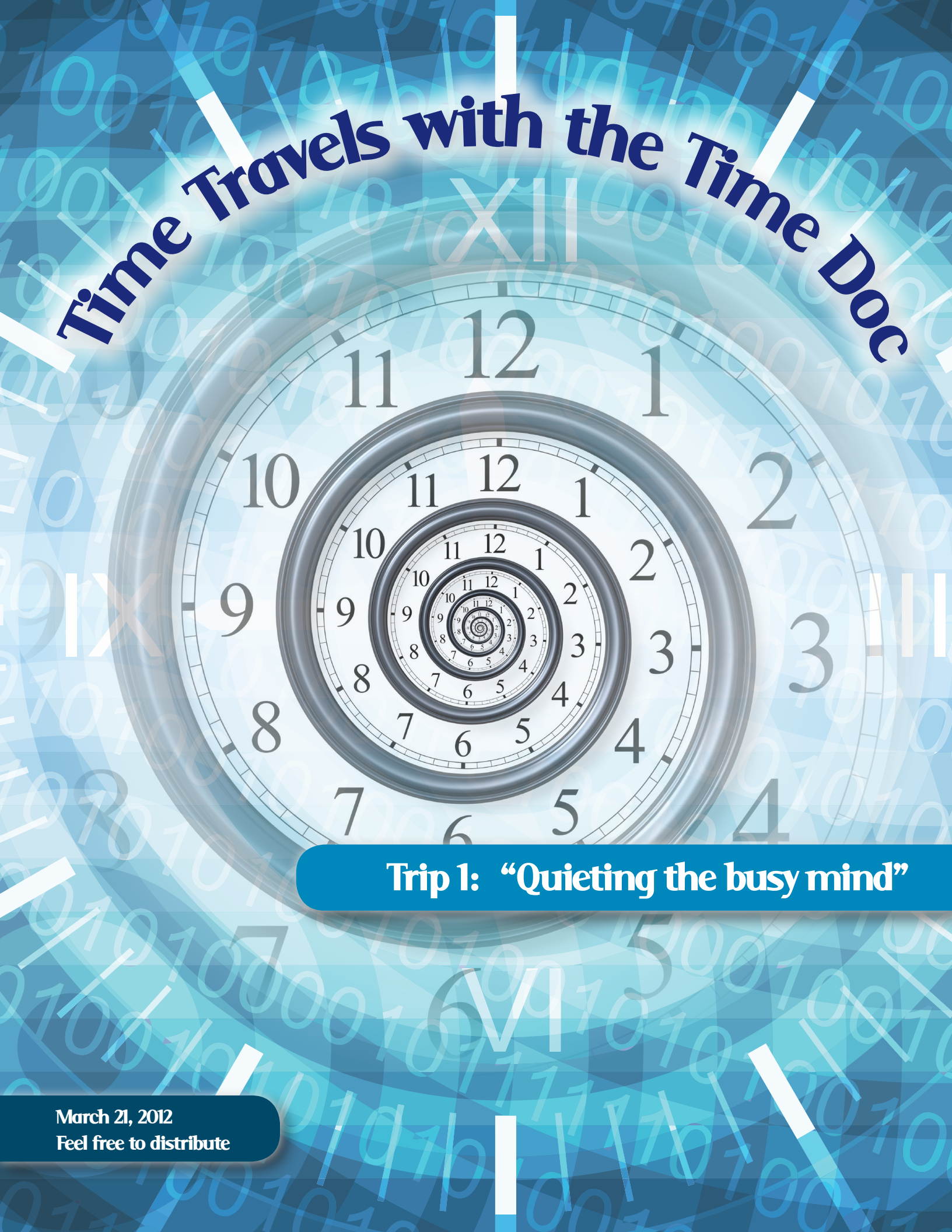
Time Travels with the Time Doc



Trip 1: "Quieting the busy mind"

March 21, 2012
Feel free to distribute

Trip 1: "Quieting the busy mind"

I, Dr. Kevin McGrew, have acquired the nickname of "The Time Doc" due to my interest in brain clock research and brain clock-based neurotechnology interventions. In particular, I am very interested in the timing-based Interactive Metronome technology (conflict of interest disclosure: I am a paid external consultant to IM and serve as the Science and Research Director for IM.)

I have been blogging about brain-clock research at my home base for many years **(Brain Clock Blog)** and more recently have been blogging at the **IM-Home website and blog.**

The problem with sharing information via blogging is that we bloggers make desired connections via hyperlinks. We insert them so you will go to prior posts for related or background information or, to encourage you to read prior posts that may be in a series. Often readers don't want to take the time to bounce back and forth between linked stories

To address this problem, I am trying something new. You are reading the first attempt now. I have taken a single important topic or concept that may be scattered across my various blog posts, as well as other sources, and am putting the essence of the material into mini-PDF e-briefs. I add additional commentary to the original sources to try distill the important key points.

I am calling this series "Time Travels with the Time Doc"' You are reading the first "trip" in a hopefully somewhat consistently disseminated series. Feedback and reader response will likely dictate if these mini-trip e-briefs continue. Enjoy. And remember "In the brain, timing is everything"

THECREATIVITYPOST

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The Brain as a Network: Focusing Your Network

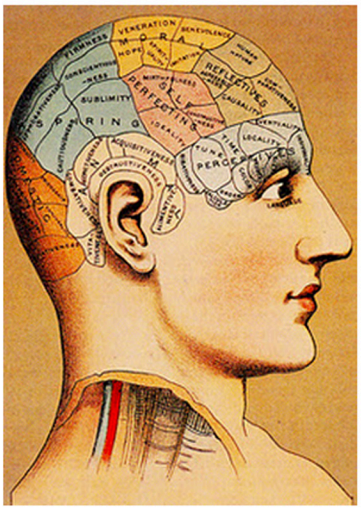
By: Dr. Kevin McGrew | December 22, 2011

Your brain works via a system of interconnected networks that coordinate different cognitive functions

Synopsis

Contemporary neuroscience research suggests that cognition is the result of a number of large scale brain networks that require efficient brain rhythm or synchronization.

