The Effect of Body Psychotherapy on the Body's Water Matrix

As Seen by NIR Spectroscopy and Aquaphotomics

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ABSTRACT

Aquaphotomics is a new discipline that uses spectroscopy to examine how water molecules change conformation under certain stimuli or perturbations (Tsenkova, R., 2006, 2009; Bazar et al., 2015; Muncan & Tsenkova, 2023; Tsenkova et al., 2018). Here we describe a novel non-invasive method for collecting NIR spectra from the palms of participants in body psychotherapy sessions at the Bulgarian Neo-Reichian Institute for Analytical Therapy, which after multivariate data spectral analysis allowed us to decipher structural changes in their water molecular matrices at the end of each session. Our results point to a structural coherence between the participants, as well as a healthier, more energized, and stress-free water matricidal signature.

Keywords: body psychotherapy, body-mind, aquaphotomics, water matrix, wellbeing, aquagrams, NIR spectroscopy

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> ***Perhaps parallels can be drawn between the state of the brain and the state of our water matrix.***

Aquaphotomics is a new "–omics" discipline introduced by Professor Roumiana Tsenkova at Kobe University, Japan (Tsenkova et al., 2018). It studies how water's molecular structure changes in vivo with controlled stimuli, known as perturbations. In this study, the perturbation was a body-mind psychotherapy session, and the readouts were aquagrams, which are visual graphic representations of the changes in water absorption of spectrum of light in the NIR (near infrared) band of the spectrum that briefly illuminated the participants' palms.

Water is the basis of all living systems. Without water there is no life. We as humans are made of around 70% water bound to proteins, sugars, DNA, RNA molecules, and lipids. This very simple molecule comprised of one oxygen and two hydrogen atoms bound together acts like a glue, which binds the intracellular and extracellular machinery of all living creatures and aqueous solutions. Not only

