, normalized pH results of days 1 to 4 were tested with One-Way ANOVA, which output was F = 0.6934, p = 0.5564, showing that the pH profiles of these days were not statistically different from each other. As well, days 5 and 6 were also tested, and, as expected, no statistical differences were also found (F = 0.0346, p = 0.8525). However, while comparing days 1 to 4 with days 5 and 6, in which the pH profiles were clearly different, the average ANOVA output was F = 7.6734 and p = 0.0156.

6.5 Discussion

Our findings show that the properties of a pH probe electrolyte changed. This condition was responsible for a systematic response that suggests conditioning of the measurement system and its output. Although we do not have a clear explanation for the outcomes of this study, the measurements have confirmed the proposed hypothesis and were coincident, by proximity, with the activities of the primary experimental period in which

focused intention was used. Therefore, considering this cause-effect scenario, it can be postulated that focused intention, often used in biofield modalities, might be involved in altering the physical reality, thus allowing to change the properties of target materials or even the ones in contact with, or sharing the same space.

Indeed, what we report here as conditioning of a pH-measurement system due to changes on the probe internal electrolyte, is supported by the results of other researchers, which have shown that various properties of water may be influenced by intention, such as the cooling rate, the molecular bonding as reflected by infrared spectra alterations, Raman spectroscopy, scattered laser light, and the pH level [34, 35, 37, 43, 46, 47, 54-58]. From the 8th to the 11th of September 2015, all the measured variables were responsive to and coincident with the periods of focused intention. Those included variables directly measured in the water, such as the Raman spectra, the pH, and electrical conductivity, and the space near the experimental spot, such as the magnetic field and UV-VIS radiation [53]. Moreover, target water samples and adjacent non-target water samples were affected, though the non-target water samples were affected to a lesser degree. In some way, this points to both a level of specificity of the phenomenon regarding the target and the ability to affect neighborhood non-targets, which might be related to the eventual conditioning of the surrounding space.

Although the changes in pH were measurable and systematically tendentious during the period of focused intention, the magnitude of variation was not as high as reported by other authors [46, 47]. Indeed, none of the measured variables in which pH was included was known by the involved biofield practitioners, and obviously, no instructions were given to increase or decrease the pH level. Moreover, the pH changes reported in this study and the antecedent were achieved during continuous measurements that lasted for a maximum of two hours, far from the more extended periods considered in similar studies.

It is essential to mention that the irregular behavior of the glass membrane electrode remained persistent for nearly two months (until the 2nd of November 2015), as confirmed both by the real-time pH response and by the higher values of electrical conductivity. While more studies are needed, including those examining shelf life effects, such results indicate that the changes were noticeable over long periods, although the effects appear to have weakened with time.

We are aware of the limitations of this study, mainly the reproducibility, given that it is difficult to ensure the same experimental conditions, specifically to recruit the same 286 biofield practitioners. Indeed, the recruitment process deserves proper attention, as we do not know if the practitioners' background and type of biofield therapy practice may impact the study's significance. Even so, we believe that our results can contribute to the debate on the effects of intention and the relationship with the biofield phenomenon, often

associated with the so-called “energy healing” modalities such as “Reiki”, Healing Touch, and external “Qigong”, to mention a few. Indeed, each one of these biofield modalities, even if, in some cases, do share some aspects, had distinct development processes and stand on practices that may involve different rituals, the use of symbols and visualization, as well as sounds or even objects. This diversity of procedures might represent an obstacle to producing objective and standardized results, which must be considered in research. Does the draw of a symbol, often referred to as a “yantra”, and the verbalization of its name, often chanted as a “mantra”, have a role in the intention process? Does a ritual enhance the eventual effects of a focused thought aiming to change something? In the case of the so-called “distant healing interventions”, does the eventual effect depend on the distance between the healer and the target? These are some questions that deserve proper attention in further studies on this subject. Moreover, without the knowledge of any proportional effects, the study involved a high number of practitioners. Further studies must be conducted to clarify if the effects depend on the quantity, the expertise, or the duration of the focused intention period.

6.6 Conclusions

Based on our findings, we conclude that the properties of the electrode internal electrolyte changed, causing the pH measurement system to have a conditioned behavior while measuring the pH of new water samples. We believe those changes occurred during the experiments conducted from the 8th and the 11th of September 2015. During that period, the Raman spectra, the pH, electrical conductivity of the water, and the magnetic field and UV-VIS radiation near the experimental spot were responsive to and coincident with the periods of focused intention. In those experiments, which preceded some of the measurements reported in this paper, the electrode was in direct contact with the water samples that served as a target of focused intention, established to change the vibrational state of the water molecules. Therefore, the reported effects might also have changed the properties of the electrode internal electrolyte, which originated a systematic, unusual, and consistent result regarding the real-time pH measurement system.