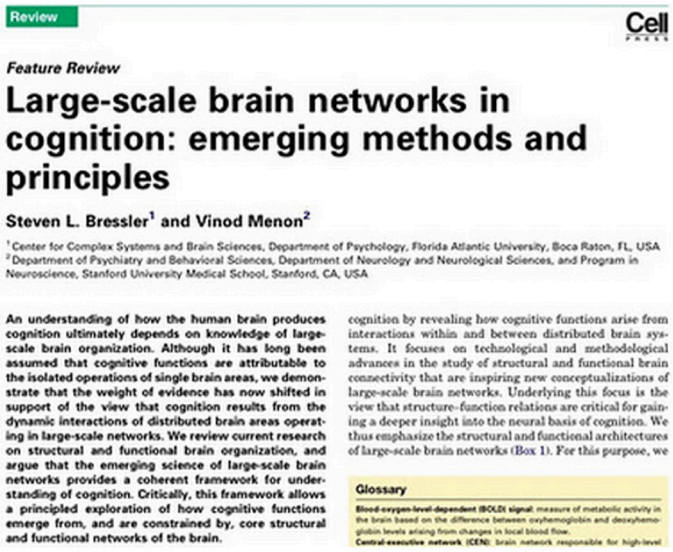
Man has always known that the brain is the center of human behavior. Early attempts at understanding which locations in the brain controlled different functions were non-scientific and included such practices as **phrenology**. This pseudoscience espoused that by feeling the bumps of a person's head it was possible to draw conclusions about specific brain functions and traits of the person.



Eventually brain science revealed that different regions of the brain where specialized for different specific cognitive processes (but it was not related to the phrenological brain bump maps). This has been called the **modular or functional specialization** view of the brain, which is grounded in the conclusion that different brain areas acted more-or-less as independent mechanisms for completing specific cognitive functions.

One of the most exciting developments in contemporary neuroscience is the recognition that the human brain processes information via different brain

circuits or loops which at a higher level can be studied as large scale brain networks. Although the modular view still provides important brain insights, the accumulating evidence suggests that it has serious limitations and might in fact be misleading (Bressler & Menon, 2010). One of the best summaries of this cutting edge research is that by Bressler and Menon.



Review

Cell

Feature Review

Large-scale brain networks in cognition: emerging methods and principles

Steven L. Bressler[1] and Vinod Menon[2]

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[2] Department of Psychiatry and Behavioral Sciences, Department of Neurology and Neurological Sciences, and Program in Neuroscience, Stanford University Medical School, Stanford, CA, USA

An understanding of how the human brain produces cognition ultimately depends on knowledge of large-scale brain organization. Although it has long been assumed that cognitive functions are attributable to the isolated operations of single brain areas, we demonstrate that the weight of evidence has now shifted in support of the view that cognition results from the dynamic interactions of distributed brain areas operating in large-scale networks. We review current research on structural and functional brain organization, and argue that the emerging science of large-scale brain networks provides a coherent framework for understanding of cognition. Critically, this framework allows a principled exploration of how cognitive functions emerge from, and are constrained by, core structural and functional networks of the brain.

cognition by revealing how cognitive functions arise from interactions within and between distributed brain systems. It focuses on technological and methodological advances in the study of structural and functional brain connectivity that are inspiring new conceptualizations of large-scale brain networks. Underlying this focus is the view that structure-function relations are critical for gaining a deeper insight into the neural basis of cognition. We thus emphasize the structural and functional architectures of large-scale brain networks (Box 1). For this purpose, we

Glossary

Blood-oxygen-level-dependent (BOLD) signal: measure of metabolic activity in the brain based on the difference between oxyhemoglobin and deoxyhemoglobin levels arising from changes in local blood flow.
Central-executive network (CEN): brain network responsible for high-level

Large scale brain network research suggests that cognitive functioning is the result of interactions or communication between different brain systems distributed throughout the brain. That is, when performing a particular task, just one isolated brain area is not working alone. Instead, different areas of the brain, often far apart from each other within the geographic space of the brain, are communicating through a fast-paced synchronized set of brain signals. These networks can be considered preferred pathways for sending signals back and forth to perform a specific set of cognitive or motor behaviors.

To understand preferred neural pathways, think of walking on a college campus where there are paved sidewalks connecting different buildings that house specialized knowledge and activities. If you have spent anytime on a college campus, one typically finds foot-worn short cuts in the grass that are the preferred (and more efficient) means by which most people move between building A and B. The combined set of frequently used paved and unpaved pathways are the most efficient or preferred pathways for moving efficiently between buildings. The human brain has developed preferred communication pathways that link together different brain circuits or loops in order to quickly and efficiently complete specific tasks.

According to Bressler and Menon (2010), "a large-scale functional network can therefore be defined as a collection of interconnected brain areas that interact to perform circumscribed functions." More importantly, component brain areas in these large-scale brain networks perform different roles. Some act as controllers or task switchers that coordinate, direct and synchronize the involvement of other brain networks. Other brain networks handle the flow of sensory or motor information and engage in conscious manipulation of the information in the form of "thinking."

Think of the connections between different brain networks as being similar to the hub and spoke system of an airline. Efficient on-time arrival and departure of planes are necessary across the regional networks and the entire network as a whole. Disruption in 1 or 2 smaller network hubs can cause serious disruption of travel. In the mind, network problems can decrease efficient cognitive functioning.