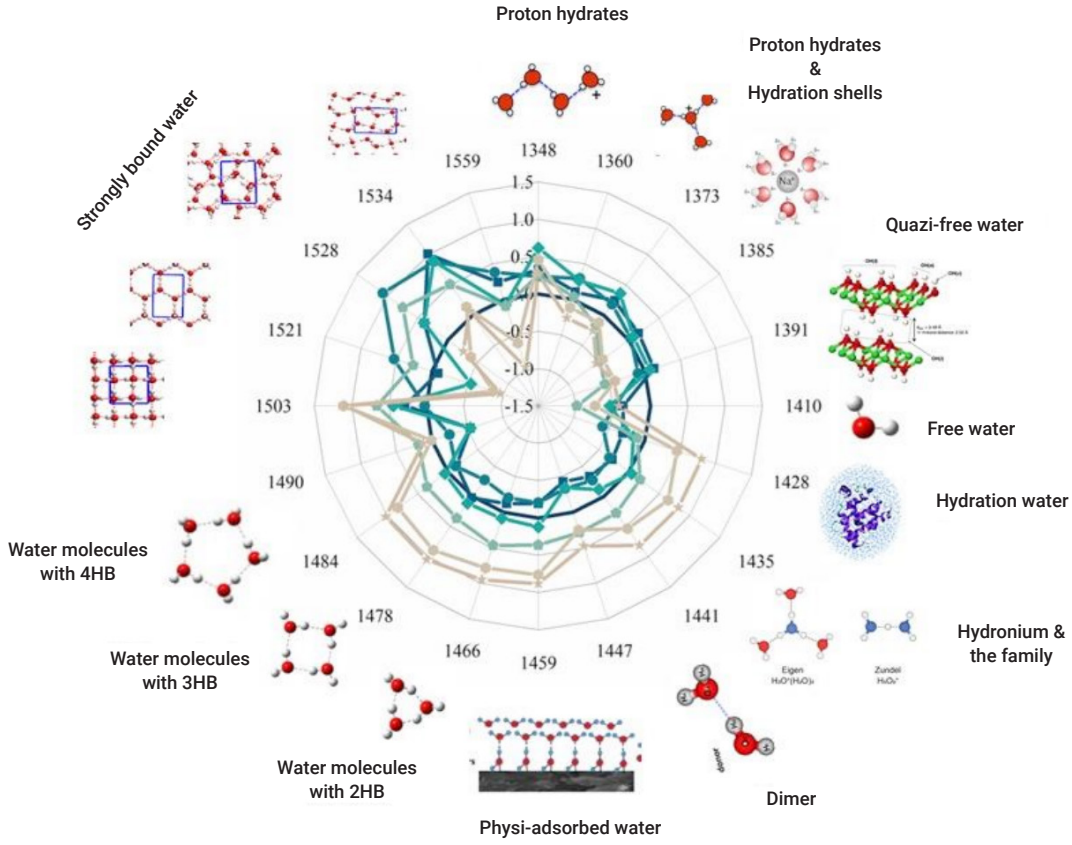
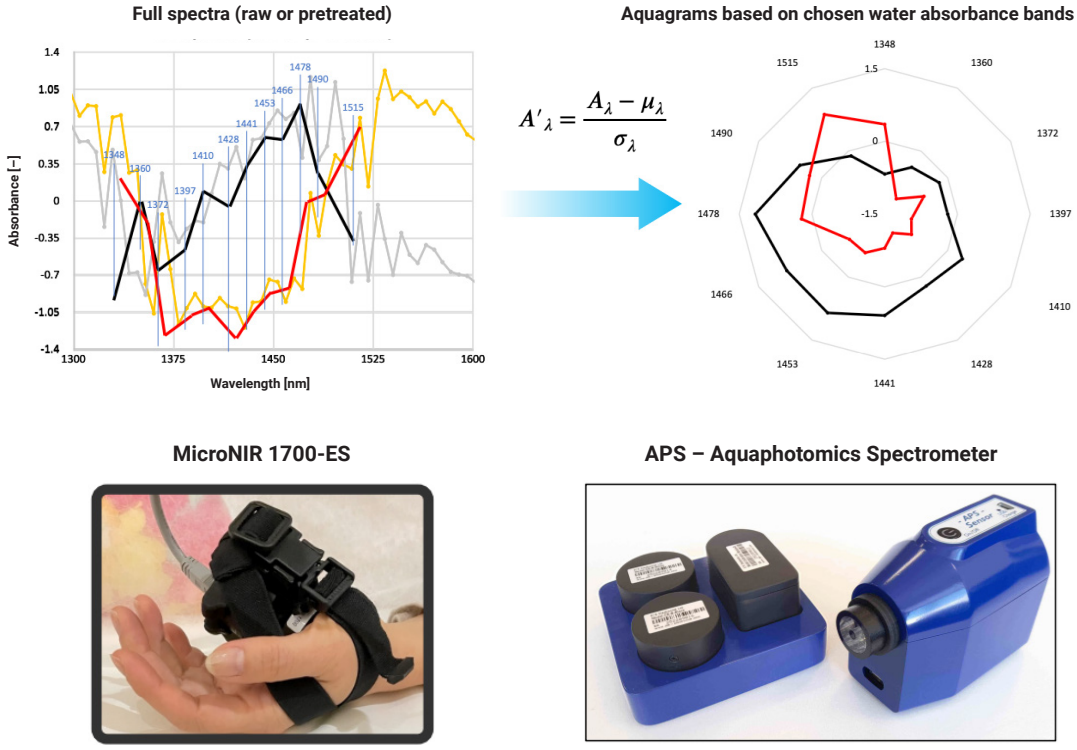


Figure 1. *An aquagram representing the different water molecular conformations detected at each wavelength in a circular fashion starting from 1300–1600 nm. The author of this diagram is Dr. Jelena Muncan, PhD.*

does it hold everything in place, but it is also essential for the work of the cell (Chaplin, 2006)[1]. All water molecules are like weak magnets; they have a positive end – the two hydrogen atoms, and a negative end – the oxygen atom. The molecule forms a dipole. Like all magnets, positive attracts negative; if you place a bunch of small magnets together, they will clump around each other in a certain configuration. If you place stronger magnets around them, that would change the configuration again. This is what happens with water as well. The weak magnets form hydrogen bonds, which cause water molecules to fall into various configurations with each other, yielding different water species with unique structures and reactive properties (Brini et al., 2017; Chaplin, 2000). Figure 1, a schematic representation of an aquagram, shows water molecules bound to proteins and sugars to form hydration and salvation shells in the top right, highly reactive small water clusters with one, two, and three hydrogen bonds on the bottom, and highly structured water lattices on the top left.

All these different water species with their various hydrogen bonds vibrate at a certain frequency. When the frequency of vibration matches the wavelength of light coming towards it, the water species absorbs the light, and that is how we know it is there. With our spectrophotometers we record all illuminated photons of various wavelengths at the start, and all photons transmitted through the tissue and arriving at the end. Those that are missing have been absorbed into the tissue. Many

1. (https://water.lsbu.ac.uk/water/martin_chaplin.html).