6.7 References

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Chapter 7. General Conclusions and Future Work

7.1 General Conclusions

Over the last few decades, Western culture has changed its views on healthcare, with a continuous shift in tendencies and an increasing demand for CAM modalities. The easier availability of these health practices and people's beliefs, convictions, and preferences that have also been changing might have played a role in searching for alternatives. Within this new paradigm, Western health systems tend to adapt themselves to the population's demands.

Western medicine is based on mainstream science, and, therefore, the standard approach to CAM is the integrative way. In this line of thought, the integration of TCM into Western health systems and research requires a profound evaluation of effectiveness and security, which has inherent a pragmatic science-based conceptualization and standardization effort that goes from diagnosis to therapeutics. Standardizing the diagnosis and therapeutic methodologies requires a systematic assessment of TCM diagnosis variables to develop new technological systems that can calibrate and mimic complex and skillful diagnosis procedures such as tongue and pulse diagnosis. This process requires measuring a wide range of variables in a representative sample and statistical procedures to validate the findings.

TCM therapeutic success is closely dependent on the accuracy of the diagnosis. TCM diagnosis is an intricate art dealing with evaluating a matrix of variables, some of them subtle and dependent on the practitioner's experience and sensibility. Generally, the diagnosis involves looking, listening, palpating, and questioning to establish a general picture of the patient's condition, involving subtle and physical factors related to their inner nature, pathological activity, and physiological status. The use of technological systems to assess and parameterize variables associated, for example, with the body complexion, motion and language, the tone of the voice and cadence of the speech, seems to be a complex but not impossible task. Image and sound systems with advanced data analysis and algorithms might contribute to the standardization process. Although some of the previous variables seem easy to gauge and common to Western medical diagnosis, others, such as TCM pulse diagnosis, are complex, skill-dependent, and based on TCM physiological concepts. Pulse diagnosis involves feeling the pulse at the radial arteries of both wrists, in three gauging sites, at two or three depths, individually or simultaneously, depending on the practitioner's training and experience. The diversity of pulse qualities felt by the practitioner represents an obvious challenge in research, as mainstream science

demands accurate parameterization and standardization of procedures and protocols to promote reproducibility and validate results.

TCM standardization requires a rational communicable theory and language that translates to Western physiology the structural concepts of TCM, making possible the inherent rational use of the reflex therapeutic systems, anti-inflammatory mechanisms, and mental training involved, for example, in acupuncture and “Qigong”. This is of primary importance to overcome the ambiguities and vagueness that some Western healthcare practitioners and researchers experience when dealing with the philosophical framework and structural concepts of TCM, such as the “yin yang” and the “qi”. Another crucial factor is the design of experimental approaches in TCM research, such as the double-blinding of acupuncture trials and the development of a placebo for “Qigong” research [1].

The World Health Organization plays an essential role by establishing criteria, guidelines and strategies and updating the healthcare community with the evidence-based results on TCM practices, such as reviewing and listing various diseases or disorders for which acupuncture therapy has been tested in controlled clinical trials. The supplementary chapter on traditional medicine conditions included in the International Statistical Classification of Diseases and Related Health Problems (ICD-11) was a significant step taken ahead in the clarification process.

TCM practices’ security is a critical issue to consider. Although most TCM therapeutics, such as acupuncture, “Tuina”, and “Qigong”, are commonly accepted as safe, Chinese herbal medicine remains a significant concern, mainly due to the origin, quality and dose-related toxicity. Although Chinese herbal medicine was not the core of this thesis, it is essential to remark that scientific evidence on efficacy, security, and quality control standards supported by *in vivo* or *in vitro* clinical trials are essential to ensure quality, toxicity, and safety. Chinese herbal medicine’s efficacy must be evaluated using the same standards as Western medicine in this process. Well-designed randomized controlled trials, considered the highest level of evidence required to establish causal relationships in clinical research, are crucial to breaking down doubts and resistance.

