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Neurodharma: Practicing with the Brain in Mind

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Introduction

In philosophy, psychology, and Buddhism, there have been many discussions between those who believe that our mental activities – the 10,000 joys and 10,000 sorrows – depend *entirely* upon natural processes and those who say that there are super-natural, transcendental influences of some kind (e.g., Batchelor 2011; Wallace, 2009). Personally, I have found these discussions interesting but often frustrating because we don't have enough information to resolve this issue, and dogmatism on either side seems uncalled for.

On the one hand, the absence of evidence is not evidence of absence: even if there is no proof yet that something transcendental is required for a complete account of the mind, this does not mean that there is no such X factor. 96% of material reality (which includes energy since $E = MC^2$) was unknown to science forty years ago, and two-thirds of the universe – dark energy – was discovered in just the past twenty years. It seems appropriately modest and in a fundamental sense scientific to accept, as Hamlet does, that: “There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy.”

Greetings

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On the other hand, scientific studies of humans and other animals have established thousands of examples of tight linkages between mental activities – such as mindfulness, suffering, compassion, happiness, and awareness – and underlying neural activities (Panksepp 1998; Porges 2011; Decety & Svetlova 2011; Mika et al. 2005; Tommaso 2009). Change the nervous system for better or worse, and the mind changes for better or worse as well. Apart from the possible effects of a hypothetical X factor – such as God, Spirit, or Ground – all mental activity depends upon underlying neural activity. Moment to moment, the mind is constrained, conditioned, and constructed by the brain (LeDoux 2003). Certainly, the mind is affected by influences outside the nervous system, such as human culture, but the final common pathway of all the natural causes streaming through us to manifest this moment of experience runs right through the brain.

Some time in the future, it might be established that natural processes alone are sufficient to produce the mind and human consciousness, or that they are not, or that the question of transcendental influences is inherently inconclusive, or that mind is a natural phenomenon yet has certain aspects (e.g., the qualia of red) which are intractable to scientific analysis. Any one of these four possible conclusions would

have profound implications. Meanwhile, down here in the trenches of everyday practice, we are left with the Buddha's encouragement to steer clear of any thicket of views about *what* is ultimately true and instead focus on *how* to end suffering here and now.

Naturalizing Buddhist Practice

In this light, how might it serve Buddhist practice to engage the causes of suffering and its end as *natural* processes embedded in our human neuropsychology? This focus on natural processes has been applied fruitfully to many phenomena, such as the diversity of life and the changes of the seasons. The causes of these phenomena may be complex and amazing – consider the tiny DNA molecules that contain the blueprint of the whole body or how the mass of the sun bends space itself so the earth rolls around this gravity well like a marble in a sink – but they are still natural. Naturalizing something enables us to understand it better – worthwhile in its own right – plus doing this often helps us to have more influence

over it. For example, understanding that many diseases are caused by microbes rather than curses has led to successful treatments.

Clearly, Buddhist practice can be effective without naturalizing it. Following the Buddha's teachings, hundreds if not thousands of people in his lifetime became enlightened and many more went far along the path of awakening. Since his death, Buddhism has spread around the world, enlightening some and inspiring, soothing, healing, and nourishing many more. None of these people needed an MRI to gain the benefits of their practice.

Still, 2500 years after the Buddha walked the dusty roads of northern India, we've learned a great deal about the material realm: matter and energy, mosquitoes and monkeys – and the brain. The Buddha engaged the *mental* causes of suffering and peace. Accelerating during the past twenty years, there is a growing scientific understanding of the underlying *neural* causes of these mental causes. What shall we do with this knowledge?

Buddhism calls us to see things squarely and deeply as they are, to deconstruct them down to their fundamental elements and causes, and to recognize how phenomena arise and pass away dependently upon each other. To turn away from the emerging understanding of how



mental and neural activity are knitted together seems antithetical to Buddhism, which considers ignorance to be the root source of suffering, and seeing clearly as among the highest aims. Further, to the extent that the causes of suffering and its end are found in the brain, then practice naturally takes us into nature itself, grounding mind in life (Thompson 2007).

The Immaterial Yet Natural Mind

To do this productively, first we need to define what this “mind” is. In brain science, mind and related terms (e.g., mental) usually mean *information* and related processing (Kandel 2007). Beginning about 600 million years ago, multi-celled creatures had grown complex enough that their sensory and motor systems needed to communicate information to each other. For example, if a sensory organ detected signs of something good to eat, it could signal muscles to swim toward it. The nervous system – whether in an ancient jellyfish or in a human being today – represents, communicates, stores, and transforms information; its evolved purpose is to enable the mind (MacLean 1990).

Information is immaterial: we cannot touch or weigh a meaning, signal, instruction, perspective, or plan. The idea of a material substrate representing immaterial information may



seem odd or remote at first, but we are surrounded by daily examples. The material shapes of the words on this page convey immaterial meanings; speak these words out loud and material sound waves will now carry their meanings; say them to someone else via a cell phone, and electromagnetic waves will now represent this information.

Even though it is immaterial, information can still be a natural phenomenon, conveyed in natural ways. The information in a thank you note is not supernatural or transcendental and is thus natural by default; it is communicated through the mails, not telepathy. Similarly, the signal that there's too much carbon dioxide in the blood is a natural event, as is the instruction to the lungs to take a deeper breath.

Most of the information in the nervous system – most of the mind, as I'm using this term – is forever outside of awareness. Walk across a room: the sensorimotor programs that guide your steps cannot themselves be known. Similarly, the continuing stream of signals coming up into the brain telling it the state of the body are mostly inaccessible to awareness. We privilege the fraction of the mind that constitutes conscious experience since it is all that we know.

It is possible that the first creatures with a nervous system were entirely unconscious. Still, over 600 million years, the simple network linking sensory and motor systems grew more complex, and developed a headquarters – a rudimentary brain – at the top of the spinal cord. This brain evolved further from the bottom up, first thickening the brainstem, next acquiring subcortical structures such as the amygdala and basal ganglia, and then growing a cortex that now includes the prefrontal, parietal, temporal, and occipital lobes. Somewhere along the way, the survival of animals was increased by evolving capacities to become aware of their internal states and external environment. Perhaps the ancient jellyfish had no awareness, but the goldfish in a pond are clearly aware of the gardener's shadow as they rise to be fed, and a cat shows heightened awareness of a nearby dog. In humans and other animals, awareness, attention, sleep, and waking all depend upon underlying neural structures and activities; consciousness is largely if not entirely a natural process (Panksepp 2005).