The two portable spectrophotometers used in the study

Figure 2. *A picture of the instruments and a graphic showing the transformation of the raw spectral data spectra to an aquagram.*

years of work and collaboration between spectroscopists, physicists, and computer model builders have helped to decipher the absorption spectrum of aqueous solutions and living organisms (Tsenkova, R., 2010, 2018; Muncan, J. et al., 2019; Ma et al., 2023; Tsenkova et al., 2015). Aquaphotomics is based on that knowledge and continues to build on it.

Here we present the first of its kind study where a portable spectrophotometer in the NIR range was used to look at the structural changes of water in human participants in mind body psychotherapy sessions. We hope you enjoy reading about it.

Study Design: Materials and Methods

Measurements. Two portable NIR spectrophotometers were used to take measurements from each participant: MicroNIR-Viavi Solutions, Santa Rosa, CA, USA, in the spectral range 908-1607 nm with approximately 7 nm resolution step, and APS-DTK Electronics, Sofia, Bulgaria, in the spectral range 600-1000 nm. The probes, as seen in Figure 2, comprise a small device that emits harmless light and is gently placed on the left palm of each participant. Seven consecutive measurements are taken over a total of 45 seconds. The probe was handheld by each participant. Before the measurements were taken, each participant quickly responded to 10 questions which rated their wellbeing with a score from 1 to 10, where 1 was *least agree* and 10 was *most agree*. The qualities rated were joy, happiness, confidence, inner peace, and confusion, which was rated with a negative score. A wellbeing total was later calculated for each participant, and the results correlated to any changes seen on the aquagrams. A separate correlation was done using each of the 10 graded components/questions.

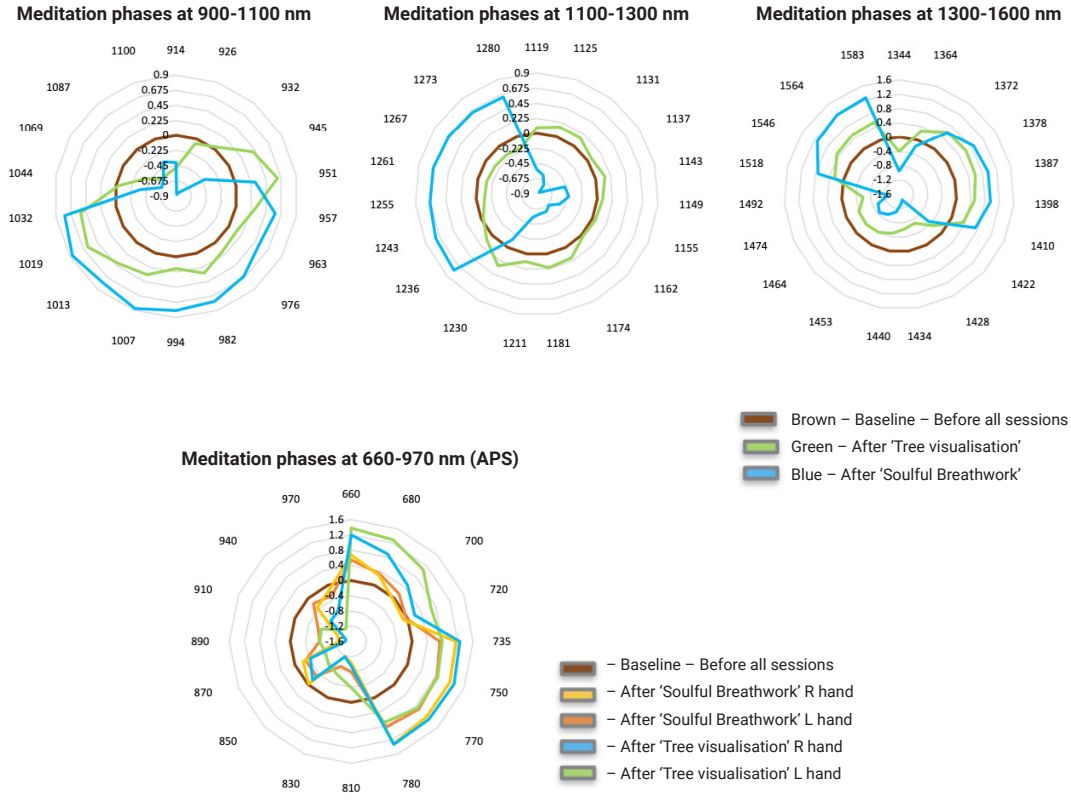


Figure 3. *A panel comprising the aquagrams of individual participants. Each aquagram has three lines – the baseline in brown, the measurement after the tree visualization session in light green, and the final measurement after the soulful breathing session in blue.*

