

CAN LONG-TERM TRAINING IN HIGHLY
FOCUSED FORMS OF OBSERVATION
POTENTIALLY INFLUENCE PERFORMANCE IN
TERMS OF THE OBSERVER MODEL IN PHYSICS?
CONSIDERATION OF ADEPTS OF
OBSERVATIONAL MEDITATION PRACTICE

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ABSTRACT: This paper presents developments in a published yet still little known model of how intensively trained individuals – adepts or virtuosi of special meditational techniques – appear to be potentially capable of radically enhancing their sensory perceptual capacities to the point of, for example, directly perceiving light at the scale of single photons, at the quantum mechanical limit of its detectability. This is a working model which is based also on little-known work of leading physicists and biophysicists from Princeton, Stanford, Berkeley and other institutions.

KEYWORDS: Meditation; Perceptual capabilities; Quantum mechanics

INTRODUCTION

This paper presents developments in a published yet still little known model of how intensively trained individuals – adepts or virtuosi of special meditational techniques – appear to be potentially capable of radically enhancing their sensory perceptual capacities to the point of, for example, directly perceiving light at the scale of single photons, at the quantum mechanical limit of its detectability (Bushell 2009a,b; Bushell 2011a,b; Bushell in preparation). This is a working model which is based also on little-

known work of leading physicists and biophysicists from Princeton, Stanford, Berkeley and other institutions.

Along with the enhanced perception of light, the working model presents evidence, based on established findings in neuroscience, for other forms of significantly, even radically, enhanced perceptual abilities: the ability to perceive on the spatial scale of a fraction of the diameter of a human photoreceptor cell, or within millionths of a meter (“hyperacuity”); the demonstrated ability to overcome “normal” limitations in experimental tests of change blindness; and others.

The model hinges on a number of key principles established in neuroscience: the phenomenon of neuroplasticity, which, in sensory-perceptual or observational terms, results from exposure to sets of visual stimuli, as well as to deliberate practice of observation; the of course closely related phenomenon of “perceptual learning,” which can lead, through practice-induced neuroplastic changes, to perception in the realm of hyperacuity; and the schema of “expert and exceptional performance,” which is a form of rigorous science devoted to investigating the superior performance of a range of leading experts (from chess grandmasters to virtuoso musicians, as well as to savants), which was originally developed by the Nobel Prize-winning cofounder of the fields of cognitive psychology and AI, Herbert A Simon.

The model winds up providing support for claims of some meditation traditions (in Tibet, India, elsewhere) that highly advanced long-term practitioners become enabled through intensive and extensive practice to *directly perceive* the world at the “limits of phenomena,” ie at fundamental levels of matter and energy. This is an alien concept in the West (except perhaps within the realm of “parapsychology,” which will not be discussed in this paper), as is the concomitant concept that these intensive and extensive practices may lead, through the “mechanisms” elucidated, to the radical transformation of the human sensorium into a kind of “soft tissue high tech” system with previously unsuspected capacities which resemble those found in modern technology. The potential capacity to observe fractal self-similarity on microscopic and macroscopic scales will also be discussed in this framework.

ENHANCED ABILITY FOR THE PERCEPTION OF LIGHT AND SCALE IN VIRTUOSO MEDITATORS?

The revision of scientific history proposed here, that the development of Western technology, paradoxically, can be utilized to demonstrate that centuries and perhaps millennia ago, developments in meditation practice led to extraordinary extensions of sensory-perceptual capacities, which in fact may be thought of as representing a kind of earlier scientific and technological revolution. Bushell (2009a) asserts that such a claim is based on recent research—the advanced high technology research mentioned

in the Dalai Lama's writings—by physicists and biophysicists from Stanford, Princeton, Berkeley, Columbia, the University of Washington, among others, research that has demonstrated that, under certain conditions, the human visual system is capable of detecting light at or near “the limit imposed by quantum mechanics,” and actually at the level of single photons. To summarize this extensive research conducted in numerous labs, Rieke and Baylor (1998), writing recently in *Reviews in Modern Physics*, claim that the human visual system, beginning with the photoreceptor cells of the retina, are “*nearly perfect photon counters. . . [which] equal or exceed the performance of man-made detectors*” including “solid state silicon detectors (photomultiplier tubes and charge coupled devices).” Speaking further of these “nearly perfect biological photon counters, built of protein, lipid, carbohydrate, and water,” Princeton biophysicist William Bialek (1987) explains that under certain conditions human “visual sensitivity approaches the limits set by the division of light into discrete photons and the statistical fluctuation in photon absorption. [And these fluctuations] are unavoidable and impose a fundamental limit to visual fidelity that no imaging device can exceed.”