Co-Dependence of Mind and Brain

In this naturalistic framework, the information of the immaterial mind must be represented by the material nervous system. Neural activity is a necessary condition for mental activ-

ity, and perhaps even a sufficient one. The nervous system constrains, conditions, and constructs the mind.

Repeated patterns of neural activity build neural structure. In the saying from the groundbreaking work of the Canadian psychologist, Donald Hebb: “neurons that fire together, wire together.” Meanwhile, connections between neurons that are not used wither away in a process sometimes called neural Darwinism: the survival of the busiest.

This means that *repeated patterns of mental activity* – represented by patterns of neural activity – *sculpt neural structure* (Christoffel 2011). This process is turbo-charged for whatever is in the field of focused awareness. For example, cab drivers who must memorize all the streets of London build new connections between neurons (called synapses) in their hippocampus, a part of the brain that helps make visual-spatial memories (Maguire, et al. 2000). Or take meditation. Regular practice builds structure in the insula (a region key to both self-awareness and empathy for the emotions of others) and in prefrontal areas behind the forehead that regulate attention, emotions, and behavior (Lazar et al. 2005).

So, what is the relationship between the mind and the brain? Imagine a conversation today with a friend. As you understand her words and their implications, flows of information that



have a logic of their own cascade through your nervous system, enlisting underlying neural activities for their representation. Suppose you speak again tomorrow about the same subject: the same events, ideas, and people will be represented by underlying neural structures and processes that will be slightly if not substantially different from the ones used today. Even as simple a concept as $2+2=4$ will be known tomorrow via different neurons and synapses than it is known today. This means that many mental activities – particularly complex and conscious ones – proceed in some ways causally independent of the underlying physical substrates that represent them. Further, our repeated mental activities today alter the brain, in turn conditioning our mental activities tomorrow.

Neural and mental activity thus co-arise, affecting each other. Causes flow both ways, from the mind into the brain and the brain into the mind. The mind and brain are two categorically distinct – immaterial and material – aspects of a single, integrated system. (Philosophically, this view is a variant of “dual-aspect monism.”) In effect, as Dan Siegel puts it, the mind uses the brain to make the mind (Siegel 2007). Consequently, we can use the mind to change the brain to change the mind for the better.

How might these insights from neuroscience support and enrich Buddhist practice? This paper offers four examples, in which practicing with the brain in mind can strengthen conviction and motivation, deepen insight and disenchantment, aid cultivation, and gradually help undo the causes of craving.

Conviction and Motivation

Attention is like a combination spotlight and vacuum cleaner, both illuminating what it rests upon and sucking it into the brain. In a traditional saying, the mind takes its shape from what it rests upon. The modern update would be that the brain takes its shape from what the mind rests upon.

Rest the mind repeatedly upon self-criticism, anxious rumination, and a resentful case against others, and then the brain will gradually take the shape of a sensitized amygdala (the alarm bell of the brain), a weakened hippocampus (which places things in context and calms down the amygdala), depleted serotonin (a neurotransmitter that supports a positive mood), and growing sensitization to stress. On the other hand, if one rests the mind repeatedly upon the recognition of your genuinely good qualities, the development of steady at-

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tention, and compassionate and kind feelings for oneself and others, then the brain will take a different shape, one with more activation in the left prefrontal cortex (linked to increased happiness), thicker cortex in the executive regions behind the forehead (for better self-regulation and emotional balance), thicker cortex in the insula (strengthening both self-awareness and empathy for others), and greater resilience and capacity to deal with the hard things in life.

The knowledge that your mind is changing your brain in lasting ways is sobering and motivating. I've become a lot more attentive to and less indulgent of the grasping and grumbling in my mind since I learned that it's grinding grooves of suffering – metaphorically speaking – in physical structures. Yes, in principle, I should already be moved to practice on psychological grounds alone, but in reality, the knowledge that my thoughts and feelings can change my *body* for the worse has extra motivational impact. This news is concrete, physical – and compelling.

Knowing that practice – on the cushion and off – can also change the most important organ in your body for the *better* has a similar motivational effect. Dharma practice has dry spells, times when nothing seems to be happening. But synapse by synapse, breath by breath, our wholesome efforts cannot help but sculpt the brain. Even if the results are not yet apparent, we can have confidence – some might call it faith – that our efforts are making tangible, physical changes that will eventually bear fruit.

Understanding the power of attention to shape the brain can add motivational juice to a person's cultivation of mindfulness. More broadly, throughout the dharma, the Buddha and other teachers have emphasized the importance of conviction – one of the five spiritual powers – as well as determination and diligence. Additionally, we are called to compassion for all beings, including oneself. Whether it comes from a muscular, sober clarity or from a

sweet caring kindness, or both, recognizing the impact of your repeated thoughts and feelings on the body, particularly on the brain, can help one stay on one's chosen path.

Insight and Disenchantment

Consider the sensations of breathing. As you inhale and air moves across the upper lip, it stimulates nerve endings woven into your skin. That stimulation becomes represented in altered patterns of local neural activity that are communicated to sensory networks in the brain – including sensorimotor cortex, the thalamus, and the insula. The 100 billion or so neurons in your head are connected in a network of about 500 trillion synapses; individual neurons typically fire 5-50 times a second, and sometimes faster. Over the course of a few tenths of a second, a far-reaching coalition of millions if not billions of synapses begins to come together as the neural substrate of the conscious experience of the breath at the upper lip.

Like an eddy forming in a stream, a self-organizing pattern of neural structures and processes stabilizes briefly before decaying and disorganizing as the sensation it produces



changes and passes away. Even while the coalition has some meaningful coherence, the specific synapses that constitute it are continually changing, with new ones enlisted every few microseconds and previously enlisted synapses disengaging, like the transient individual molecules of water passing through a relatively stable eddy in a river. And these individual synapses themselves are changing all the time in their molecular structures and sensitivities to activation. Meanwhile, other eddies of neural activity have been swirling into being and then dispersing as other perceptions, feelings, and desires have been appearing and disappearing alongside each other in the streaming of consciousness.