Regarding acupuncture and moxibustion, the study presented in Chapter 3 explored the changes in the electrical potential of acupoints of the Lung and Large Intestine primary conduits while using typical TCM therapeutic stimulations. The simultaneous and continuous measurement of the electrical potential in selected acupoints, considering SP6 as the reference, was not published elsewhere. The results of this study may indicate a functional relationship between the therapeutics and the electrical potential of acupoints. These effects seem to be explainable considering the specific properties of each acupoint, the relationship between phases, and the dynamics between coupled conduits. Thus, the simple act of puncturing a point might have initiated an innate reflex electrophysiological

response, not only on that point but also on others. This behavior was observed, for example, in LI4 and LU7 during baseline measurements immediately after puncturing those points. In this case, the electrical potential profiles had opposite tendencies, following the theoretical concept of coupling these two acupoints.

The slope analysis based on the derivative of the electrical potential for each time increment allowed us to observe significant shifts along with the intervention. Indeed, during the dispulsion of LI4, the potential dropped, and the slope increased after releasing the needle. However, an opposite tendency was noticed in the LU7 slope.

The use of moxibustion on LU5 seems to act on the phases Water and Fire. Although the changes on LU5 were not significant during moxibustion, the slope analysis allowed us to observe relevant changes in the electrical potential of LI2 and LU10, two acupoints belonging to the phases Water and Fire, respectively. These results might indicate that, by strengthening the phase Water, a cooling or descending effect can be seen on the phase Fire, oppositely connected to Water through the phases system.

The results of this work encourage the study of skin electrophysiology and the use of objective measurements to systematically assess TCM vegetative functional manifestations observed before and after therapeutic interventions. In addition, these findings encourage further research to develop non-invasive equipment that might aid the automatic physiological analysis of TCM practices and diagnosis.

The study presented in Chapter 4 explored the biophysical effects of “Qigong” assessed by measurements of the electrical potential of the skin. The results show that the changes in the electrical properties of acupuncture points and the possible association with the bioelectrical flow of charges during “Qigong” practice seem to be related to the practitioner’s intention and consistent with the theoretical foundations of TCM, that is, the “xue” is moved by the “qi” and guided by the intention of the mind, the “yi”. Therefore, the activation of the “qi” flow depends on the practitioner’s particular mental state of awareness, which triggers the manifestation of vegetative physiological changes, such as the increase of the microcirculation and changes in the electrical potential of the skin. On the other hand, the main changes in electrical potential during “Qigong” practice occurred in acupuncture points. Such points, when linked together, form a channel or conduit, in our case the “Ren Mai” and “Du Mai”, in which the relative polarity was following TCM’s dialectical view of the human body.

The human biofield is a challenging concept that is not fully compatible with the dominant biomedical paradigm. The mechanisms behind this phenomenon are still unclear or unknown. However, some experimental results and clinical applications support rather than deny its existence, thus justifying further studies about its nature and action mechanism. Nevertheless, there is still some stigma related to this subject and much

anecdotal evidence lacking scientific methodology, contributing to some resistance to accepting this concept into mainstream scientific research. The literature on the subject is still weak, some references are not readily available to consult, and some are written in Chinese. Evidence-based approaches are required to assess the effectiveness of these practices and concepts. In this context, well-designed studies with proper controls and standard procedures are required to ensure quality and reproducibility. The fulfillment of these requirements is a challenge to research, as a high number of variables might have an impact on the studies, such as the practitioners' background, the number of practitioners involved, the type of biofield therapy, the duration of the focused intention intervention, and the frequency of biofield therapy during the experimental period. This field of research requires in-depth scrutiny and clarification, as there are still many question marks. Considering the healer a crucial element in the healing process and the supposed source of driving force and biofield activation, what kind of physiological changes occur in these subjects? Often measured biomarkers include electroencephalography (EEG) and heart rate variability (HRV); however, EEG changes seem inconsistent and not specific to biofield therapies. Baldwin and Hammerschlag (2014) found that HRV results suggest activated physiology for reconnective healing, Bruyere healing, and Hawaiian healing, but no changes were detected for "Reiki" and therapeutic touch [2]. Are these results due to the biofield practice itself or the practitioner's experience and particular abilities? Here, a parameterization effort similar to the one seen in TCM diagnosis and practices [3] is imperative to "calibrate" the healers and healing process. Recently, Connor et al. (2021) reported a set of portable and cost-effective measures that scientists could use to determine the competence of "energy practitioners" so that qualified practitioners could be selected to improve research accuracy. Those measures involved the use of a triaxial extra low-frequency magnetic field meter, data logging multimeter, radio frequency (RF) field spectrum analyzer, acoustimeter, broadcast frequency counter, digital pH meter, digital total dissolved solids (TDS) meter, gas discharge visualization (GDV) and physiology suite including heart rate variability, galvanic skin response, respiration, electromyography (EMG), electrocardiography (EKG), temperature and blood volume pulse [4]. The expected results from proper experimental designs may contribute to the debate and help understand the possible effects and involved mechanisms.