Continuing with the project, the program, of investigating the purported ability of virtuoso , Indo-Tibetan practitioners of “yogic directly perception of the limits of phenomena,” the “partless particles” of that which exists; our framework suggests that the intensive focus on developing the technical (“soft tissue-high tech”) means to do so, is based on what in contemporary cosmopolitan neuroscientific terms are principles recently established, namely neuroplasticity-mediated perceptual learning in the direction of hyperacuity, the “remarkable” (in Princeton biophysicist William Bialek’s words) human capacity to perceive distances within the range of a fraction of the diameter of a photoreceptor cell, ie within the range of millionths of a meter.

A recent study, (see Pizzi et al 2016) exploring the capacity of normal subjects to perceive light at the magnitude of the single photon, does not include subjects who have trained in the observational meditation methods described for the specific and explicit intensive light investigation, as outlined in Bushell 2009a, 2011a,b, and Bushell, in preparation. While this is an excellent study, like all other studies on human photon detection, there is no incorporation of extensive “deliberate practice,” (Ericsson et al, in Bushell, 2009; Ericsson & Simon 1993) into the study design, which can be crucial to understanding human potential. Pizzi et al do mention a range of proficiency in their subject population, but as Simon and Ericsson and colleagues have conclusively demonstrated, deliberate practice meeting the special criteria of “expert and exceptional performance” can produce magnitudes of improvement in both qualitative and quantitative measures of performance in many areas, including performance in sensory-perceptual tasks.

The explicitly and specifically stated goal of the Indo-Tibetan yogic tradition is to directly perceive the miniscule, the microscopic, and beyond. We have already seen that a compelling case exists for the ability to perceive light at its quantum statistical limit, in the range of individual photons, and now we will specifically consider that which is illuminated by light, in terms of microscopic distances in space, the surfaces of “matter.”

Here again, our enterprise will lead us to outline and describe the Indo-Tibetan practices and associated phenomena, and possible parallel or homologous types of phenomena from disparate and scattered areas of Western neurology, psychophysics, “anomalous psychology,” and neuroscience. These examples are necessarily disparate because Western science does not have a prominently known, conceptually organized, coherent schematic framework for how statistically anomalous psychological and psychophysical capacities might be developed by potential practitioners, cultivated, enhanced, and directed to the bold and revolutionary enterprise of direct sensory-perceptual prehension (Whitehead’s term) of a domain defined by ontologically and metaphysically (in the academic philosophy of science meaning of that term) “ultimate” categories of existents.

As will become apparent in this part of the analysis, we begin by describing an intensive and extensive practice of mental imagery cultivation, visualization meditation; this will eventually bring us, however, to an understanding of how this practice leads “organically” to, among a number of goals, a potentially radically enhanced sensory-perceptual goal in particular.

GENERAL INDO-TIBETAN KALACHAKRA MANDALA MEDITATION PRACTICE

The practice focused on here is mandala meditation (specifically the formidable Kalachakra Mandala meditation practice, though the principles are generalizable to other mandalas; see immediately below) in the Indo-Tibetan Buddhist tradition, for which however there are at least relatively comparable practices in other meditation and yoga traditions. The first phase of the practice consists of observational meditation sessions in which the practitioner intensively observes a model of one of a number of versions of the Kalachakra mandala, which may be a 3D model composed of wood, stone, or other materials; may be a sand mandala; or may be a thangka (composed on cotton, silk applique, or other material). This observation meditation seeks to record as many details of the mandala as possible, which – particularly in the case of the Kalachakra mandala and practice – can be quite considerable in the sheer number of visual details. In this discussion we focus first on the version which consists of 722 deities (see immediately below), within a mandala palace or mansion, and includes the grounds and surrounding area of the structure proper. The architectural details of the

structure (including landscape architecture) itself are often extremely elaborate and complex, involving multiple colors, shapes, features, etc (see B Simon et al, 1985; Arnold 2009).