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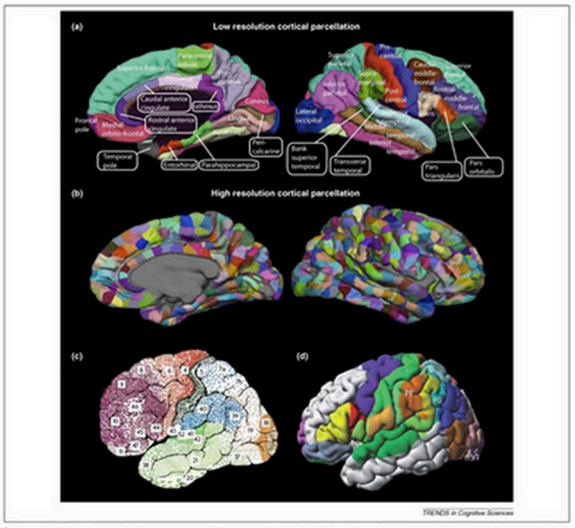
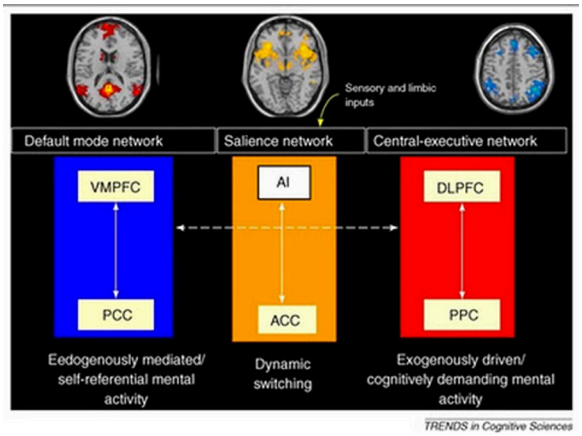
Coordination and efficient synchronization between brain networks makes for better cognitive performance.



As illustrated in the figure to the left, neuroscientists have identified a number of core brain network nodes or circuits. The important new insight is that these various nodes or circuits are integrated together into a grander set of higher-level core functional brain networks. Three important core networks are receiving considerable attention in explaining human behavior.

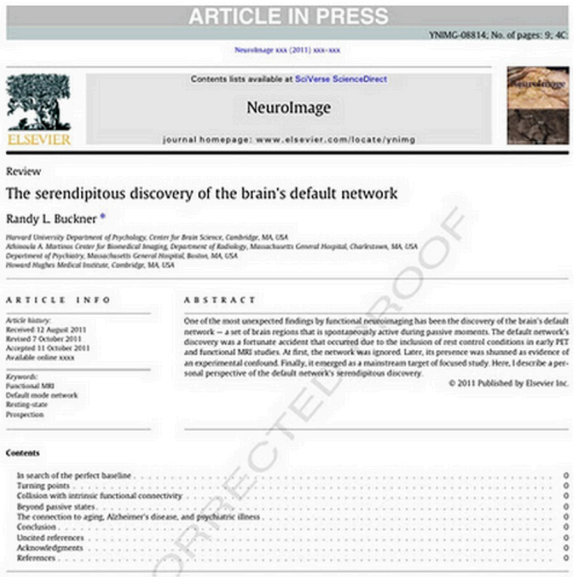
Major functional brain networks

The default mode (DMN) or default brain network (shown in blue) is what your brain does when not engaged in specific tasks. It is the busy or active part of your brain when you are mentally passive. According to Bressler & Menon the "DMN is seen to collectively comprise an integrated system for autobiographical, self-monitoring and social cognitive functions." It has also been characterized as responsible for REST (rapid episodic spontaneous thinking). In other words, this is the spontaneous mind wandering and internal self-talk and thinking we engage in when not working on a specific task or, when completing a task that is so automatized (e.g., driving a car) that our mind starts to wander and generate spontaneous thoughts. As I have discussed previously at the **Interactive Metronome-HOME blog**, the default network is responsible for the unquiet or noisy mind. And, it is likely that people differ in amount of spontaneous mind wandering (which can be both positive creative thinking or distracting thoughts),



Your default brain network is the little voice inside your brain that wanders from thought to thought; often in a spontaneous random wandering manner.

Mind wandering can produce positive creative thinking. But when trying to do something challenging, you want to silence this inner voice as it makes "focus" difficult. You want to "quiet the busy or noisy mind" so you can focus your attention like a laser beam on the important task at hand.



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Review

The serendipitous discovery of the brain's default network

Randy L. Buckner *

ARTICLE INFO

ABSTRACT

Contents

with some having a very unquiet mind that is hard to turn off, while others can turn off the inner thought generation and self-talk and display tremendous self-focus or controlled attention to perform a cognitively or motorically demanding task. A very interesting discussion of the serendipitous discovery and explanation of the default brain network will appear in a soon to be published scientific article.

Cool...huh? Linking the Time Doc's prior analogy to the airline hub and spoke networks and now the air traffic controller

The *salience network* (shown in yellow) is a controller or network switcher. It monitors information from within (internal input) and from the external world surrounding us, which is constantly bombarding us with information. Think of the salience network as the air traffic controller of the brain. Its job is to scan all information bombarding us from the outside world and also that from within our own brains. This controller decides which information is most urgent, task relevant, and which should receive priority in the queue of sending brain signals to areas of the brain for processing. This controlling network must suppress either the default or executive networks depending on the task at hand. It must suppress one, and activate the other. Needless to say, this decision making and distribution of information must require exquisite and efficient **neural timing as regulated by the brain clock(s)**.

Finally, the central-executive network (CEN; shown in red) "is engaged in higher-order cognitive and attentional control." In other words, when you must engage your conscious brain to work on a problem, place information in your working memory as you think, focus your attention on a task or problem, etc., you are "thinking" and must focus your controlled attention. As I understand this research, the salience or controller network is a multi-switching mechanism that is constantly initiating dynamic switching between the REST (spontaneous and often creative unique mind wandering) and thinking networks to best match the current demands you are facing.

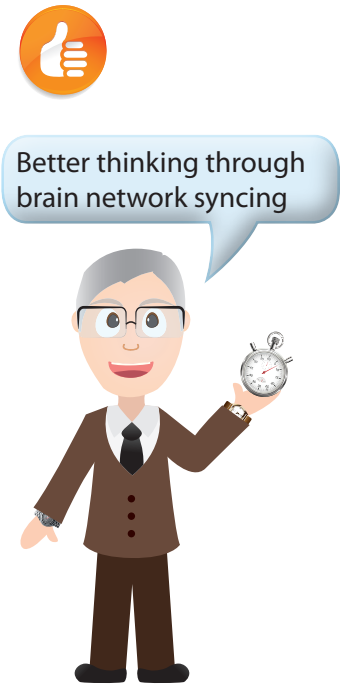
According to Bressler and Menon, not only is this large scale brain network helping us better understand normal cognitive and motor behavior, it is providing insights into clinical disorders of the brain. Poor synchronization between the three major brain networks has been implicated in Alzheimer's, schizophrenia, autism, the manic phase of bipolar and Parkinson's (Bressler & Menon, 2010), disorders that have all been linked to a brain or neural timing (i.e., the brain clock or clocks). I also believe that ADHD would be implicated. If the synchronized millisecond based communication between and within these large networks is compromised, and if the network traffic controller (the salience network) is disrupted in particular, efficient and normal cognition or motor behavior can be compromised.