Although other researchers have studied the phenomenon of intention, the mechanisms behind the most reported outcomes are still unclear or unknown. Based on the study presented in Chapter 5, we cannot further explain such interactions but only report that the measurements and the combined analysis of the variables point to changes coinciding with specific experimental period moments. Given that coincidence does not equate with causality, we cannot offer a conclusive explanation for the observed changes.

Nonetheless, the questions regarding the effects of intention remain relevant and warrant more research.

We can also suppose that this phenomenon, if confirmed, could hypothetically affect neighboring targets. Thus, considering a hypothetical scenario in which a person asks for a “distant healing intervention”, we do not know if the effects could affect other persons sharing the same space unaware of what is going on. This might raise some ethical issues regarding “distant healing interventions”.

The time dependence of the eventual effects is also of importance. How long are the changes measurable? Is there any proportional decreasing tendency in the changes as a function of time? Shelf-time experiments should be done to clarify this issue.

Finally, we are aware of the difficulties of reproducing that study, given the complicated, if not impossible task of recruiting the same 286 practitioners and ensuring the same conditions. Moreover, this high number of participants was based on availability rather than on the knowledge of any proportional effects. Therefore, further studies must be conducted to clarify if effects are dependent on the number of practitioners, their levels of expertise, or the duration of the meditation time.

The follow-up study presented in Chapter 6 allowed us to conclude that the properties of the electrode internal electrolyte changed, causing the pH measurement system to have a conditioned behavior while measuring the pH of new water samples. We believe those changes occurred during the experiments conducted from the 8th and the 11th of September 2015. During that period, the Raman spectra, the pH, electrical conductivity of the water, and the magnetic field and UV-VIS radiation near the experimental spot were responsive to and coincident with the periods of focused intention. In those experiments, which preceded some of the measurements reported in this study, the electrode was in direct contact with the water samples that served as a target of focused intention, established to change the vibrational state of the water molecules. Therefore, the reported effects might also have changed the properties of the electrode internal electrolyte, which originated a systematic, unusual, and consistent result regarding the real-time pH measurement system.

TCM is a challenging field of research where the conjugation of modern science and traditional paradigms are welcome. This conjugation should be balanced, as balanced should be the relationship between “yin” and “yang”, never denying the power of cultural, philosophical foundations and considering millennia of empirical evolution and accumulation of knowledge. Although some TCM practices defy the dominant biomedical paradigm, the effort being made by the scientific community, and the number of positive results derived from clinical applications studying either its nature and mechanisms, are significant. Moreover, challenging experiences are crucial to promoting continuous scientific innovation and breakthroughs.

7.2 Future work

Future studies should be planned in an integrated manner, involving academia and research institutions, the healthcare community, and therapists' associations to explore fundamental sciences and the clinical applicability of TCM practices.

Meanwhile, the experimental work carried out within the scope of this thesis generated additional data that is currently being analyzed. Future articles considering this data will include:

1. The correlation of traditional Chinese face diagnosis and facial temperature patterns assessed by infrared thermography;
2. The effects of acupuncture and moxibustion on subjects evaluated by EAV;
3. The correlation between the diagnosis based on the Heidelberg model, the EAV diagnosis and the electrical potential of acupoints of the Lung and Large Intestine conduits.

Further research on the biofield should include the effects on electrophysiology and homeostasis, the assessment of changes in physiological and physical variables, the test of the nonlocality character of the intervention and the eventual entanglement within the system. Also, the demystification of philosophical terminology such as the circulation of "qi" or "prana" in channels or "nadis", in TCM and Ayurvedic medicine, respectively; the "energetic" fields of "dantians", and the relation to "chakras" in Ayurvedic medicine; or even the layers of the human energetic field, commonly referred to as the person's aura, are aspects to explore further. A particular emphasis should be given to research exploring the effects of intention and its relation to the biofield. For example, TCM holds that "xue" (similar to blood) is moved by the "qi" and guided by the "yi", the intention of "shen" (mind). Therefore, the activation of the "qi flow" depends on the practitioner's particular mental state of awareness, which triggers the manifestation of vegetative physiological changes, such as the increase of the microcirculation and changes in the electrical potential of the skin. How do these changes measured during "Qigong" practice relate to the biofield? Measurements of biophotonic emission from the human body, particularly the hands, during "Qigong" or other biofield-based practice will be helpful to understand whether this physiological response has power enough to trigger changes, for example, in biological material placed in the vicinity of the practitioner.