Repeat measurements were acquired in an identical manner, using the same hand after each psychotherapy session by each participant. The measurements were taken as the participant exited the session room so that other influences were reduced to a minimum. A parallel questionnaire on wellbeing was also completed by the participant. With the APS device, a measurement was taken from both hands after each session in order to see whether laterality mattered.

Psychotherapy sessions. The first psychotherapy session was a reflective session called *the tree*, where participants lay on a mat on the floor with their eyes closed. Through the gentle guidance of the session leader, they were encouraged to imagine they were a tree with deep roots weathering different storms, and enjoying the sun when it came up. The session lasted 20 minutes. The second session, called *soulful breathing*, was also initially guided by the session leader. It focused on deep breathing and allowing various thoughts to freely enter one's mind. Deep breathing, part of neo-Reichian mind-body psychotherapy, continued throughout the session, which lasted an hour. In similar fashion, each participant was scanned immediately after exiting the room and completed a wellbeing questionnaire.

Data analysis. The SNV – Standard Normal Variate – method normalizes the spectra by subtracting from each spectrum its own mean, and dividing it by its own standard deviation. SNV attempts to make all spectra comparable in terms of intensity (or absorbance level). It can be useful to correct spectra for changes in optical path length and light scattering. The SNV values are plotted on the aquagrams presented.