Since writing this the Time Doc has read a new research synthesis that suggests that ADHD may be a default brain network disorder. Stay tuned.

I find this emerging research fascinating. I believe it provides a viable working hypothesis to explain why different brain fitness or training neurotechnologies have shown promise in improving cognitive function in working memory, ADHD, and other **clinical disorders.** It is my current hypothesis that various brain training technologies may focus on different psychological constructs (e.g., working memory; planning; focus or controlled attention), but their effectiveness may all be directly or indirectly facilitating the synchronization between the major brain networks. More specifically, by strengthening the ability to invoke the salience or controller network, a person can learn to suppress, inhibit or silence the REST-producing default brain network more efficiently, long enough to exert more controlled attention or focus when invoking the thinking central executive network. Collectively these brain fitness technologies may all improve the use of those abilities called **executive function,** or what I have called the personal brain manager. Those **technologies that focus on rhythm or brain timing** are those I find most fascinating. As a **recent example**, the use of melodic intonation therapy with **Congresswoman Gabby Giffords** (she suffered serious brain trauma due to a gun shot) demonstrates how rhythm-based brain timing therapies may help repair destroyed preferred and efficient neural pathways or, develop new pathways; just as a new footpath emerges in the grass on a college campus when construction disrupts the preferred network of pathways.

To understand the beauty of the synchronized brain, it is best to see the patterns of brain network connections in action. Below is a video called the **"Meditating Mind."** I urge you to view the video for a number of reasons.

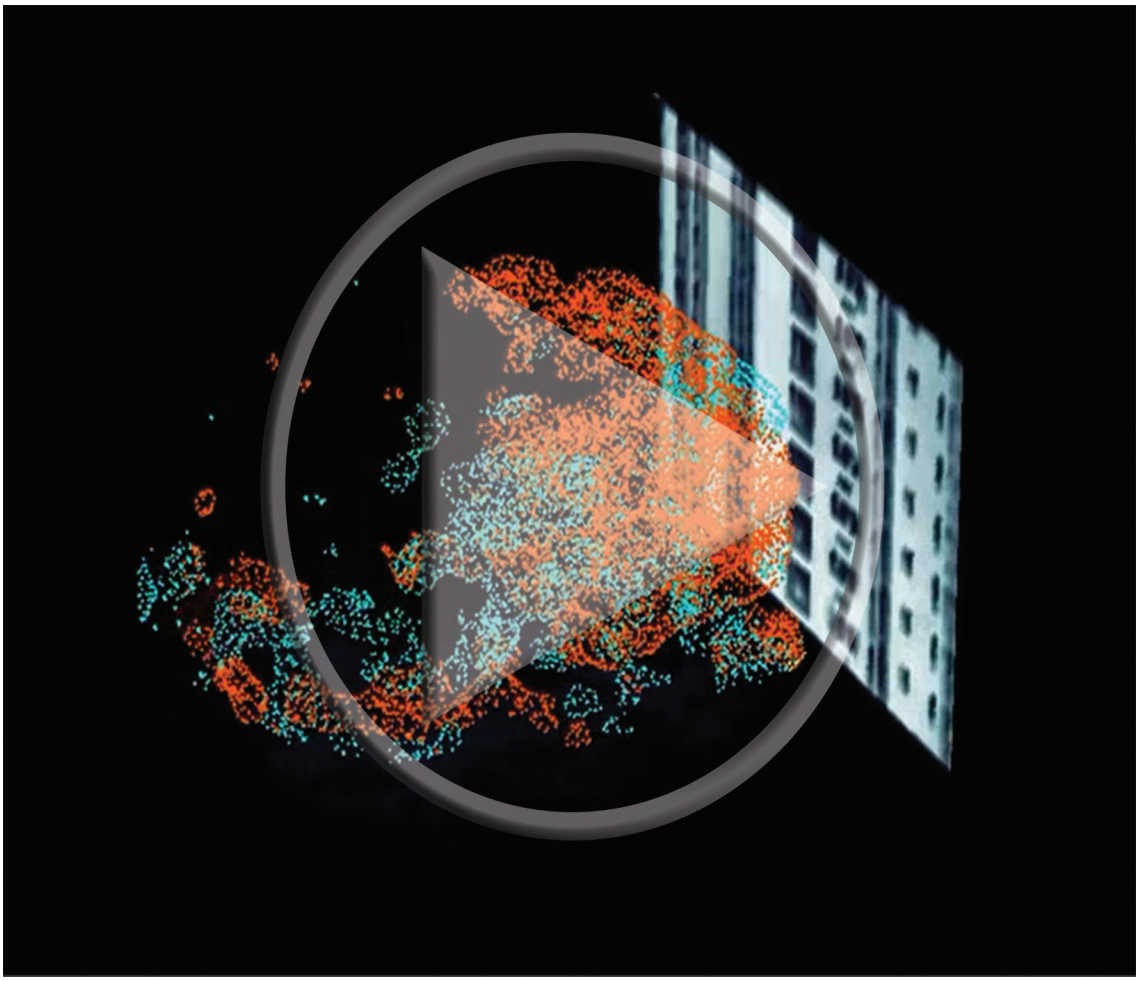
A number of observations should be clear. First, during the first part of the video the brain is seen as active even during a resting state. This is visual evidence of the silent private dialogue (REST) of the default mode or network of the brain. Next, the video mentions the rhythm of increased and decreased neural activation as the brain responds to no visual information or presentation of a video. The changes in color and sound demonstrate the rich rhythmic synchronization of large and different parts of the brain, depending on whether the brain is engaged in a passive or active cognitive task. The beauty of the rapidly changing and spreading communication should make it obvious that efficient rhythmic synchronization of timing of brain signals to and from different networks or circuits is critical to efficient brain functioning.