Additionally, measurements of the magnetic field properties in well-controlled conditions during the interventions might be valuable to check if eventual changes are assessed systematically and if they support space-conditioning hypotheses associated with intentional factors. Here, using water as a "sensor" and evaluating its properties by

vibrational spectroscopy might help determine if the intervention has effects, not only in the experimental space but also in target and non-target materials within that space. Few studies have recently been published in this field [5–7], demanding more investment and research to confirm or deny the reported outcomes.

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Appendix A. Articles front pages

Figures A.1 to A.7 show the front pages of the original publications produced with the work developed for the present thesis.

healthcare

Review

Understanding Traditional Chinese Medicine Therapeutics: An Overview of the Basics and Clinical Applications

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Abstract: Traditional Chinese medicine (TCM) is a systematic healthcare system developed from clinical experience based on a scientific model of regulation. TCM relies on unique theories and practices to treat diseases and enhance health. These practices include Chinese herbal medicine and dietetics, acupuncture and moxibustion, and other non-medication therapies such as Chinese body work or manual therapy, known as "Tuina", and traditional biofeedback exercises, known as "Qigong" and "Taijiquan". The integration of TCM in Western health systems and research requires a rational communicable theory, scientific proof of efficacy and safety, and quality control measures. Understanding the structural concepts of the TCM language makes possible the parallelism to Western physiology, and the inherent rational use of the reflex therapeutic systems, anti-inflammatory mechanisms and mental training involved, for example, in acupuncture and "Qigong". The results of TCM clinical trials and fundamental research on its nature and mechanisms have encouraged the development and application of well-designed research strategies such as double blinding in acupuncture to overcome limitations and resistances in integrating these practices into the existing biomedical paradigms of the West. This review aims to overview some TCM theoretical concepts and the evidence-based clinical application of TCM's leading practices to create an easy-to-consult and condensed source of information, available for the healthcare community, facilitating the understanding and communication between conventional health professionals and TCM practitioners and acupuncturists.

Keywords: traditional Chinese medicine; herbs; dietetics; acupuncture; moxibustion; "Tuina"; "Qigong"; "Taijiquan"; Heidelberg Model of TCM

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1. Introduction

Although the origin of TCM remains uncertain, some evidence points to more than 5000 years of history. Indeed, some archaeological findings of acupuncture needles and traces of herbal treatments suggest 4000 to 8000 years of existence [1,2]. The "Yijing" ("I Ching" or The Book of Changes) and the "Huangdi Neijing" (The Yellow Emperor's Classic of Internal Medicine) are the oldest known written sources of information in TCM philosophy and clinical application. The "Yijing", dating back 3000 to 5000 years, describes the course of life systematically based on a mathematical model of regulation. It describes its changes and modalities, offering advice on personal emotional lifestyle and guidance [3,4], while the "Huangdi Neijing" is comparable in importance to the Hippocratic Corpus in Greek medicine [5].

Figure A.1. Front page of the article DOI: 10.3390/healthcare9030257, adapted in Chapter 2, section 2.1.

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Review

Can Traditional Chinese Medicine Diagnosis Be Parameterized and Standardized? A Narrative Review

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Abstract: The integration of Traditional Chinese Medicine (TCM) in Western health systems and research requires a rational communicable theory, scientific proof of efficacy and safety, and quality control measures. The existence of clear definitions and the diagnosis standardization are critical factors to establish the patient's vegetative functional status accurately and, therefore, systematically apply TCM therapeutics such as the stimulation of reflex skin areas known as acupoints. This science-based conceptualization entails using validated methods, or even developing new systems able to parameterize the diagnosis and assess TCM related effects by objective measurements. Traditionally, tongue and pulse diagnosis and the functional evaluation of action points by pressure sensitivity and physical examination may be regarded as essential diagnostic tools. Parameterizing these techniques is a future key point in the objectification of TCM diagnosis, such as by electronic digital image analysis, mechanical pulse diagnostic systems, or the systematic evaluation of acupoints' electrophysiology. This review aims to demonstrate and critically analyze some achievements and limitations in the clinical application of device-assisted TCM diagnosis systems to evaluate functional physiological patterns. Despite some limitations, tongue, pulse, and electrophysiological diagnosis devices have been reported as a useful tool while establishing a person's functional status.