There are multiple purposes for the memorization of the components of the mandala. One of the primary “higher-level” (conceptual) purposes, as I have discussed elsewhere (Bushell 2009a, b), is to provide a mnemono-technically efficient means of allowing for memorization of the considerable range of particular concepts signified or embodied by particular deities (egs, compassion, wisdom, insight, many others); this function in fact utilizes the fundamental mnemono-technic of the “memory palace,” or “method of loci,” the actual efficiency of which has been demonstrated experimentally and clinically (see Bushell 2009a, and references therein). The historical-cultural reasons for the use of this methodology by practitioners include prosaic ones, such as relatively rare access to mandala models, thangkas, and even texts (ie, the latter describing the rich and elaborate meanings associated with the deities), in traditional and even contemporary contexts. In more profound terms, there is the native sense that direct “memorization” – in terms of internalization and integration of what are considered deep, profound spiritual truths – is in fact radically superior to merely possessing a depiction of or text describing the mandala and its contents, that one can more easily refer to (see Bushell 2009b; Yates 1966; Ong 2002). It is held by the tradition that this form of meditative memorization actually leads to the potential for deep transformation through such mnemonic internalization and integration of the concepts (see Gyatso 1992) – and with respect to the Kalachakra practice in particular, the stages of the practice are formally and explicitly associated with stages of childhood, invoking and evoking visceral, subliminal, and vibrant nostalgic as well as unconscious, programmatic “cues” for the most powerful forms of learning and transformation that are most often found robustly in the universe of childhood.

Furthermore, relevant to our thesis in this context is the idea that the practice of mandala meditation, according to a large body of indirect but highly relevant data from the field of “environmental enrichment,” is likely to trigger stem cell activation in the brain, neurogenesis (see Bushell 2001, 2005), which in turn would likely be associated with neuroplastically-mediated perceptual learning in the direction of the enhancement of the capacity for hyperacuity.

In what follows we adopt an orientation that combines data from the field of Indo-Tibetan yoga/meditation (text, commentary, and oral tradition) studies with data from the Western (or more accurately, cosmopolitan) science fields of neurology, anomalous psychology, psychophysics, and neuroscience.

THE SPECIFIC KALACHAKRA MANDALA MEDITATION PRACTICE

In one of the more demanding versions of the Kalachakra Mandala Meditation Practice, a key early milestone in the development of proficiency is when the beginning practitioner, through intensive and extensive practice, becomes capable of creating an internalized (mental) image of the mandala in which all the deities are at once completely visible and perceived in full detail clearly, as a unified whole, in the practitioner's mental visual field. At this point in the analysis we focus on the version of the Kalachakra in which there are 722 deities. In other words, the practitioner is expected at this beginning-intermediate stage to be able to create an extremely clear and precisely detailed mental image of the Kalachakra Mandala, with all 722 deities, each clearly visible, within the architectural structure in all its details (see Jackson 1985).

There are two key concepts in addition to those described above (in the section on photon detection) which are central for an integrative understanding of the processes involved here: "eidetic imagery" and "subitizing." Eidetic imagery is defined by the dictionary as "of, relating to, or constituting visual imagery vividly experienced and readily reproducible with great accuracy and in great detail" (from the Greek root for "equivalent to"; <http://www.dictionary.com>). According to a fairly extensive body of research, eidetic imagery is rare, more often found in children than adults, and there is some evidence, though controversial, that the trait is more often found in traditional cultures than in more modernized ones (see discussion in Bushell 2009b, and Crawford et al 1986).

Of further importance in the context of this discussion, there is evidence that eidetic or eidetic-like imagery capacities can be "brought on," developed, and enhanced through mental imagery practice, and also through pursuing such practices in conjunction with the induction of states of attentional absorption, a formal quantitative and qualitative construct developed to instrumentalize terms such as "trance" and "hypnosis" or "hypnotic states," as well as for further elucidation of meditational states and the relationship of the latter to the former. (For further discussion of these matters, including the idea that eidetic imagery can be developed, and the idea that there are commonalities between mental imagery, hypnotic, and meditational states, see Bushell 2009b).