The physical processes that produce conscious experience – that produce the aggregates of form, feeling, perception, formations, and awareness – are utterly ephemeral. The coalitions of synapses that underlie a sound, taste, touch, smell, sight, or thought never last more than a few seconds. The fleeting pattern of neural stability that is the reduction of uncertainty that forms the information that manifests as the sensation of breathing emerges out of fertile synaptic chaos and quickly destabilizes back into it. At the same time, countless other patterns of momentary neural stability are also forming to represent transient conscious and unconscious mental activity throughout the nervous system – and then dispersing as well.



These neural activities unfold due to factors in the nervous system, such as the trillion glial (support) cells in the brain, currents of neurotransmitters, gene expression within neuronal nuclei, and the gross physical structures of the brain. The nervous system interacts with and depends upon other bodily systems (e.g., immune, cardiovascular, endocrine), and what happens in these systems in turn intertwines with the environment as well as with nature and physical reality altogether. The material processes underlying any moment of conscious experience are local manifestations of ripples through a vast web of matter and energy, coming and going dependent upon other ripples and the web as whole. Further, due to the co-arising of neural and mental activity, these material processes in one person's nervous system are driven in part by flows of information both within that person's mind and within larger networks of human relationships and culture. Reaching back in time, this moment of experience also depends upon neural structures sculpted to meet the survival needs of ancient creatures in environments far different from the ones we live in today. A seemingly simple and taken-for-granted sight or thought is actually the result of an extremely complex and remarkable cascading of causes reaching back to the origins of the nervous system, life, and the universe itself.



A person may understand in a general way the truth of *anicca* and *anatta*. But unless one is able to have a powerful experience of these truths, typically in concentrated contemplative absorption, they tend to remain merely psychologized, applied to the flow of conscious mental activity. On the other hand, a basic understanding of the profoundly impermanent and interdependently arising nature of the *physical* processes necessary for any moment of consciousness deepens insight into the evanescent and contingent nature of any experience. The knowing of the physical world has a particularly penetrating clarity and persuasive power for humans and other animals. As Piaget and other developmental psychologists have shown, sensorimotor knowledge is the foundation of cognition. Our animal ancestors needed to know what was physical, and the apparatus of this knowing is embedded in the oldest structures of the brain, which also produce our most fundamental feelings and desires. It's certainly plausible that a physicalized understanding of the *anicca* and *anatta* of one's mind could make insight more visceral, and thus more emotionally and motivationally beneficial.

Taking it a step further, when you realize that your thoughts and feelings, seemingly so personal and precious, are actually the result of impersonal physical factors reaching back billions of years, it's a lot harder to take your experience so seriously and to identify with it so tightly. It aids disenchantment to appreciate that a viewpoint, want, emotional reaction, or sense of being an "I" looking out through the eyes is the conscious expression of gooey, passing electrochemical flows inside a brain cobbled together to help worms, rats, and baboons survive.

Cultivation

In essence, there are three ways to engage the mind. First, we can simply be with what it contains, witnessing and opening to it. Other mental factors may be present alongside this receptive awareness – such as compassion, investigation, tranquility, or rapture – but there are no active efforts to influence the mind except for whatever is minimally necessary to sustain and deepen the witnessing. This stance toward the mind is of course enormously useful. But it's not the entirety of practice. The Buddha also taught two other ways to engage the mind: decrease what's negative and increase of what's positive. This is the cultivation – *bhavana* – dimension of practice that's summarized in the Wise Effort part of the Noble Eightfold Path. The rest of the path includes the deliberate, active, and diligent cultivation of wise view, intention, speech, livelihood, action, mindfulness, and concentration. Even Wise Mindfulness, the most receptive, even passive, part of the Path, involves the develop-

ment of attention, the resolute application of that attention to a variety of themes (e.g., the feeling tone of experience, the Four Noble Truths), and in some cases the deliberate encouragement of specific qualities of mind, such as the tranquilizing of the body or kindling of rapture in the Anapanasati (mindfulness of breathing) Sutta. While bare witnessing is sometimes presented as the heart or even the whole of Buddhist practice, throughout the Pali Canon as well as in the Tibetan, Zen, and Pure Land strands of Buddhadharma, there is great emphasis on cultivation.

Cultivation is wholesome *learning*, a beneficial change of thought, word, or deed. A morning sit helps you be more centered during the rest of the day; a teacher's comment opens a new perspective; routinely wishing others well nurtures a compassionate heart. In the naturalistic frame, these changes in the mind require changes in the brain. Studies of the neuropsychology of learning have much to tell us about how to help these neural changes go well.

Learning means memory, which comes more or less in two forms. To simplify a bit, explicit memory is the storehouse of personal recollections and “declarative” knowledge about the world (e.g., what is meditation). Implicit memory is the much larger storehouse of “procedural” knowledge (e.g., how to meditate), assumptions, expectations, models of relation-



ships, inclinations, habits, and the emotional and sensory residues of lived experience. The contents of explicit memory – for instance, a conceptual understanding of the dharma – certainly matter, but the contents of implicit memory have much more influence over our experience, behavior, and progress down the path of awakening. Implicit memory contains most of the inner strengths we need for coping, healing, well-being, effectiveness, and spiritual practice – inner strengths such as mindfulness, lovingkindness, virtue, resilience, positive emotions, and wisdom. Some of these inner strengths are developed through negative experiences, but they are mainly acquired – cultivated – through positive experiences. Repeatedly feeling thankful develops gratitude, repeatedly feeling compassionate develops a warmer heart. Unfortunately, the brain has a built-in bottleneck in turning positive experiences into positive neural structure.

Researchers have found that personal recollections have a positivity bias; we tend to edit pain out of our remembrances (Sharot 2011). But implicit memory has a marked *negativity bias* (Baumeister et al. 2001; Royzin & Royzman 2011). For example, the brain encodes learning from pain faster than learning from pleasure. Embarrassing information about someone is better remembered than complimentary information. Negative interactions have more impact in relationships than positive ones. It is easy to acquire “learned helplessness”



from a handful of experiences of inescapable pain, and it usually takes many times as many experiences of agency to undo this sense of impotence. If twenty things happen in your day – ten that are pleasant, nine that are neutral, and one that’s unpleasant – which one do you tend to dwell upon? In a vicious cycle, the stress hormone, cortisol, sensitizes the brain to negative experiences so it learns more quickly from them, increasing the negativity further.