Keywords: traditional Chinese medicine; TCM diagnosis; tongue diagnosis; pulse diagnosis; electrophysiology; acupoints; acupuncture

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1. Introduction

Traditional Chinese medicine is an ancient medical system that gives emphasis to human body integrity and regulation and its interrelationship with the surrounding environment [1,2]. The worldwide use of TCM practices has raised the question of how its integration in Western healthcare systems and research could be practically managed. This has encouraged the development of research strategies and the publication of a considerable number of scientific studies on the mechanisms and effects of TCM therapeutics [3–17]. Nevertheless, there is still much anecdotal evidence demanding appropriate study designs and sample dimensions to break down the resistance within mainstream conventional medicine [18]. The integration of TCM is a bidirectional process that requires the following preconditions [19]:

1. A rational communicable theory;
2. Scientific proof of efficacy and safety;

Figure A.2. Front page of the article DOI: 10.3390/healthcare9020177, adapted in Chapter 2, section 2.2.

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Review

Perspectives, Measurability and Effects of Non-Contact Biofield-Based Practices: A Narrative Review of Quantitative Research

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Abstract: Practices such as "Reiki", therapeutic touch, healing touch, and external "Qigong" have been regarded as some form of "energy medicine" or "biofield therapy". The biofield concept has been studied and debated by researchers of distinct areas of expertise, and although the phenomenon was sometimes described as physically related to electromagnetics, other factors such as "subtle energy" and focused intention might be involved. These nonconventional practices integrate contact and non-contact techniques, and those dealing with so-called distant healing interventions are perhaps the most difficult to understand and accept. Practitioners describe these so-called nonlocal interventions as involving intentional factors and particular states of consciousness. With a spiritual mindset and a particular state of awareness, compassion is said to work out as a catalyst to produce physiological and physical changes through mechanisms that are still unknown. At the body level, these vegetative changes might be related to individual self-perception variations as part of the body neurovegetative feedback system of regulation. Further mechanisms are difficult to document and measure, and might be more accessible to research by using physical signal detectors, chemical dynamics methods, detectors using biological materials, detectors using living sensors, and detectors using the human body. The growing interest in these practices and the considerable amount of research exploring their effects and clinical applications encouraged this narrative review, which aims to provide an easy to consult partial overview of the history, theory and findings of quantitative research strategies exploring non-contact biofield-based practices. This work also aims to stimulate the reader's mind with the raised hypotheses, catalyzing further research on the subject to confirm or deny the reported outcomes.

Keywords: biofield; nonlocality; consciousness; intention; healing

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1. Introduction

The effects and mechanisms behind nonconventional healing practices have been studied over the last decades. The biofield, a field thought to exist within and around the body, is among researchers' topics. To explore possible biofield effects and their hypothetical mechanisms, practitioners of traditional medicine and the so-called "energy healers" have been often involved in this research field.

Figure A.3. Front page of the article DOI: 10.3390/ijerph18126397, adapted in Chapter 2, section 2.3.

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Diagnostic Methods

Can the electrical potential of acupoints be used to assess the functional state of meridians and the effects of therapeutics? An exploratory data analysis

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ABSTRACT

Introduction: Acupoints have bioelectrical properties distinct from common skin. Besides the higher electrical conductivity and lower resistance, acupoints show capacitor-like properties, which can be related to their endogenous electrical potential. Traditional Chinese Medicine (TCM) postulates that meridians are physiological structures connecting acupoints and working as a conduit for the flow of two essential substances known as *qi* and *xue*. **Objectives:** This pilot study was focused in evaluating whether the electrical potential of acupoints can be correlated objectively to the functional properties as described by ancient Chinese medical theories, such as the theories of coupled meridians of the same phase ('elements'), and the principle of coupled points. **Methods:** Direct needle moxibustion on LU5 and needle dispulsion of LI4 were performed in 21 subjects. The electrical potential of each acupoint was measured with a high-resolution data acquisition system taking to reference the acupoint SP6 of the Spleen conduit. **Results:** The results may indicate a functional relationship between the therapeutics and the electrical potential response on the selected acupoints. These effects seem to be explainable considering the specific properties of each acupoint, the relationship between TCM phases, and the dynamics between coupled conduits. **Conclusion:** The evaluation of the endogenous electrical potential of acupoints and the changes caused by an external stimulus might contribute to the understanding of TCM concepts, mechanisms, and the effects of associated therapeutics. The observed phenomena encourage the systematic assessment of the functional vegetative status via skin electrophysiology and using objective measurements.