Finally, the contrast between the same brain under normal conditions and when engaged in a form of meditation is striking. Clearly when this person's brain is mediating, the brain is responding with a change in rates and frequency of brain network activation and synchrony. As I described in my personal **IM-Home based experience post**, mastering Interactive Metronome (IM) therapy requires "becoming one with the tone"…which sounds similar to the language of those who engage in various forms of **meditation**. Could it be that the rhythmic demands of IM, which require an individual to "lock on" to the auditory tone and stay in that synchronized, rhythmic and repetitive state for as long as possible, might be similar to the underlying mechanics of some forms of meditation, which also seek to suppress

irrelevant and distracting thoughts and eventually "let the mind go"---possibly to follow a specific train of thought with complete and distraction free focus.

Yes…this is speculation. I am trying to connect the dots between research-based and personal experience. It is exciting. My IM-Home based personal focus experience makes sense from the perspective of the function and interaction between the three major large scale brain networks.



Also available at: **http://tinyurl.com/78cxors**

On-demand-focus

By: Dr. Kevin McGrew | January 4, 2012

Is there similarity between the attentional focus required during IM-Home training and that attained by experienced meditators? Emerging scientific evidence suggests the answer is "yes."

In two prior IM-Home posts (**here** and **here**; one reproduced at the **CreativityPost blog**), I suggested that the requirement to quiet my unquiet or busy mind, via controlled focus on the IM auditory feedback cowbell tone, might be similar to the sense of being "in immediate awareness" as described by those who meditate. Furthermore, I hypothesized that both IM and meditation training might be training the mind to silence the ever-present random self-talk of the *default brain network*. By silencing this network, it becomes possible to attain singular focus on a stimulus or immediate experience. The constant wandering of our minds, which can be focused on both positive and negative thoughts and ideas, can be trained to disappear by invoking certain executive functions (our personal brain manager) and high levels of attentional control. The **video of an experienced meditator** watching identical visual images in both non-meditative and meditative states provides clear evidence that the networks of the brain function differently during these two different states.

In this context, I was excited to read an article in the prestigious **Proceedings of the National Academy of Science** consistent with my hypotheses and experience. In Brewer et al.'s Dec. 13, 2011 PNAS article *"Meditation experience is associated with differences in default mode network activity and connectivity"*, the authors state:

> *Many philosophical and contemplative traditions teach that 'living in the moment' increases happiness. However, the default mode of humans appears to be that of mind-wandering...and with activation in a network of brain areas associated with self-referential processing. We investigated brain activity in experienced meditators and matched meditation-naive controls as they performed several different meditations (Concentration, Loving-Kindness, Choice less Awareness). We found that the main nodes of the default-mode network (medial prefrontal and posterior cingulate cortices) were relatively deactivated in experienced meditators across all meditation types...Our findings demonstrate differences in the default-mode network that are consistent with decreased mind-wandering. As such, these provide a unique understanding of possible neural mechanisms of meditation.*

Here is an IM-Home blog post where I advance the position that IM training can help you build a powerful brain tool --- "on demand focus" --- use it when you need it.

These authors suggest that we spend approximately *50% of our time in* the mind-wandering default mode! As I described in a prior **post**, I believe that individuals differ in their amount of spontaneous mind wandering, and I am on the high end of the busy mind continuum. For those who want to read the original article, I have provided access to an annotated version via the **Brain Clock Blog.**

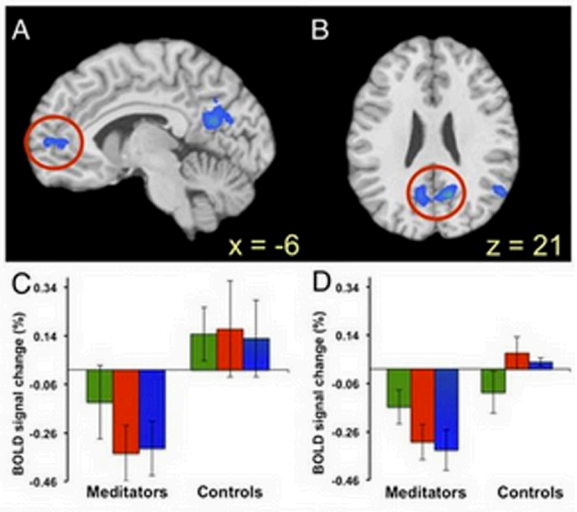


Fig. 1. Experienced meditators demonstrate decreased DMN activation during meditation. Brain activation in meditators > controls is shown, col-

Wow. Up to half the time our brain is in neutral gear and engaged in spontaneous mind wandering.

This possible IM-meditation connection (suppressing and controlling the default mind wandering brain network) has increased my motivation to continue my IM training. Unfortunately, due to the holidays I have not been able to complete any IM sessions this past week. However, I have discovered that knowing that I can turn my default wandering mind off for brief periods of time (2-5 minutes) has resulted in myself invoking on-demand-focus. This typically occurs when I am driving, a period of time when my mind is extremely busy with a number of private conversations. I remember the newfound skill required during my IM sessions and make a conscious decision to focus only on the immediate task of driving. I can successfully invoke controlled focus for 2-5 minutes at a time. I would like to make them longer, but this is the best I can do now. I am confident that increased IM training will extend the time I can engage in what I call deliberate on-off focus--or on-demand-focus.