The brain evolved this bias since negative experiences generally have more urgency and impact on survival than positive ones do (Baumeister et al. 2001). In effect, unpleasant experiences have fast-track memory systems that quickly convert negative mental *states* into enduring negative neural *traits*. Meanwhile, positive experiences – the primary source of inner strengths – use standard memory systems, in which mental material must be held in short-term memory buffers long enough for it to transfer to long-term storage, the neural instantiation of mental cultivation. “Long enough” depends on the experience and the individual, but generally it’s at least five or ten seconds, if not even longer. But how often do we do this with our experiences? Even if our experiences are mainly positive, interspersed with frequent neutral ones and the occasional upsetting moment, the incoming positive or neutral experiences dislodge the current positive experience out of short-term buffers before it has a chance to sink in and start being encoded in lasting memory structures. Consequently, most positive experiences wash through the brain like water through a sieve while negative ones are caught and kept; the brain is like Velcro for negative experiences but Teflon for positive ones. These transient positive experiences are momentarily pleasant but from the standpoint of lasting value, they may as well not have happened, since they made no difference to the brain.

This design feature of the brain has serious implications for practice. It means that we tend to over-learn from our negative experiences and under-learn from our positive ones. A boring or frustrating meditation likely has more impact than a richly rewarding one. You join a new sitting group and the first nine times you attend are good but at the tenth one someone is curt or dismissive toward you and now it’s hard to make the time to go. You listen to a dharma talk and something in it strikes home, but a day later it’s as if nothing has happened. More broadly, moments of craving and suffering sink in while moments of ease and peace slip by like water sheeting over a driveway. The negativity bias weakens cultivation and hampers progress in practice. It’s also disheartening: hard-won experiences of tranquility, compassion, or insight can have little lasting value. This bias is the basis of the central weakness in dharma teaching and practice, as well as in formal and informal approaches to

psychological healing and growth, mindfulness training, and parenting, coaching, and human resources development: the brain is good at learning from bad experiences but bad at learning from good ones.

Happily, studies of learning in humans and other animals don't just reveal the negativity bias, they point the way to dealing with it. You begin with a positive experience in the first place, usually by noticing one you're already having – the relaxation in exhaling, the pleasure in drinking water when thirsty, the comfort in a friend's smile – and sometimes by creating one, such as deliberately calling up feelings of compassion and kindness. The brain is like an old-fashioned tape recorder rather than an iPod: you must get the song playing in order to record it; an *activated* mental state is the basis of an *installed* neural trait. Second, you enrich the experience through one or more of five factors known to increase neural encoding and thus learning: duration, intensity, multimodality (felt in the body and perhaps enacted), novelty, and personal relevance. You're getting lots of neurons firing together so they wire together. Third, you help your brain absorb the experience by intending and sensing that it's sinking into you as you sink into it, thus priming and sensitizing implicit memory systems. This is "taking in the good," which is like making a fire: first you ignite it,



second you add fuel, and third you absorb its warmth. This process usually takes just a dozen seconds or so, though you can always do it longer if you like. During formal practice and in the flow of life, a few times a day, you take the time to register wholesome experiences, to weave them into the fabric of your brain and your life. And if you are trying to cultivate a particular mental factor at this stage in your practice – some specific inner strength, such as steadiness of mind, determination, or forgiveness – you can help yourself have experiences of this inner strength and then “take them in” to your brain.

This is neither hedonism nor clinging to positive experiences. We are called to wish for and work for the happiness and welfare of all beings – including oneself. It is acceptable and even more, it is *desirable* to cultivate wholesome states of mind in anyone, including oneself. Further, helping your brain learn from your experience feels like a gently kind encouragement of wholesome states while simultaneously letting them go. Over time, we rest the mind upon positive states so the brain may gradually take their shape. As it does so, as inner strengths and peace increasingly become a person’s nature, the active practice of cultivation gradually falls away, like a raft that is no longer needed once one reaches the farther shore.



De-fueling the Fires of Craving

One application of cultivation is so important, and so informed by recent evolutionary neuropsychology, that it deserves special attention. It gets at the heart of the Second and Third Noble truths, craving and its end.

To simplify a long and complex journey, as our ancestors evolved, the brain developed in three stages stacked on top of each other like the floors of a house – brainstem, subcortex, and cortex – loosely associated with the reptilian, mammalian, and primate/human stages of evolution. As the brain grew, so did its capacities to meet any animal's three core needs for *safety*, *satisfaction*, and *connection*, which are met, respectively by three broad-scale motivational and regulatory systems that use the whole brain to *avoid* harms, *approach* rewards, and *attach* to others.

When we experience that our core needs are met, the brain defaults to its resting state, in which it guides the body to refuel and repair itself, and colors the mind – in terms of the three motivational systems – with a basic sense of peace, contentment, and love. This is not itself enlightenment, but in this resting state – the responsive mode of the brain, a kind of “green zone” – there is little or no deficit or disturbance, and thus little or no innate basis for craving.

On the other hand, when we experience that one or more core needs are not met, there is a deficit or disturbance, and the brain fires up for fighting, fleeing, or freezing. It directs the body to burn resources faster than they're replenished while halting long-term building projects such as strengthening the immune system, and it colors the mind – in terms of the avoiding, approaching, and attaching systems – with a basic sense of fear, frustration, or heartache. This is the reactive, “red zone” mode of the brain, the biological, neuropsychological, naturalistic operationalization of *tanha* and *dukkha*, craving and suffering. It feels bad because it *is* bad for us, in biological terms.

The responsive setting of the brain is our home base, a sustainable equilibrium that feels good because it *is* good, biologically speaking. Nonetheless, due to the negativity bias, we are very vulnerable to being driven from home by the least whiff of threat, loss, or separation. Once in the reactive mode, we're also vulnerable to over-learning from it, which sensitizes

the brain toward future reactivity, in a vicious cycle.

When our reptilian, mammalian, primate, hominid, and early human ancestors lived brief, pain-filled lives in harsh conditions, the short-term benefits for survival of the reactive mode outweighed its long-term costs. But these days, when many people are living into their eighties and beyond, and when the well-being of oneself and others is a significant value, the costs of the reactive mode far outweigh its benefits. Plus, from the standpoint of Buddhist practice, the path is in many ways about disentangling from the reactive mode and cultivating the responsive one. We have no choice about the three layers of the brain, about the three motivational, regulatory systems, and about their two settings; our only choice is which setting is active, responsive or reactive.