Another key concept for this discussion is that of "subitizing" or "numerosity." To subitize is defined by the dictionary as "to perceive the number (of a group of items) at a glance and without counting" (thefreedictionary.com; parentheses in the original). Many dictionary definitions also note that the general limit for the general population is 5-7 items of comfortably subitized elements. In fact, this number was based on early post-war experimental psychology research, and formed part of the basis for why

phone numbers were designed to be within such a range of digits, for easy recollection and recognition (Miller 1956).

The capacity for radically enhanced subitizing capacity appears to be inherent in the descriptions of the Kalachakra meditation practice, and in some of those phenomenal experiences described herein. Again, through our methodology of searching in the Western neurological, anomalous psychological, and neuroscientific literatures for parallels with these descriptions, one finds a disparate scattering of similar phenomena which in this case tends to be associated with individuals characterized as autistic, autistic savants, and “prodigies” (see Obler and Fein 1988; Ericsson et al 2009; Bushell 2009b, 2011a; and Bushell in preparation, for a discussion of these categories of anomalous psychology and “expert and exceptional performance”). However, our colleague Ericsson, in collaboration with Herbert A Simon, showed that with sufficient (usually substantial) amounts of “deliberate practice” time, subjects who perform within the normal range of memory on standardized tests, can significantly and even radically increase their ability to remember, recall, and recognize (all capacities related to subitizing). Ericsson and Simon and their colleagues trained several such normal subjects to improve from 7-digit memory to over 80 and 100 digits, with dozens/hundreds of hours of deliberate practice time (see Ericsson et al, in Bushell et al, 2009 for review and discussion).

A few examples of dramatic subitizing abilities will now be described here (only a few due to space constraints), in order to provide a sense that can open a door to the appreciation of the potential veridicality of the descriptions of both eidetic imagery and subitizing, as well as hyperacuity, in the Indo-Tibetan yogic context. (It should also be noted that the issues of spontaneous versus practice-induced factors in these cases will not be addressed in what follows, also due to time and space constraints. These questions, however, are indeed of major significance and are complex).

One particularly evocative clinical account of subitizing comes from the well-known (and scientifically highly regarded) neurologist Oliver Sacks, MD. Sacks did extensive clinical research on individuals with autism and savantism (as well as some with non-autistic prodigies), and recounts in this context a particularly striking account of subitizing (Sacks 1995, 1985). Visiting twin savant patients of his at their home in the Bronx, Sacks accidentally knocked a box of kitchen matches to the floor. The box spilled its contents, and the twins instantly, in unison, exclaimed, “111!” They then proceeded, also immediately, without a pause, to factor 111 (a perfect totient number) into the product of the prime number 37 multiplied by 3, prime numbers being the twins’ life obsession. Sacks of course counted the matches and found, indeed, that there were precisely 111. The twins did no “counting” of the matches, their reporting

of the number was instantaneous and immediate according to Sacks, they saw or subitized the exact number in a moment, in one instantaneous unified perceptual act or “frame.” This case report, in fact, resonates with a body of clinical and anecdotal data, which has also more recently gotten further support through experiments conducted by the pioneering neuroscientist Allan Snyder, who induced a form of subitizing in normal volunteer subjects through magnetically manipulating key brain areas found to be active in studies of subitizing versus counting (transcranial magnetic stimulation; see Snyder 2009).

Sacks’ body of work on anomalous and prodigious visual capacities also includes several non-autistic/savant cases of persons who are often referred to as “prodigies.” One such case is the history-making Australian amateur astronomer Robert Evans, who for years specialized in spotting extremely rare supernovae in the night sky through his amateur 10- and 16-inch telescopes. Evans has made an historic number of such discoveries, and was actually thereby substantially contributing to the development of contemporary astronomical science through his unprecedented record of such discoveries over a period of years. A technological innovation in astronomical observation, however, to a significant extent altered the importance and volume of his discoveries more recently.