1. Introduction

For many years researchers have claimed that acupuncture points are unique locations on the body surface at which the skin's electrical conductivity is higher compared to neighbouring spots (Comunetti et al., 1995; Pérez Samartín 2011). Moreover, the electrical properties of these "bioactive" points are also characterised by a reduced impedance and resistance, an increased capacitance and higher electrical potential compared with non-acupuncture points (Ahn and Martinsen 2007). Once the conductivity between two points along the same meridian (or conduit) is higher than that between points not sharing this relationship, researchers have postulated that meridians are reflections of superconducting-like pathways of least electrical resistance throughout the body

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Figure A.4. Front page of the article DOI: 10.1016/j.jbmt.2020.12.038, adapted in Chapter 3.

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Pilot Study

Changes of skin electrical potential in acupoints from *Ren Mai* and *Du Mai* conduits during *Qigong* practice: Documentation of a clinical phenomenon

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ABSTRACT

Qigong is a therapeutic method of traditional Chinese medicine (TCM) that combines slow, soft movements and postures with breath control and a special mental state of 'awareness'. TCM holds that the practice of *Qigong* promotes the 'circulation of *qi*' in the human body, the 'flow' of upward *yang qi* and downward *yin qi* to establish 'balance'. In Western terms, this may be generally equivalent to vegetative homeostasis and the emotionally balanced state induced thereby. Researchers have often attempted to evaluate the functional movements of *qi* using measurements of the skin's electrical resistance. However, these methodologies have proven difficult to gauge, validate, repeat, and interpret. We aimed to overcome these limitations by measuring the skin's electrical potential between two points of the same system. The main goal of this study was to assess the skin's electrical potential changes in acupoints from the *Ren Mai* and *Du Mai* conduits, or meridians, as well as in other points of interest, during *Qigong* practice. While participants performed a specific *Qigong* exercise called 'White Ball', we observed significant changes in the skin electrical potential on *Mingmén* (GV 4), *Shéndào* (GV 11) and *Baihui* (GV 20), from the *Du Mai* conduit, as well as on *Huiyin* (CV 1), *Qihai* (CV 6), *Zhongwan* (CV 12) and *Danzhong* (CV 17), from *Ren Mai*. These observations are in accordance with TCM theory and may contribute to the explanation of the vegetative physiological changes that are associated with '*qi* flow' in TCM.

1. Introduction

Qigong is a traditional vegetative biofeedback therapy used in Chinese Medicine. It comprises concentrated motion and postures combined with breathing exercises (Matos et al., 2015; Chen and Liu, 2010). The '*qi* activation' is achieved with breath control and a special mental state of 'awareness' (Greten 2009, 2013; Enz, 2011; Posadzki, 2010; Jahnke et al., 2010). TCM holds that the *qi* itself cannot be seen and is intangible, whereas the effects of *qi* may be seen in the functional so-called organ patterns, which include functional changes of the conduits or 'meridians'. Thus, the practice of *Qigong* promotes the 'circulation of *qi*' in the human body, the 'flow' of upward *yang qi* and downward *yin qi* to establish 'balance,' thereby improving and strengthening overall well-being and homeostasis (Zeng et al., 2014; Song et al., 2017; Zou et al., 2017). From a Western standpoint, these exercises may be understood as vegetative feedback promoters in which *yin*, *yang* and the Phases are cybernetic elements of a circular process of physiological regulation. This process is governed by transmitters and neuronal pathways, where sympathetic functions are more active in *yang* phases and parasympathetic (vagal) activity is more present in *yin* phases (Greten, 2008a; Galantino and Muscatello, 2011).

The Heidelberg model of TCM, which is a model of vegetative system biology (Greten, 2008b; Sertel et al., 2010), sees strong analogies between the effects of *xue* ('blood'), as described by the classical texts and the clinical effects of microcirculation in Western

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Original Article

Instrumental Measurements of Water and the Surrounding Space During a Randomized Blinded Controlled Trial of Focused Intention

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Abstract

The main goal of this work was the assessment of measurable interactions induced by focused intention, frequently used in biofield practices such as Healing Touch and *Reiki*. Water, as the main component of the human body, was chosen as a model. Intention experiments were performed over 4 different days at a scheduled interval, during which 286 trained biofield practitioners from several countries were instructed to meditate with the intention to change the molecular vibrational state of water samples selected by a blinded operator. The experimental protocol was randomized, blinded, and controlled; the measured variables included Raman spectra and the pH and electrical conductance of the water, as well as the magnetic field and UV-VIS (ultraviolet-visible) radiation near the experimental spot. Although a direct causal relationship cannot be established, some measurements of the water samples, as well as the magnetic field and radiation near the experimental spot, were responsive during the experimental period.