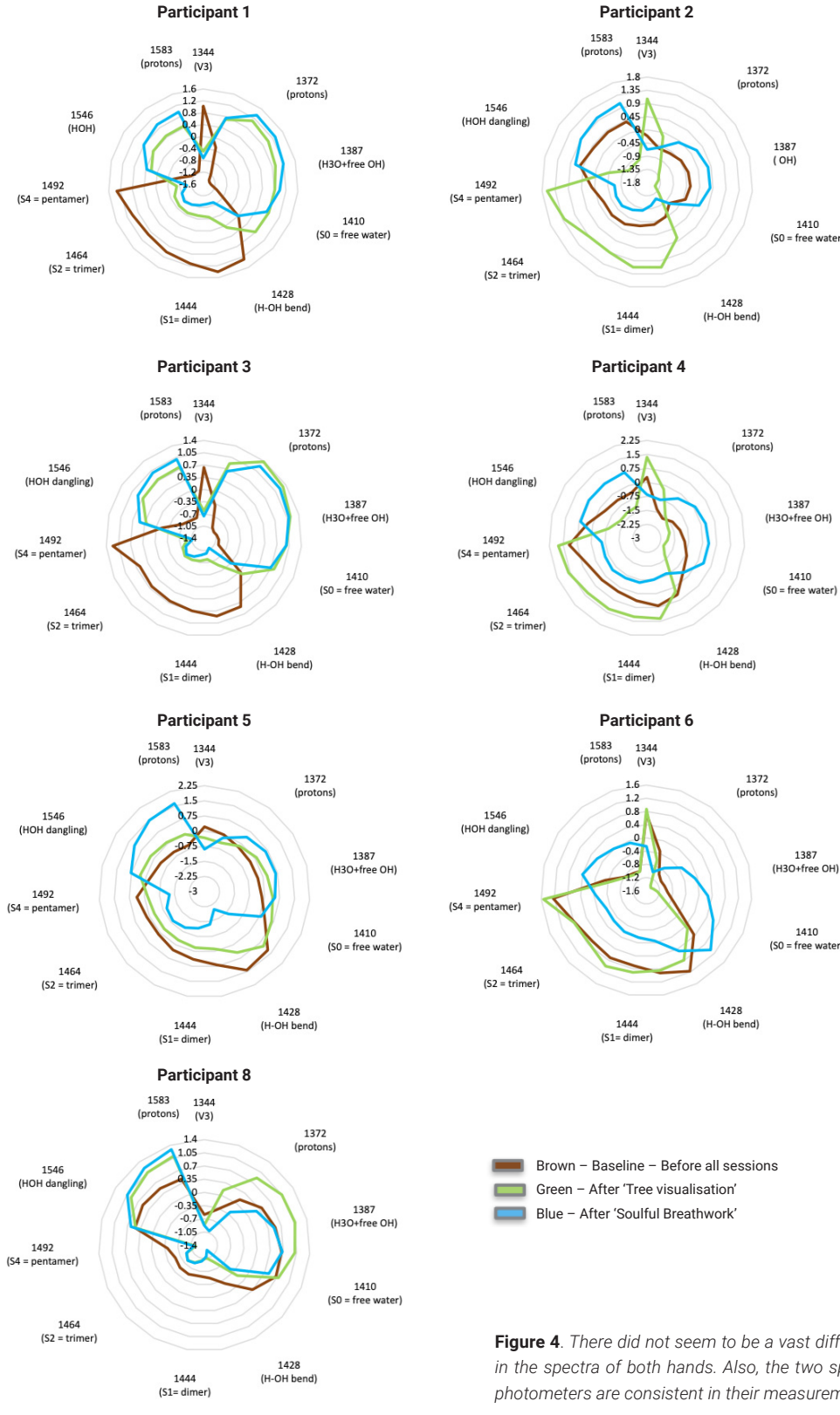


Figure 4. *There did not seem to be a vast difference in the spectra of both hands. Also, the two spectrophotometers are consistent in their measurements.*

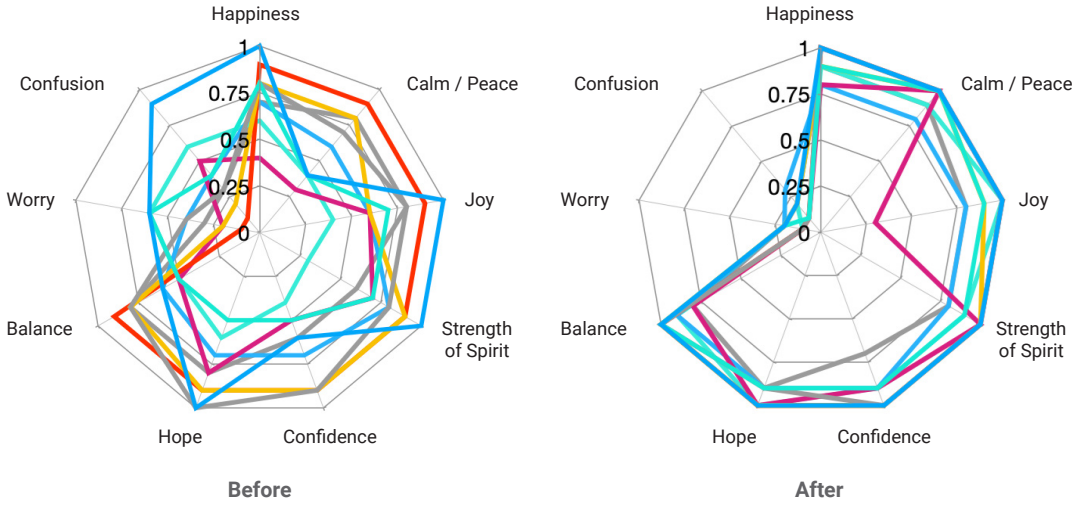


Figure 5. *A panel of three graphs showing the combined well-being questionnaire results before and after the sessions for each participant, as well as the average results.*

Results

Examining the raw spectra and after the SNV analysis, it is clear that all participants had a different aquagram to start with. In other words, their tissue water matrix had a unique mixture of water species bound to each other and to other biomolecules and ions. Participant 1, for example, had an abundance of water species absorbing between 1430 and 1490 nm, which is where the hydrogen bonded small reactive water clusters reside (Figure 3). In contrast, Participant 2 had no small reactive water clusters, but instead had an equal number of all water species, with a small predominance of the highly structured water lattice absorbing between 1510 and 1570 nm. Different still was Participant 8, who had hardly any small water clusters, and instead was rich in hydrated protons and ionically bound small water molecules forming hydration shells around proteins.

At the end of the first therapy session, which was the tree visualization lasting 20 minutes, the individual aquagrams continue to differ among participants (Figure 3). Participant 1 suddenly lost all their small reactive water clusters, and drastically increased their water solvation shells, hydroxylated water clusters, and proton – all absorbing between 1372 and 1420 nm. In contrast, Participant 2 increased their small reactive water clusters, absorbing between 1430 and 1480 nm at the expense of all other water species except for V3, which absorbs 1344 nm. Participant 5 favored reactive free water molecules known as S0, which absorbed 1410 nm after the tree visualization session. We thus see a variety of water molecular conformations at the outset, and a variety after the first psychotherapy session. In some participants, the changes in the water matrix are dramatic and qualitative (Participants 1, 2, and 3), while in others (Participants 4, 5, 6, and 8), they are small and mainly quantitative.