The tipping point from responsive to reactive is the felt sense that a core need is not handled. Through repeatedly having and taking in experiences of core needs being met, you can build up an internal sense that you are fundamentally safe, satisfied, and connected that is less and less dependent on external conditions. Like deepening the keel of a sailboat, you're able to deal with the worldly winds – praise and blame, pleasure and pain, fame and ill repute, gain and loss – without them tipping you over into the reactive mode, or at least



you recover more quickly. As you build up the neural substrates of the responsive mode, it becomes harder and harder to trigger the sense of deficit or disturbance that drives the craving that leads to suffering and harm. You engage life from within the green zone, sometimes quietly and sometimes with passion, but without a mind caught up in worry and irritation, disappointment and pressure, or loneliness and shame. In a Buddhist context, there must still be the cultivation of virtue, concentration, and wisdom, but it is much more effective to do this when the fires of craving have been banked low due to lack of fuel.

Plus “going green” in the sense here is a sweet path in its own right. As three umbrella terms, peace, contentment, and love are at the heart of the life that many would aspire to. They certainly encompass central Buddhist values. They are the fruits, the ends of a life well lived. And – due to both experience-dependent neuroplasticity and the motivational architecture of the mind/brain system – taking in experiences of peace, contentment, and love is also a skillful means to these ends. As in the Tibetan saying, the fruit can be the path.

Limitations in Naturalizing Buddhist Practice

When the dharma pierced my heart in 1974, at the tail end of college, I knew nothing about the brain. Yet I did know that this way of seeing things as impermanent and interdependent and selfless was profoundly true, and that the simple and direct practices I first learned – stay aware, be in the body with the breath, open and let go – felt deeply right and effective.

Now, forty years later, most of my practice as a dharma student takes the mind as it appears, observing the stream of consciousness and sometimes giving it a nudge one way or another, without reference to its underlying neural substrates. In a way it’s like growing corn. At one level of analysis and action – plant seeds and water them – a knowledge of the chemistry of nitrogen-based nutrients is not relevant. In the same way, staying in the present and wishing that beings be happy can proceed without any knowledge of neurotransmitters. In fact, intellectualizing about the neurology of dharma practice could get in the way of the practice. If you had to figure out the molecular genetics of a corn plant in order to water it, it would get very thirsty.

Further, if we were to privilege a certain class of dharma teachers – those who know something of neuropsychology – as the keepers of the deep truth, that would be both unfair and foolish. It would also be highly premature, since there is so much that’s still unknown about

the relationship between the mind and brain. Trying to reduce the complex and subtle shadings of our experiences of suffering, craving, lovingkindness, tranquility, disenchantment, and liberating insight to “just” electrochemical flows is a kind of category error that also reinforces the excesses of scientific materialism.

Still, a growing understanding of the natural basis of most if not all of the mind has informed and strengthened my practice. Returning to the corn analogy, knowing about nitrogen-based nutrients could lead you to better fertilizers. Similarly, learning about your brain is not necessary for practice, but it might enrich it.

Conclusion

I visualize the expression of the dharma over time has been a kind of cone originating with the historical Gautama the Buddha, and moving toward us over 2500 years while also widening to encompass Theravadan, Tibetan, Zen, Pure Land, and other developments. While we’ll never know precisely what the Buddha said or thought, he initiated a Buddhastream of realization and practical wisdom that many others have contributed to, and which should be



judged on the Buddha's own terms: *ehipassiko*, see for yourself what hurts and what helps.

In our own age, a significant new eddy in the Buddhastream seems to be emerging, with these elements:

- a high percentage of householders engaging deep contemplative practice
- multiculturalism as both a reality and a value
- ready access to and eclectic use of the full array of Buddhist teachings and practices
- flattening hierarchies
- assimilating ideas and findings from science, including psychology
- naturalizing dharma practice
- deconstructing and using Buddhist perspectives and practices in non-Buddhist settings (e.g., pain-control clinics, schools, psychotherapy)

Of course, the eddies in the Buddhastream swirl together and influence each other, and many people draw upon more than one. The developing naturalization of the dharma may well influence other parts of the Buddhastream. Who knows what the future holds? All eddies disperse eventually, whether inside the brain or in the human unfolding. Meanwhile, we have an extraordinary opportunity to draw upon a great toolbox that is historically unprecedented in its richness and diversity, including its naturalized ideas and methods.

Ehipassiko.

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White Lies

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The “I” is a lie
conceived by desire
achieved by action
deceived by death.

But it’s ok.
Just a fleeting
white
light
lie.

Cognitive Enhancement: A Side Effect of Meditation

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Abstract: The literature on meditation and cognitive functioning is reviewed. Mechanisms explaining how it enhances cognitive functioning are explored. The correlation between changes in neuroanatomy, neurophysiology, illness, and cognitive functioning are summarized. Implications for formal education are drawn out. Society would probably benefit more from this primary prevention orientation than awaiting the onset of illness or dementia before administering meditation therapy. Guidelines are presented to improve meditation programs and research in our school systems.

* * * *

The traditional aim of meditation is enlightenment which liberates and liberation which enlightens. The predominant impediment is the egocentrically-dominated mind. Egocentricity impairs cognitive functioning: When it no longer infects the mind, cognitive functioning recovers (Bezanson 2014).

Test your ability to do mental math while thinking, “I am a zero” or “I am a hero.” Then do mental math without self-referencing thoughts. Was it easier without self-preoccupation?

Improved adaptation, coping, and scholastic learning ability are superficial manifestations of enlightenment. Addiction to academic intellectualization, however, interferes with enlightenment.

Like philosophers, scientists hold a wide array of definitions of mind (Bezanson 2014). Nevertheless, there is a widespread consensus that it includes cognitive functioning and awareness (i.e., attention). For each cognitive function to operate, continuous perfusion with awareness is required.