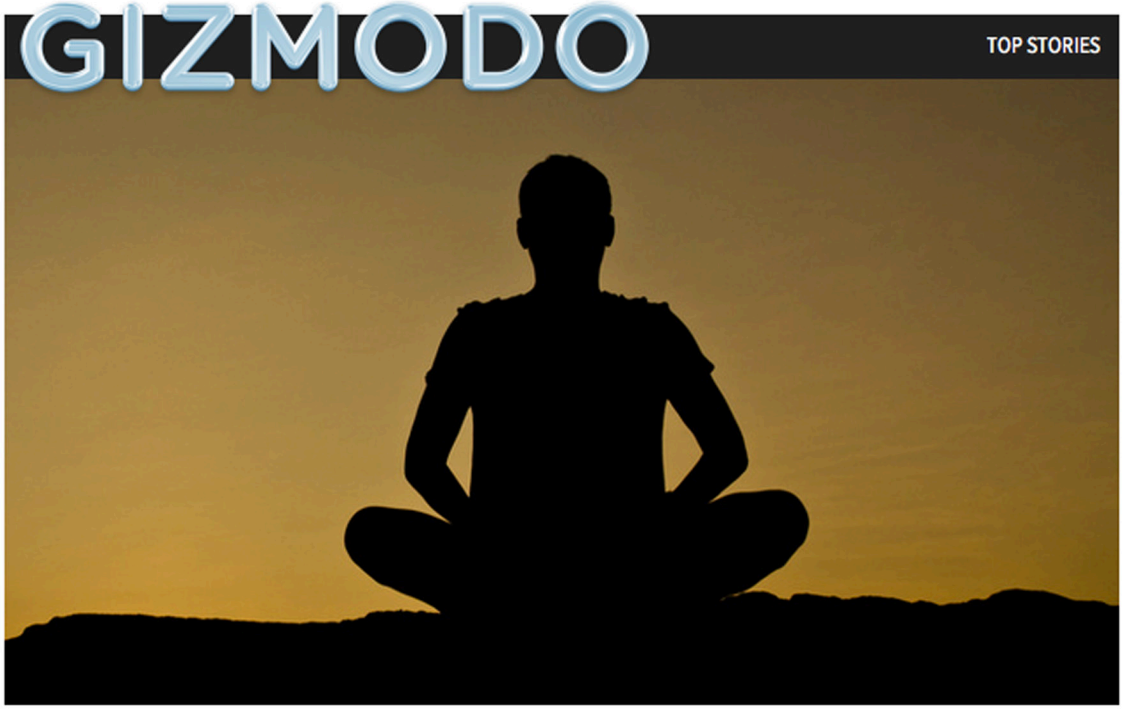
My confidence in my ability to invoke *on-demand-focus* has empowered me to use and practice it in non-IM real world settings. In the field of educational psychology, this type of competence-specific confidence is called **self-efficacy**, a motivational trait that facilitates performance in the domain where the competence is felt. An analogy is the childhood story of the Little Engine That Could… that chanted "I--think--I--can, I--think--I--can"--but in my case it is "I--know--I--can, I--know--I--can." This is the essence of self-efficacy—an apparent indirect positive outcome of my IM training. Furthermore, the fact I am aware of this emerging skill and have confidence to deploy it, indicates that I am "thinking about my thinking," which is what cognitive psychologists call **metacognition.**

In summary, my personal IM experience and research readings suggest that IM training has similarities to formal meditation techniques. Both methods train the mind to block out mind wandering self-talk and invoke focus in the immediate moment. My success may be partially due to an indirect non-cognitive benefit of IM—increased self-efficacy in my ability to focus and exert controlled attention. What I find exciting is my newfound (yet still not fully developed) ability to invoke on-demand-focus. Having such a mind tool can only facilitate my cognitive efficiency and ability to perform in situations where I need to focus like a laser beam.

Meditation produces brain changes that increase brain speed (neural efficiency)

In the previous pages the Time Doc suggested that the core benefit of IM is quieting the default brain network (which is responsible for REST-rapid, episodic spontaneous thinking--the internal wandering "busy mind").

IM trained FOCUS is similar to meditation techniques that require a person to focus on something (sound, breathing, a mantra, etc.)



Meditation Makes Your Brain Quicker

Most people dismiss meditation as a bunch of hippy nonsense, but no longer. Scientists have established that meditation, if done regularly and for long enough, is linked to the brain being able to process information faster. Take that, skeptics.

The research, undertaken at UCLA, used MRI scans to compare the brains of 50 meditators to 50 non-meditators. What they discovered was that long-term meditators display large amounts of something known as gyrification in the brain. Gyrification is just a fancy-pants term for the amount of folding in the cortex—it's what gives the brain its unique, ridged appearance. Furthermore, there's a heap of evidence supporting the fact that the more folded a **brain is, the quicker it can process information.**

In the intelligence literature the dominant theory for differences in general intelligence is that people with more efficient and quicker processing in the brain can perform more intelligently. It is called the "neural efficiency" hypothesis. See my IM HOME blog post for more information: Brain or Neural Efficiency: Is it quickness or timing?

In fact, the researchers found a direct correlation between the number of years participants had been meditating and the amount of gyrification, which suggests that, over time, people who meditate see an increase in the speed at which they can process information. **Speaking to Medical Express**, Eileen Luders, one of the researchers, said:

> "Meditators are known to be masters in introspection and awareness as well as emotional control and self-regulation, so the findings make sense that the longer someone has meditated, the higher the degree of folding..."

While the finding will likely make those who meditate smile smugly and say "I told you so", you should attempt to rise above it with Zen-like calm. After all, it might do you good.

Psychology Today

The Mindful Self-Express

The mind-body experiment

By: Melanie Greenberg, Ph.D. | September 25, 2011

Changing Your Brain By Changing Your Mind

How meditation rewires your brain to be more positive

When it comes to managing stress, the Eastern traditions may be especially effective. The Western health model is based on diagnosing the underlying cause of a problem and then finding an active medical or behavioral intervention to remove it. People with chronic illness are often urged to "stay strong," or to have "a fighting spirit." Eastern medicine has a more holistic view of disease as indicating a lack of balance or an energy blockage. The solution is to bring the body and mind back into balance using gentle, noninvasive techniques such as herbs, manipulative techniques, movement, or meditation.

How the Brain Processes Emotion

Our lower brain centers, such as the amygdala or hypothalamus, were made to detect and respond to threats, such as a tiger about to eat us. They generate an immediate "fight or flight" response to increase the odds of survival, but they can become hypersensitive, interfering with our ability to experience the present moment in an open and relaxed way. Daily meditation practice can help to correct this imbalance and allow us to retrain our minds so we are less likely to overreact with intense anger or fear to psychological threats, such as rejection. Being less chronically stressed can also help our immune systems function more efficiently to fight off disease.

Mindfulness Meditation

Mindfulness-Based Stress Reduction Therapy (MBSR) is a meditation program developed by John Kabat-Zinn and researchers at Harvard Medical School to help people living with chronic pain. Central to this form of meditation is a focus on the breath to bring the mind back to the present moment when it wanders off. Over time, this leads to greater conscious control over attentional focus, such that more primitive alarm responses are less able to control our thoughts and behaviors. The final goal of the meditation training is to integrate present-moment awareness into every aspect of daily life.