What is interesting is that following the second psychotherapy session of soulful breathing lasting about an hour, the aquagrams of all participants resembled each other (Figure 3). The shape of a two-winged butterfly can be seen in all seven aquagrams by looking at the pale blue line, which signifies the measurement after the second psychotherapy session. The left wing shows the increased absorption of hydrogen-bonded water molecules forming a lattice, while the right wing has hydrated protons, strongly bound to ions of single water molecules forming hydration and solvation shells. There is a small underbelly, too, pointing to a small reactive water cluster between S1 and S2 at 1454 nm, which, however, is much smaller compared to the wings.

Moving on to Figure 4, we see three aquagrams, which represent the average of all participants'

SNV data normalized to each participant's baseline (the brown line represents the baseline at 0). Focusing on the 1300 to 1600 nm range (the third from left to right), which represents the first overtone of water, one notices the above-mentioned butterfly in blue spanning the same regions. It is interesting that the pale green line of the first session closely resembles the blue line, suggesting that overall, the psychotherapy sessions move towards and achieve the water matrix conformation split between weakly oscillating lattices, and hydration shells with almost no reactive water clusters. This observation is confirmed by the absorption patterns at 1100 to 1300 nm (second aquagram) and 900 to 1100 nm (first aquagram), containing the second overtone of the water absorption bands, as well as by the bottom aquagram, which shows absorption in the first overtone of water absorption between 660 and 970 nm. The last aquagram was built using data from the second handheld spectrophotometer, called APS. Despite there being more overlap of information in the shorter wavelengths, they penetrate further into the tissue, and can be more informative in that way. We measured both hands at the same location following each session with the APS instrument in order to see whether there was a significant difference between the two. There did not seem to be a vast difference in the spectra of both hands. Also, the two spectrophotometers are consistent in their measurements.

Looking at the subjective way each participant graded their well-being before and after sessions, there was an average increase in the total score from 5.7 to 6.8 points. We can observe this positive trend in the individual graphs of each participant as well (Figure 5). Happiness, peace, joy, strength of spirit, confidence, and hope increase, while worry and confusion decrease. These results point to the positive impact that the mind-body psychotherapy sessions have on how people feel about themselves and the world.

Discussion

The idea for this study was born over a discussion between friends, whereby one asked whether emotions leave a footprint on our cellular water matrix. We intuitively know that good emotions make us feel happy, and happy people are healthier and live longer, while bad or negative emotions bring stress, and lead to disease. Mind-body psychotherapy helps us address and release stress from our bodies. We came up with the idea of using aquaphotomics to examine the changes in water matrix brought about through mind-body analytical psychotherapy sessions.

It is important to note that performing the actual measurement was easy, quick, and reliable. This was all thanks to the two portable light spectrophotometers, MicroNIRS and APS, which take spectra quickly, painlessly, and with great precision. There are no known harmful effects to the skin, connective tissue, and muscle in the hand, where the measurements were performed. The intensity of the light is minimal – enough to collect data and not too much to change the scanned tissue in any lasting way. APS uses shorter wavelengths in order to penetrate deeper into the tissue without having to increase intensity, and its newly built software generates aquagrams automatically. After several pilot experiments, we realized that it is very important to perform the measurements very close to the end of the session and before the participant has started talking, eating, drinking, or simply thinking about something else. The more the participant was immersed in the session, the more consistent the results. The wellbeing questionnaire was usually completed after or just before the measurements were taken, which makes us think it was also a good reflection of the participant's internal state.

Our participants all had very different aquagrams at the outset. After the second session, the aquagrams all resembled each other, which would suggest that the participants had synchronized in some way in the mind-body psychotherapy sessions, or that the sessions led to structuring their water molecules in a particular way. Synchronization of breathing, heart rate, and even brain waves has already observed and documented in mind-body psychotherapy sessions (Matiz et al., 2021); hence, this was no surprise. But what is the significance of what happens to the cellular water matrix in our participants' bodies when they attend the mindfulness sessions?