The task of this careful, extremely detailed observation of enormous swaths of the celestial firmament, as described by the science writer Bryson, also familiar with the case of Evans, reveals what appears to be a prodigious eidetic memory for star fields, as in visual terms, the occurrence of a supernovae is observable within the visual field of the astronomer as a dot the size of a grain of salt; in Bryson’s (2003) words:

“To understand what a feat this is, imagine a standard dining room table covered in a black tablecloth and someone throwing a handful of salt across it. The scattered grains can be thought of as a galaxy. Now imagine fifteen hundred more tables like the first one – enough to fill a Wal-Mart parking lot say, or to make a single line two miles long – each with a random array of salt across it. Now add one grain of salt [ie, representing the supernova, which is no bigger than the other stars] to any table and let Evans walk among them. At a glance he will spot it...” [my parentheses; incidentally, this case might also be considered an example of the so-called “Genius Dot Test,” <https://itunes.apple.com/us/app/genius-dot-test/id988222365?mt=8>]

One can understand this as a case involving both extremely accurate eidetic imagery and a subitizing or subitizing-like capacity, and a case in which such mental imagery functions mnemonically in an applied way to enable detection of extremely miniscule alterations in visual fields, ie, eidetically memorized star fields. As impressive as this case may appear to be, it is nevertheless of course an anecdotal one. The next

and last case presented in this discussion is equally as or more impressive and yet is a more rigorously investigated single-case study, and was investigated using an impressively error-proof methodology, and was published in the leading journal *Nature*.

A series of experiments were conducted by a team of leading visual scientists from MIT, Harvard, and Bell Laboratories on a non-autistic eidetiker with reputedly unusually prodigious eidetic abilities. The tests were conducted using a methodology called unfakeable computer-generated random dot stereograms, in which the subject is presented with 2 random dot patterns, one to each visual field independently (ie, left and right eyes), through a stereoscope. The random-dot patterns are generated by a computer such that when viewed through the stereoscope simultaneously, a hidden figure will emerge in the stereoscopically fused visual field of the subject. The figure, usually such as a large letter, cannot be seen unless the 2 independent fields are presented simultaneously, and because of the complexity of the dot fields composed of thousands of randomly arranged dots, the figures can also not be guessed. This methodology was developed to clinically test stereoscopic vision, and was adapted to test for eidetic imagery, because in the test for eidetic imagery, one of the fields is removed before the fusion step in the test. A true eidetiker would be able to use the ongoing eidetic image in memory of one of the visual fields to then merge that alleged eidetic mental image with the actual image of the other visual field screen, allowing for the hidden embedded figure to emerge.

The subject “E” was tested for potential eidetic ability by viewing the two different “companion” random-dot fields, each one sequentially and independently, with durations of separate viewing of 24 and 4 hours, respectively. In the 24-hour separate visual field viewing test, the random-dot field was composed of 10,000 dots, and the 4-hour separate visual field viewing test was composed of 1 million randomly scattered dots. In both cases, and in a number of trials, E successfully detected the computer-generated figures “embedded” and “hidden” in the computer-generated random dot patterns. This remarkable performance clearly demonstrated that the eidetic visual memory of this subject had full access, “control,” of at least from 10,000 to 1,000,000 “bits” of visual information, to a “texture” or “grain” of her visual field with complete access to this highly textured visual memory; detection of the hidden and embedded organized pattern would have been impossible to achieve in the computer-generated array of randomly dispersed dots otherwise.

Returning to consideration of the claims of the tradition of Indo-Tibetan Kalachakra Mandala practice, we can already appreciate the potential range of human visual capacities, in terms not only of least light perception, but also of

hyperacuity, eidetic imagery and memory, and subitizing, before continuing to consider the claims of that tradition. Returning to explicit description of the practice, we see that the text specifies that the practitioner should simultaneously see (in Western neuroscientific terms, “subitize”) the 722 deities of the mandala in a mental (or eidetic) image maintained continuously in memory with profound veridical detail. The next qualification is that the practitioner to attain proficiency should be able to see (ie subitize) with crystal clarity, the whites of the eyes of all 722 deities, which now actually specifies a total of at least 1444 visual “items” to be clearly viewed in a single glance (and which should also be maintainable for an extended duration); and of course the total viewing is actually greater, as the full figures of the deities and their surroundings are also to be seen (ie, not just the two eyes of each).