Research over the past 10 years or so has begun to show how meditation may change the brain and improve mental and physical wellbeing.

Improved Immune Response

A 2003 study by Richard Davidson and colleagues, with healthy employees, showed that 8 weeks of meditation practice changed the pattern of electrical activity in the brain. There was greater activation in the left hemisphere among meditators than people assessed at the same time who did not have meditation training (control group). The researchers also looked at immune response to an influenza vaccine and found that the meditator group had more antibody titers to the vaccine than the control group, indicating better immune functioning. These benefits lasted for months after the intervention.

Changes in the Brain's Grey Matter

A more recent controlled study showed that meditation was associated with increased grey matter in the hippocampus, which is responsible for learning and memory, and decreased grey matter in the amygdala, which is the initiator of the brain's pre-cortical alarm system. These physiological changes parallel the theory that meditation increases conscious control over emotional, behavioral, and attentional response to threat.

Reduced Pain Sensitivity

Researchers are also beginning to show that meditation can change the way we experience pain. Chris Brown and colleagues at the University of Manchester showed that a Mindfulness Meditation course led to less unusual activity in areas of the prefrontal cortex when subjects expected to receive a painful stimulus (such as a small electric shock or contact with a hot object). Those who meditated reported finding the pain less unpleasant as well.

Shift From Negative to Positive Affect

Patients in another mindfulness study demonstrated significantly greater changes in brain electrical activity from activation in the right to the left cortical hemisphere, from before to immediately following meditation and several months later, compared to a control group. This pattern of brain activity is associated with a shift away from negative and towards more positive emotional experience. In other words, mindfulness meditation regimen appeared to help people to experience more positive emotions such as love, compassion, or contentment.

Bingo. Exerting conscious deliberate control over attentional focus, or what is often called controlled attention, is the core essential task requirement of IM. Instead of a focus on breathing, as in meditation, your mind must focus like a laser beam on the mili-second constant feedback provided as well as the repeating cowbell sound.

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This is also true when first trying IM. It is very hard to stay focused and not let your mind wander (due to default brain network). Research suggests that 20 -30 minutes of total focus is the best most people can do.

Does a Briefer Intervention Work?

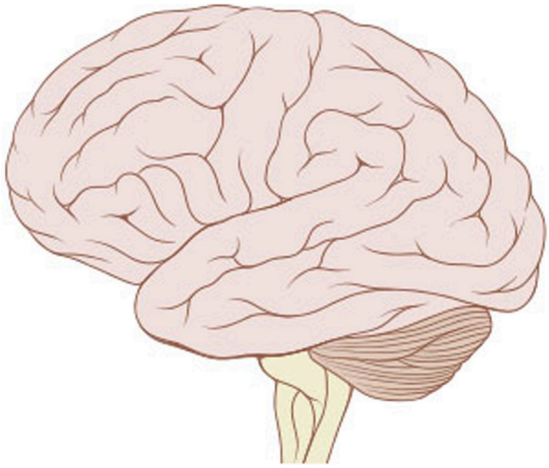
One reason why people resist meditating is the time it takes. The original protocol involved eight weeks of mindfulness training sessions plus 45 minutes a day of at-home practice. At the beginning, many people find it difficult to sustain attention on the breath for that length of time. Logistical and time considerations make patients more hesitant to sign up or result in dropout. A briefer intervention that could be used more widely in hospital, employee wellness, and outpatient mental health settings might be more cost-effective and palatable to patients.

A very recent study published in the journal Psychological Science shows that a briefer meditation protocol can produce similar changes in cortical activity. Researcher Christopher Moyer and his colleagues at the University of Wisconsin-Stout assigned subjects at random to either a 5-week Mindfulness Meditation group or to a group put on a waiting list for services. Data showed people in the meditation group practiced at home a couple of times a week for about 25 minutes each time, on average. These meditation subjects showed the same changes in cortical activity as those who got the full intervention in earlier studies; that is, a significant increase in left hemisphere cortical activation. The waiting list group did not demonstrate these changes. This is an exciting finding, since it suggests even shorter meditation periods can significantly increase positive emotional experience in the brain.

PSYPOST

A wandering mind reveals mental processes and priorities

University of Wisconsin at Madison | March 16, 2012



Odds are, you're not going to make it all the way through this article without thinking about something else.

In fact, studies have found that our minds are wandering half the time, drifting off to thoughts unrelated to what we're doing – did I remember to turn off the light? What should I have for dinner?

A new study investigating the mental processes underlying a wandering mind reports a role for working memory, a sort of a mental workspace that allows you to juggle multiple thoughts simultaneously.

Imagine you see your neighbor upon arriving home one day and schedule a lunch date. On your way to add it to your calendar, you stop to turn off the drippy faucet, feed the cat, and add milk to your grocery list. The capacity that allows you to retain the lunch information through those unrelated tasks is working memory.

The new study, published online March 14 in the journal Psychological Science by Daniel Levinson and Richard Davidson at the University of Wisconsin–Madison and Jonathan Smallwood at the Max Planck Institute for Human Cognitive and Brain Science, reports that a person's working memory capacity relates to the tendency of their mind to wander during a routine assignment. Lead author Levinson is a graduate student with Davidson, a professor of psychology and psychiatry, in the Center for Investigating Healthy Minds at the UW–Madison Waisman Center.

The researchers asked volunteers to perform one of two simple tasks – either pressing a button in response to the appearance of a certain letter on a screen, or simply tapping in time with one's breath – and compared people's propensity to drift off.

"We intentionally use tasks that will never use all of their attention," Smallwood explains, "and then we ask, how do people use their idle resources?"

Throughout the tasks, the researchers checked in periodically with the participants to ask if their minds were on task or wandering. At the end, they measured each

This mind wandering is the internal self-talk from the default brain network.

Some researchers have hypothesized that attentional control is the essence of working memory...that is, controlled attention is what makes efficient working memory possible.

Mind wandering is not always bad. If you have good working memory and are doing something easy or automatized (e.g., driving your car) good working memory allows for the creative side of mind wandering.