To answer this question, we need to look at the aquaphotomics literature published over the last 20 years, where thousands of NIR absorption spectra have been collected and analyzed, and parallels drawn. These include diagnostics and understanding of mammary gland inflammation in cows

(Tsenkova et al., 2001), prion protein fibrillation (Tsenkova, R., 2004), ovulating pandas (Kinoshita et al., 2016; Kinoshita et al., 2012), soybean plants with tobacco mosaic viruses (Jinendra et al., 2010), resurrection plants (Kuroki et al., 2019) and mice with prion proteins and insulin fibrillation (Chatani et al., 2014; Tsenkova et al., 2004). We also must review research published on the physicochemical properties of water determined through experiments (Brini et al., 2017; Chaplin, 2000), and at computer models describing how water molecules interact with each other under certain conditions and the different structures they form (Brini et al., 2017; Kovacs et al., 2020; Muncan & Tsenkova, 2023).

Going back to the model aquagram in the beginning, which describes the different water structures detected under the first overtone of stretching vibrations of water between 1300 and 1600 nm, we understand that light absorption in the far right between 1300 and 1400 nm reflects the presence of the "working" water species – free water molecules and those forming hydration shells around proteins, sugars, DNA (Zhang et al., 2007), etc. They are present when there is normal metabolism in the cell; they are important for homeostasis and day-to-day cellular functions in a balanced, healthy organism (Averina et al., 2023). On the far left of the model aquagram between 1500 and 1600 nm, one sees the highly structured water lattice of weak hydrogen bonds, which are again seen in health (Hassanali et al., 2013). They act like water batteries, and release energy when needed (Kovacs et al., 2021; Muncan, J. et al., YEAR). A composite of these two water structures is seen to predominate following the last psychotherapy session – the above-mentioned butterfly, which shows a healthy cellular arrangement.

The water structures missing from our post-psychotherapy session aquagrams are the so-called small reactive water clusters found between 1400 and 1500 nm, known as S0, S1, S2, S3, and S4 (Zhang et al., 2021). The numbers refer to the number of hydrogen bonds formed between the water molecules. S0 is a single water molecule with no H-bonds, S1 is a dimer with 2 H-bonds, S3 is a pentamer, and so on (Chaplin, 2000). Different experiments have shown that these water clusters appear when the living system is under stress – during inflammation (Tsenkova et al., 1999), post-radiation (Tsenkova et al., unpublished data), and desiccation (Kuroki et al., 2019), or when bombarded with free radicals (Muncan & Tsenkova, 2019), etc. These highly reactive small water clusters are not a sign of health, but a sign of emergency measures employed to keep the organism alive. They are also present when it finally dies. These water structures are the ones that are greatly reduced by our psychotherapy sessions. Simply put, the hour-long soulful breathing analytical psychotherapy session seems to restore the healthy balanced water signature in the body while reducing stressful, emergency measure structures.

Further work needs to be done to elucidate the mechanisms through which these psychotherapy sessions elicit their effects on a physical level. A lot of research is currently underway on monitoring the brain during mindfulness sessions through fMRI and EEG recordings (Ahani et al., 2014; Matiz et al., 2021). Perhaps parallels can be drawn between the state of the brain and the state of our water matrix. This is the first time such an experiment has been performed in psychology, and one of the very first in humans. NIR spectroscopy and aquaphotomics is a rapidly growing scientific field spanning many disciplines. We hope this work in psychotherapy can be developed further through collaborations as we continue to understand how our minds affects our bodies.

Acknowledgements

We would like to thank the Bulgarian Neo-Reichian Institute for Analytical Psychotherapy for providing the space and setup for the study, as well as for financial support. The Aquaphotomics laboratory at Kobe University in Japan provided the MicroNIRS spectrophotometer, while DTK Electronics built the APS device, together with Professors Roumiana Tsenkova and Kolio Iordanov. Alexander Stoilov at Yunosato Aquaphotomics Laboratory analyzed the spectral data and built the aquagrams. Dr. Ilina Iordanova designed and conducted the experiments in collaboration with psychotherapist Madlen Algafari, and developed the wellbeing questionnaire.