The kinds of awareness studied by science are:

~ sensory: a) exteroceptive – the world outside the body

b) interoceptive – inside the body

~ emotional

~ cognitive

~ reflexive, self-definitive, or self-referential

The only species known to have the latter are dolphins and higher-order primates. Meditation enhances all four kinds as well as a fifth, i.e., holistic. This includes the other four kinds, yet transcends them: The nucleus of enlightenment, it is empty of egocentricity.

Evolutionary progression occurs from sensory to holistic. The most primitive creatures are preoccupied with sensation and have little awareness of more subtle levels of awareness.

Scientific research on meditation has studied cognitive awareness more than the others. Let's focus on cognitive changes for which there are reliable and valid measures. These functions are quantified by neuropsychologic and scholastic tests of abilities, aptitudes, skills, and intelligence. We will peruse only the research on classic forms of meditation, not experimenter-contrived attention-modulating exercises.



Meditation may enhance kinds of cognitive functioning for which reliable and valid measures have not yet been developed, e.g., insight. This conjecture is based on self-report studies of ‘advanced’ meditators.

Academic Performance (A.P.)

Subjects taught mindfulness increased their reading comprehension and recall (Mrazek et al. 2013). Graduate students who practiced TM had superior A.P. (Kember 1985).

Components of Intelligence (C.I.)

Those practicing TM showed improvements on C.I. (Cranson 1991). Literature reviews summarized improvements associated with many kinds of meditation (Doraiswamy and Xiong 2009; Chiesa et al. 2011; Gard et al. 2014; Marciniak et al. 2014).

Sustained Attention (S.A.)

Meditation increased S.A. (Valentine and Sweet 1999; MacLean et al. 2010; Rani and Rao 2000; Chan 2004). Zazen (Soto Zen sitting/emptying) increased S.A. (Pagnoni & Cekic 2007).

Literature reviews of many styles of meditation show improvements in S.A. ((Raffone & Srinivasan 2010).

Psychomotor Vigilance (P.V.)

TM practice improved perceptual-motor speed (requiring P.V.) (Jedrcazk et al. 1986). During meditation P.V. was improved (Kaul 2010).

Working Memory (W.M.)

Mindfulness increased W.M. (Jha 2010).

Verbal Fluency (V.F.)

In subjects with memory impairment, meditation increased V.F. (Newberg et al. 2010).

Attention Shift and Sequencing (A.S.)

In subjects with impaired memory, meditation increased A.S. speed (Newberg et al. 2010).

Recall (R)

In subjects with memory impairment, meditation increased logical recall (Newberg et al. 2010).

Mindfulness improved R ability (Zeidan et al. 2010) following a lecture to university students (Ramsburg & Youmans 2014). Both immediate and delayed verbal R were

improved in those practicing mindfulness (Lenze et al. 2014).

Executive Functioning (E.F.)

Mindfulness increased E.F. (Zeidan et al. 2010).

Visuospatial Processing (V.P.)

Mindfulness increase V.P. (Zeidan et al. 2010).

Perceptual Discrimination (P.D.)

Subjects who learned meditation had keener P.D. (MacLean et al. 2010).

Mechanisms

The literature on cognitive functioning is consistent with neuroanatomic studies demonstrating neuroplasticity. Neuroimaging has revealed an increase in both gray and white matter densities in certain regions of the brain (Bezanson 2014 May; Erwin-Wells 2013; Lazar 2005; Luders 2009; Raffone & Srinivasan 2010; Hanson & Mendius 2009; Holzel 2011).

Gray matter consists of neuronal cell bodies (containing the nucleus, RNA, and DNA), dendrites, unmyelinated axons, capillaries, and glial cells. White matter is primarily myelinated axons.

The increased density is probably a combination of:

- a) increased number, diameter, and length of dendrites
- b) increased diameter of axons

As the diameter of each increases, they transmit more information. Each is like a fiber-optic cable that enables the neurons to communicate with one another.

Whether the population of synapses, receptors, or neurons increases is unknown.

As we develop new skills and practice them regularly, the 'wiring' comprising requisite neural pathways becomes more dense – increasing the 'bandwidth.' Because meditation is a skill, it is not surprising to find increased density.

Some experiments measured both neuroanatomy or neurophysiology (e.g. with functional magnetic resonance imaging – fMRI) as well as cognitive functioning.

These have revealed a direct correlation between the increase in neuroplasticity and

cognitive functioning (Pagnoni & Cekic 2007; Newberg et al. 2010).

One mechanism to explain both increases is the anti-inflammatory effect of mindfulness.

In the last decade, inflammation has gained more attention than cholesterol from scientists and clinicians as a chronic illness risk factor. The lengthy list of ills includes cardiovascular disorders, diabetes, and some dementias, e.g., Alzheimer's. Collectively, these disorders are the major medical cause of impaired cognitive functioning in adults.

Inflammation narrows the internal diameter of the arteries, impeding circulation to all organs including the brain. This exacerbates the universal progression of atherosclerosis accompany aging, which is detectable from about age twenty onward. Mindfulness decreases inflammatory expression of the genome and stress-provoked inflammation (Kaliman et al. 2014; Rosenkranz 2013).

Countering the deleterious impact of inflammation and atherosclerosis, meditation has been found to at least temporarily increase circulation to certain regions of the brain (Newberg et al. 2010; Hanson & Mendius 2009; Davidson & Begley 2012).



Perspectives on Self-Care

Be careful with all self-help methods (including those presented in this *Bulletin*), which are no substitute for working with a licensed healthcare practitioner. People vary, and what works for someone else may not be a good fit for you. When you try something, start slowly and carefully, and stop immediately if it feels bad or makes things worse.

Another mechanism accounting for cognitive enhancement is diminished substance abuse. Research has shown that meditation curbs substance use. As substance intake diminishes, cognitive functioning improves.

Another mechanism accounting for cognitive enhancement is diminished chronic pain, mental illness, and stress. Hundreds of

experiments have found that these degrade cognitive functioning. In turn, hundreds of experiments have found that meditation alleviates many forms of each.

Many articles that highlight the effects of meditation on the brain appear in popular media each month. Neurosciences are too rudimentary to extrapolate the cognitive functioning correlates of neuroplasticity. Most cognitive functions are only measured by neuropsychologic tests. Subjects in the above experiments were adults.