Keywords

intention, nonlocality, meditation, Raman spectroscopy, water vibrational spectra

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Paradigms are determined by cultural differences and perceptions of reality, and often define the borderline between science and pseudoscience. Indeed, the history of science is full of challenging anomalies that, by defying the dominant paradigm, were ignored by the scientific mainstream until explained.[1,2] Over the past several decades, researchers have been interested in the effects and potential mechanisms of certain energy-healing practices or biofield therapies such as *Qigong*, Healing Touch, and *Reiki*.[3,4] As a result, practitioners of traditional medicine and so-called "energy healers" have been involved in a wide number of studies.[5-15] Philosophically, each of these biofield therapies relies on a "vital force" as the main driving mechanism of health, pathogenesis, and healing. This philosophical approach is an ancient and shared concept understood, for example, as *Qi*, *Ki*, *Prana*, *Ankh*, and *Pneuma* in Chinese, Japanese, Hindu, Egyptian, and Greek cultures, respectively.[16]

Qigong, used in Chinese medicine as traditional vegetative biofeedback therapy, considers the existence of a differential external protective field known as *Wei Qi*, which acts on the physical, emotional, and spiritual levels.[17] The hypothetical existence of such a complex and dynamic biologic field within and around the body, which is involved in homeostasis,[18,19] could be partially based on the electromagnetic field theory,[20-30] on acoustic and thermal related effects,[5,9,31,32] and possibly other subtle energy fields, which, in some cases, seem to generate physical changes that are measurable with current technological methods.[5,18,33,34] However, some practices appear to act in a manner described as nonlocal, thus acting at a distance, possibly compromising consciousness or even

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Figure A.6. Front page of the article DOI: 10.1177/2156587217707117, adapted in Chapter 5.

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Can measurements be physically conditioned by thought? Further observations following a focused intention experiment

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Abstract:
Background: The biofield is a controversial concept among the scientific community. Some aspects of this phenomenon relate to measurable factors of mainstream science such as electromagnetics, while others, involving nonlocal interventions, intention, and consciousness, seem to produce physical changes through mechanisms that are still unknown, making the outcomes of many studies not fully explained by our current state of scientific understanding. This study explored the hypothetical effects of intention on the conditioning of a pH system with continuous data acquisition for real-time measurements. As a follow-up study, those effects were related to changes in the physicochemical properties of water samples chosen as a target in a previous large-scale intervention of focused intention.
Methods: The intention experiments were conducted under controlled conditions from the 8th to September 11, 2015. During this period, 286 qualified biofield therapy practitioners meditated at a distance with the intention of changing the vibrational state of the water molecules contained in specific flasks. Several variables were evaluated, including the magnetic field and ultraviolet-visible (UV-VIS) radiation from 175 to 954 nm near the experimental spot, as well as Raman spectra, pH, and electrical conductivity of all the water samples. After this period, real-time pH measurements of water samples were taken with the same equipment and under the same experimental conditions, except for the practitioners' awareness of those experiments, and without their focused intention. Real-time pH, electrical conductivity and the concentration of cations and anions measured by ion chromatography in the water samples were used to test the proposed hypothesis.
Results: Real-time pH was responsive during the intention experiments and after this period. Further continuous measurements performed after the 11th September showed that the pH variations overtime kept a systematic and consistent tendency similar to the one observed during the experimental activities involving focused intention. After the replacement of the electrode internal electrolyte, this behavior was no longer verified, and the pH was stable as the initial tests to evaluate the equipment sensitivity.
Conclusions: After the experimental period involving focused intention, the pH system maintained a systematic and consistent behavior while measuring the pH of new water samples. An eventual intention-mediated conditioning of the pH measurement system occurred because of changes in the properties of the electrode internal electrolyte.

Keywords: biofield, intention, meditation, nonlocality, pH measurement
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Introduction

Energy medicine modalities have been categorized in the United States using two main classes: the veritable, which must be measurable using conventional technology; and the putative or subtle, which have not been definitively, scientifically measured [1–3]. This classification is no longer included on the website of the National Center for Complementary and Integrative Health (NCCIH); however, its foundation considers that external

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Figure A.7. Front page of the article DOI: 10.1515/jcim-2017-0056, adapted in Chapter 6.