Moreover, there is still an even more elaborate version of the Kalachakra Mandala, consisting of a palace with 1,620 deities, instead of 722. These must be viewable such that the whites of their eyes are also all clearly seen, so at this point in the process there are at least 3,240 visual “items” to be distinctly seen (ie, subitized), and of course also the remaining parts of each deity, and the structure of the mandala, and its thousands of little and big details. And furthermore, it is next stipulated that the advancing practitioner must *then* be able to “shrink” this extremely rich, detailed, and full image to the size of a mustard seed, and to still retain the ability to see all the details fully, in one, subitizing, act of perception.

In our attempt to develop a model based on potential parallels and homologous types of perceptual phenomena in the fields of neurology, anomalous psychology, etc, we may then now add to the capacities for eidetic imagery and subitizing, that of hyperacuity. For the size of a mustard seed is 1-2 millimeters in diameter, and hyperacuity as defined above refers to the ability to accurately perceive phenomena within the range of millionths of a meter, so this feat is still hypothetically within the range of possibility; creating this testable hypothesis within the interdisciplinary, cross cultural, anomalous psychological/psychophysical framework presented here. Indeed, through the neuroplasticity-mediated perceptual learning and development of enhanced hyperacuity logically assumed to be associated with this practice, we see that the original focus on the development of radically enhanced mental imagery, may in turn potentially lead to the development of extremely fine-grained production of mental imagery fields, that could then be utilized in visual perception.

In the terminology of cosmopolitan sensory-perceptual neuroscience and psychophysics, all the extensive training in mental imagery has among a number of simultaneous functions and goals, ultimately also a perceptual, not merely a mental imagery goal: to enable the practitioner to perceptually access the realm of the

miniscule, the microscopic; to attain to the range of the “limits of phenomena,” to the level of the “partless particles” of the “substance” of the universe.

And in fact the obvious relevance of this explicitly stated goal of the meticulously outlined and detailed program of “yogic direct perception of the limits of phenomena,” the “partless particles” is can perhaps be most clearly linked to the final stipulation for the aspiring Kalachakra Mandala practitioner, as she passes on through to the most advanced stage of practice. At this point, one must not only be able to see (subitize) the 3240 eye whites of the Deities, but also the Deities’ eyes’ reflections of each other. The text stipulates that one must be able to see in the mind’s eye the reflections of each eye in each other eye, which in turn produces further reflections, and further reflections, etc, ad infinitum.

This is a version of the “infinity mirror phenomenon” in optics and geometry, specifically in turn involving the phenomenon of fractal self-similarity across scales. There are strong indications that the Indo-Tibetan (and other traditions) recognized the profound significance of the notions of fractal self-similarity across scales (as well as the “holographic” significance of reflections) in their theoretical cosmological “speculations” (see the Dalai Lama, 2005; Mumford et al, 2002; Cook 1977; and Bushell, in preparation). Moreover, in conclusion, we see here that the mental imagery exercises of the Kalachakra Mandala Meditation Practice may in fact usher the practitioner to the developed capacity to *perceive* within the range of single photons and hyperacuity, and may also open a sensory-perceptual portal in the direction of the infinitesimal. A major guiding idea of the tradition and its “soft tissue-high tech” scientific system, has been to penetrate through the seemingly solid substance of the universal plenum, to smaller and smaller particulate textures of the apparent solid substance, hidden by our *seemingly* limited perceptual capacities – which may in fact turn out to be not as limited as was thought. In fact this is the premise of the system developed to realize “yogic direct perception of the limits of phenomena,” to “move beyond...the (purportedly) inaccurate sensory-perceptual constructions which systematically distort dense spatiotemporal textures into solid objects” (Bushell 2011b), and possibly beyond those particulate textures as well, to a form of fractal-holographic realm of energy or information (or “consciousness”?), which is the intended meaning of the Eastern term “emptiness,” and at the same time resonates with the holographic model of the universe in contemporary cosmopolitan cosmological science?

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