Educational Applications

Anything that enhances cognitive functioning has profound implications for education and warrants further research. Unfortunately, meditation scientists have largely neglected our children. As a former K – 12 student and a current substitute teacher, I have oft heard teachers command, “pay attention.” Yet, none explained how to improve attention regulation (or whom to pay!). Teachers are quite aware that attention is necessary for learning. Because meditation is the most extensively researched attention regulation practice, teachers with open minds are likely to be curious.

I have taught relaxation exercises, biofeedback, and elementary styles of meditation to children as young as age five. Many were able to develop enough skill to obtain clinically significant relief of disorders. No adverse side effects were reported. In children and adults, seizure disorder is the most common condition requiring precautions: Guidelines are to be observed (Bezanson 2014).

Mindfulness-based Social & Emotional Learning programs for K – 12 pupils have demonstrated scholastic test score increases of fourteen percent in a meta-analysis of over 100 schools (Lantieri & Goleman 2008). These interventions lack control groups and are not research.

About one dozen methodologically pallid to sound studies note that meditation improved attention, scholastic achievement, behavior, emotional disorders, self-control, social skills, happiness, or recall ability while diminishing behavioral problems and stress of students. The behavioral results are mostly subjective ratings by students, teachers, or parents. The cognitive functioning results, measured with neuropsychologic and scholastic tests, looked at conflict monitoring, alerting, executive functioning, attention, quantitative and language arts, scholastic tests, intelligence measures, field independence, information processing, recall, reflectivity, and flexibility. All of the cognitive results except one were significant (Waters 2014). In the study with insignificant results, children who scored low on executive functioning before the study showed significant gains. (Of the many organizations providing meditation programs in school settings, none are using cognitive functioning tests as outcome measures. They target interpersonal functioning, stress, and behavioral disorders.)

Research Considerations

- Instead of the customary critique of the literature, guidelines for improvement are likely to promote higher-quality research. Many of these guidelines also apply to



program design and planning.

- Experiments having dependent variables of scores on standardized scholastic achievement tests and neuropsychological tests are needed.
- To isolate the effect of meditation it is important to limit the intervention to meditation, without adding other interventions.

Some researchers have used sham or pseudo meditation as the control group. Subjects are informed that they are being taught meditation. These imposter practices appear to be like meditation. Little is known about the effects of these contrivances, limiting their utility as a control condition. The ethics of using such are questionable. How would you feel if you thought you were practicing genuine meditation for a three month intervention; yet when debriefed at the end were informed that you had been practicing a fabrication of unknown value? Before investigating experimenter-generated styles, I recommend that the scientific community first attain a much better understanding of the classic styles that have been practiced by millions.

There are three kinds: a) concentrative, e.g., mantra, b) awareness, e.g., mindfulness, c) emptying, e.g., Zazen.



Study groups are one of the best control conditions. Rest is a popular control condition. It controls for most of the same factors as the study condition. Rudimentary relaxation exercises, e.g., quiet place visualization or muscle relaxation are a control condition that is more similar to meditation than rest.

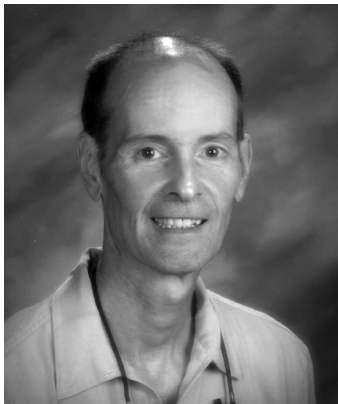
It is vital that instructors be highly qualified professionals who are advanced meditators. The instructors are to meditate simultaneously with subjects in classes: This provides nonverbal instruction that is palpable.

Motivation to learn meditation is a common problem for persons of any age. To maximize the impact of meditation it is important to enhance motivation, especially during the initial month of practice. An individualized motivation plan, collaboratively created by the student and parents is optimal. (Yes, this topic deserves an entire article.)

Taking it to the Next Level

Would you prefer to have smarter neighbors? Have your local school contact providers of programs, e.g., www.mindfulschools.org, www.mindfuled.org, one of the many organizations mentioned in *Educating Angels* (Armstrong 2013), or the author. If you are interested in collaborating with me to conduct research or provide programs that measure cognitive functioning and scholastic test scores, please post a comment on my blog: www.meditationonwheels.org/blog/. We may use the blog as a cyberoffice in which to meet, connect, and brainstorm. General recommendations for school-based programs may be viewed on the author's website, below, at the end of the Appointments section.

It is time for meditation practice to emerge from cloisters, caves, and concealed monasteries. Our school systems and society would benefit immensely from an infusion of meditation.



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David Bezanson, Ph.D. blogs at Meditation on Wheels. You can find out more about him at <http://www.meditationonwheels.org/qualifications/>.

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FOUNDATIONS OF WELL-BEING

Quizzes: Mindfulness

THE LIZARD, THE MOUSE, AND THE MONKEY © Rick Hanson, 2014

How in touch are you with your core needs: for *safety*, *satisfaction*, and *connection* (broadly defined)? How is it going with meeting these needs? Do you have any significant issues in one or more of these three areas?

For example, recurring feelings of helplessness, anxiety, irritation, or immobilization (“freezing”) could call for developing more psychological resources – more inner strengths – for meeting your need for safety. Frequent feelings of disappointment, frustration, loss, failure, addiction, stressful drivenness, or blahness about life suggest a need for more inner strengths for satisfaction. If you often feel hurt, let down, left out, insecure in relationships, inadequate, envious, jealous, muzzled, or caught up in ongoing conflicts with others, then it could help to develop more inner strengths for connection.

You can explore these matters by reflecting on and answering the questions below. (This quiz has more questions than some of the other ones.) Of course, a brief quiz like this one can’t cover all aspects of this topic, and feel free to adapt these questions to your own situation and needs, ignore some if you like, and even add new ones for yourself to answer. And it might be interesting to talk about these questions with others, including on the Foundations forum.

For each question, try to find a response in one of these five categories:

1 - strongly disagree | 2 - disagree | 3 - neither agree nor disagree | 4 - agree | 5 - strongly agree

A person’s responses to questions like these are often more complex and nuanced than a single number can indicate. But for scoring purposes, for each question please choose the number above that is most accurate (or least inaccurate!).