Ilina Iordanova, MD, PhD, *is a trainee neurosurgeon at ISUL Queen Joanna Medical Center in Sofia, Bulgaria. She obtained her MD (MB PhD) at the University of Cambridge Clinical School and the Department of Physiology, Development and Neuroscience under the supervision of Prof. William Harris. While at Cambridge, she forged a collaboration between Dr David Brown and Prof. Roumiana Tsenkova, which lead to the study of prion proteins with NIR spectroscopy and laying the foundations of aquaphotomics. Following foundation training at NHS hospitals in the UK, Dr Iordanova pursued postdoctoral research at the Department of Neurosurgery at Stanford University Medical Center under the supervision of Prof. Gary Steinberg. There, she focused on the role of Wnt-3a signaling in post-stroke recovery in mice. In Spring of 2022, Dr Iordanova contributed to the collaborative efforts between Prof Tsenkova from Kobe University, Japan, and Madlen Algafari at the Bulgarian Neo-Reichian Institute for Analytical Psychotherapy by conducting the current study.*

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Roumiana Tsenkova, *Professor at Kobe University, Graduate School of Agricultural Science, Aquaphotomics Research Field has pioneered the area of non-invasive disease diagnosis with near infrared spectroscopy (NIRS) and multivariate analysis. Dr. Tsenkova is the founder of a new "omics" discipline called Aquaphotomics. In 2005, she discovered water absorbance bands specific for biological and aqueous systems and proposed to build up a database called aquaphotome to be further used for diagnosis, quantification and functional characterization on a system level discovering the phenomena of water being a mirror.*

Dr. Tsenkova has written more than 20 chapters in books, 120 papers and has 17 patent applications. The total number of citations of her work exceeds 4400. She has been a PI for more than 21 projects. She is the recipient of the Japanese Near Infrared Society Award *for 1998 and the* Tomas Hirshfeld International Near Infrared Spectroscopy Award *for 2006. Dr. Tsenkova has been a keynote speaker at a number of national and international conferences, including the UN 2023 Water Conference in New York, organized by the United Nations.*

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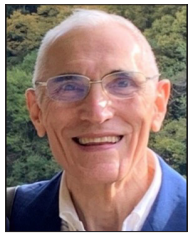

Kolio Iordanov *is a software system engineer who graduated from Ruse Technical University in 1979. He has worked for Japanese software companies since 1993 and helped develop various software and platforms. After his retirement in 2021, he joined the laboratory of Professor Roumiana Tsenkova at Kobe University, Japan and is using his skills to build and run an aquaphotomics database. Since 2016, has collaborated with Daniel Todorov of DTK Electronics in building a specialized VIS-NIR spectrophotometer for expanding the knowledge of aquaphotomics.*

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Daniel Todorov *is the executive director of DTK Electronics Ltd., which he founded in 1996. It is one of the leading manufacturers of telecommunications and measuring equipment in Bulgaria. Since 2016, in collaboration with Professor Tsenkova and Kolio Iordanov, he has been working on the design and production of specialized VIS-NIR spectrophotometers covering the technical requirements of aquaphotomic science.*

As a high school student Daniel was part of the laboratory of Professor Tsenkova at Ruse Technical University, where he was involved with experiments using NIR (Near Infrared Spectroscopy) for cow's milk diagnosis. He graduated in 1993 with a master's degree in Medical Electronics at the Technical University of Sofia, Bulgaria. He was head of the research and development department of the Eurotour SAT TV company until the end of 1995.

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Shogo Shigeoka *was born in Hashimoto, Japan in 1967. He became a director of the Shigeoka Company in 1987, after which, in 1989 he graduated from Kindai University, Osaka, Japan, with a Bachelor degree in Business Administration. In 1998, became a director of the Yunosato Company. After showing interest in supporting science, in 2011 he started joint research with Kobe University's Aquaphotomics Science Department led by Professor Roumiana Tsenkova. Since 2015, he has been the CEO of both the Shigeoka and Yunosato Companies, and in 2020, he established the Yunosato Aquaphotomics Lab which is the first and, up to this day, only industrial aquaphotomics laboratory.*

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Madlen Algafari *is a psychologist, psychotherapist, author of 12 books, and theater director. She received her MA in psychology from the University of Sofia "St. Clement Ohridski" in 1991, and in 1998, a postgraduate specialization in Neo-Reichian analytical psychotherapy with Prof. Waldo Bernasconi in Lugano, Switzerland. She is a member of the Bulgarian Neo-Reichian Association, of the Bulgarian Scientist's Union–Psychology and Pedagogy section, President of the Board of Directors of the Bulgarian Institute for Neo-Reichian analytical psychotherapy, member of The Bulgarian Association of Psychotherapy, and member of the European Association of Body Psychotherapy. She is the former Editor-in-Chief of the* International Body Psychotherapy Journal.

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