QUESTIONS

1. I often feel worried, apprehensive, or anxious.
2. I frequently feel frustrated.
3. I often feel hurt or let down by others.
4. I’m easily irritated, exasperated, or annoyed a good deal of the time.
5. I don’t experience much pleasure or fun in life.
6. I often feel a desire or need to impress others, or gain their approval.
7. I feel pretty thwarted or helpless in improving what’s happening in my life or how I feel about it.
8. Honestly, I’m abusing or dependent upon something (e.g., alcohol, drugs, sugar, pornography, video games, gambling) that is harming me or others.
9. I often feel envious or jealous.
10. My body feels pretty tense a good deal of the time.
11. I feel revved up and driven a good deal of the time.
12. It’s often hard for me to say what I really think or feel in important relationships.
13. I have experienced a significant amount of trauma in my life.
14. I have experienced a significant amount of loss in my life.
15. I have experienced a significant amount of abandonment in my life.

SCORING

Your responses to particular questions can be taken at face value, in their own right, as opportunities for seeing useful things about yourself, for investigating further—perhaps talking about them with others—and for identifying inner resources that would be good to develop further in yourself.

Additionally, it can be helpful to get an overall sense of where you stand. Add up your responses to each question to get your **total** score.

More specifically, the questions are clustered in three groups—in terms of our three core needs: safety, satisfaction, and connection—and you should add up your responses to each of these groups of questions:

Safety – 1, 4, 7, 10, 13

Satisfaction – 2, 5, 8, 11, 14

Connection – 3, 6, 9, 12, 15

See where your scores fit in just below; please hold these descriptions lightly, but in a general sense it could well be true that:

Total Score

- 60 - 75 | You currently have substantial issues, overall. You probably feel that none of your core needs is being adequately met. There is probably some depression. If you are not already receiving professional help for these issues, please consider doing so.
- 31 - 59 | Your needs are being met to a moderate degree overall, or they're being met highly in terms of one or two core needs but not so well met in terms of the other one(s).
- 15 - 30 | You feel like all three of your core needs are being met to a high degree.

Safety Score

- 20 - 25 | You are currently experiencing a high degree of anxiety, anger, and/or helplessness. You are and/or you feel significantly threatened. (As well, it is possible that your innate temperament is highly sensitive, anxious, or irritable, which would heighten the impacts on you of threats and other challenges.) Your body is on "red alert" much of the time. Your mood is likely depressed. It is very important to be doing what you can to be and to feel safer, including reaching out to other people or professional resources as appropriate. Meanwhile, you can use the *safety* track in the Foundations program (the pillars of Self-Caring, Vitality, Calm, and Courage) to develop more inner strengths for safety.
- 11 - 19 | You feel somewhat challenged by immediate or potential threats, probably feeling like you are coping OK but that you could be coping better. You don't feel overwhelmed, but you do feel worried, irritated, or stuck a fair amount of the time. The *safety* track in FWB (see just above) will likely have some good resources for you.
- 5 - 10 | You may be dealing with significant threats and other challenges to safety, but you feel like you are coping well with these. On the whole you feel pretty protected, strong, calm, relaxed, and at peace much of the time.

Satisfaction Score

- 20 - 25 | You are currently experiencing a high degree of disappointment, frustration, loss, and/or lack of enjoyment in life. You are probably dealing with major losses, or with major obstructions in attaining your goals (these obstructions could have the added impact of being based on an injustice, such as prejudice or discrimination). In terms of your losses, there could be strong feelings of grief or mourning. You could feel stressed or driven much of the time. Your mood is likely depressed. There could also be significant issues with addiction in some sense of the word. It is very important to be doing what you can to feel more satisfied, including reaching out to other people or professional resources as appropriate. Meanwhile, you can use the *satisfaction* track in the Foundations program (the pillars of Mindfulness, Gratitude, Motivation, and Aspiration) to develop more inner strengths for satisfaction.
- 11 - 19 | You could be somewhat challenged by losses or obstructions, or feel pretty stressed about reaching some goals. But you're not feeling overwhelmed (usually) by these things, and you feel like you are dealing with them, more or less. Nonetheless, you're still probably experiencing a fair amount of disappointment, frustration, or pressure. Or perhaps life simply feels really, really blah, like there is little in it that's enjoyable; there could be a chronic sense of the "blues." You could be overdoing it with alcohol, eating, or other problematic ways to feel some stress relief or pleasure in life. The *satisfaction* track in FWB (see just above) will likely have some good resources for you.
- 5 - 10 | You may be dealing with losses, everyday hassles, or other challenges to satisfaction, but you feel like you are coping well with these. On the whole you feel pretty grateful, glad, successful, pleased, and contented much of the time.

Connection Score

- 20 - 25 | You are currently experiencing a high degree of hurt, insecurity, and/or conflict in your relationships. A sense of rejection, in one form or another, is a major issue. You probably feel very let down by others, or mistreated by them. You don't have a strong sense of self-worth, and frequently feel inadequate, envious, or jealous. You could be caught up in trying to impress others or win their approval. Growing up, you likely experienced significant abandonments, or other kinds of "insecure attachment" with your parents or other caregivers. Perhaps for very good reason, you do not feel very trusting of others. You could feel clingy, overly dependent upon others, or trapped in a relationship; or at the other end of the spectrum, you could feel very isolated, uncomfortable with close emotional contact, and focused on maintaining a comfortable distance from others; at either end of this spectrum, you probably feel unable to express yourself in authentic, open ways. It is very important to be doing what you can to feel more connected, including reaching out to other people or professional resources as appropriate. Meanwhile, you can use the *connection* track in the Foundations program (the pillars of Learning, Confidence, Intimacy, and Service) to develop more inner strengths for connection.
- 11 - 19 | You feel somewhat challenged by interpersonal, social issues – such as rejections, loneliness, or feelings of inadequacy – but you're handling these issues so they're not overwhelming. You probably feel good in at least a few important relationships. But you probably would also like to feel included, seen, appreciated, liked, and loved – and compassionate, kind, and loving yourself – more of the time. The *connection* track in FWB (see just above) will likely have some good resources for you.
- 5 - 10 | You may be dealing with interpersonal issues of one kind or another, but you feel like you are coping well with these. You feel good in most if not all of your relationships. On the whole you feel included, seen, appreciated, liked, and loved – and compassionate, kind, and loving yourself – much of the time.

Fare Well

May you and all beings be happy, loving, and wise.