But...when working memory is taxed you need to shut off the default brain mind network wandering and focus--"on demand focus" is an important cognitive control skill.

participant's working memory capacity, scored by their ability to remember a series of letters given to them interspersed with easy math questions.

In both tasks, there was a clear correlation. "People with higher working memory capacity reported more mind wandering during these simple tasks," says Levinson, though their performance on the test was not compromised.

The result is the first positive correlation found between working memory and mind wandering and suggests that working memory may actually enable off-topic thoughts.

"What this study seems to suggest is that, when circumstances for the task aren't very difficult, people who have additional working memory resources deploy them to think about things other than what they're doing," Smallwood says.

Interestingly, when people were given a comparably simple task but filled with sensory distractors (such as lots of other similarly shaped letters), the link between working memory and mind wandering disappeared.

"Giving your full attention to your perceptual experience actually equalized people, as though it cut off mind wandering at the pass," Levinson says.

Working memory capacity has previously been correlated with general measures of intelligence, such as reading comprehension and IQ score. The current study underscores how important it is in everyday situations and offers a window into the ubiquitous – but not well-understood – realm of internally driven thoughts.

"Our results suggest that the sorts of planning that people do quite often in daily life – when they're on the bus, when they're cycling to work, when they're in the shower – are probably supported by working memory," says Smallwood. "Their brains are trying to allocate resources to the most pressing problems."

In essence, working memory can help you stay focused, but if your mind starts to wander those resources get misdirected and you can lose track of your goal. Many people have had the experience of arriving at home with no recollection of the actual trip to get there, or of suddenly realizing that they've turned several pages in a book without comprehending any of the words.

"It's almost like your attention was so absorbed in the mind wandering that there wasn't any left over to remember your goal to read," Levinson says.

Where your mind wanders may be an indication of underlying priorities being held in your working memory, whether conscious or not, he says. But it doesn't mean that people with high working memory capacity are doomed to a straying mind. The bottom line is that working memory is a resource and it's all about how you use it, he

says. "If your priority is to keep attention on task, you can use working memory to do that, too."

Levinson is now studying how attentional training to increase working memory will affect wandering thoughts, to better understand the connection and how people can control it. "Mind wandering isn't free – it takes resources," he says. "You get to decide how you want to use your resources."

A clear link between the ability to control attention like a laser beam when cognitively challenged. Attentional control can be trained by shutting down the default brain network when necessary. IM and some forms of meditation seem to do this, and it is likely that some brain fitness technologies are also likely working on attentional control via the working memory focus of many of these programs.

Conversely, creative mind wandering is good if you are doing something easy and automatized (e.g., jogging). Thus, you want and need the ability to muster "on demand" differential task-specific focus. That is, let your creative mind wandering occur when doing an automatic task as this can be positive. However, if the situation changes and you are in an environment that places major demands on your working memory (e.g., driving a rental car on a major freeway in a strange large city), you need to invoke your "on demand focus" and shut down the internal self talk. The research suggests that those with better working memory can engage in the positive creative mind wandering when doing something that is easy and automatic, but if your working memory is weak you may not be able to do this...or should not try to do so. Training to improve focus or controlled attention may help increase working memory capacity.

SCIENTIFIC AMERICAN™

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Mind Wandering Is Linked to Your Working Memory

By: Christie Nicholson | March 17, 2012

A new study has found a strong correlation between how much your mind wanders and your working memory capacity.

The scientific study mentioned in the blogs the Time Doc has shared is making all the rounds in all the major psych, neuro, and science blogs. It is somewhat viral on the science blogosphere (March 2012). Information regarding the article is above. Below is one example of a credible science blog (Scientific American) featuring this study. You can listen to the text via an MP3 link if you want:

Visit: http://podcast.sciam.com/psych/sa_p_podcast_120317.mp3

Newsletter Links

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Brain Clock Blog: http://www.brainclock.net/
IM-Home website and blog: http://imhome.org/index.php/latest-news.html

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Phrenology: http://en.wikipedia.org/wiki/Phrenology
Modular or functional specialization: http://en.wikipedia.org/wiki/Functional_specialization_%28brain%29

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Interactive Metronome-HOME blog: http://www.imhome.org/index.php/latest-news/entry/my-personal-and-professional-experience-and-task-analysis-of-im-home-focus-and-controlled-attention.html

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Neural timing as regulated by the brain clock(s): http://www.brainclock.net/

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Clinical disorders: http://www.brainclock.net/search/label/clinical%20disorders
Executive function: http://en.wikipedia.org/wiki/Executive_functions
Technologies that focus on rhythm or brain timing: http://www.brainclock.net/2009/08/brain-rhythm-treatment-efficacy-can-we.html
Recent example: http://www.brainclock.net/2011/11/gabby-giffords-response-to-music.html
Congresswoman Gabby Giffords: http://en.wikipedia.org/wiki/Gabrielle_Giffords
"Meditating Mind": http://www.youtube.com/watch?v=TJLdNRebeWE
IM-Home based experience post: http://www.imhome.org/index.php/latest-news/entry/my-personal-and-professional-experience-and-task-analysis-of-im-home-focus-and-controlled-attention.html
Meditation: http://en.wikipedia.org/wiki/Meditation

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Metacognition: http://en.wikipedia.org/wiki/Metacognition

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Brain or Neural Efficiency: Is it quickness or timing?: http://imhome.org/index.php/latest-news/entry/brain-or-neural-efficiency-is-it-quickness-or-timing.html

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About the Author

Dr. Kevin McGrew is the Director of the Institute for Applied Psychometrics (IAP). He received a masters degree in school psychology at Moorhead State University and his doctoral degree in Educational Psychology at the University of Minnesota. He was a practicing school psychologist for 12 years. He spent 10 years as a Professor of Applied Psychology at St. Cloud State University. He is currently a Visiting Professor in Educational Psychology at the University of Minnesota. He serves as the Research and Science Director for Interactive Metronome.

Dr. McGrew conducts research in the areas of theories of human intelligence, intelligence testing, school learning, and the application of neurotechnology to cognitive performance and learning. He has published over 60 different journal articles, books or book chapters in his areas of expertise. He is a coauthor of the Woodcock-Johnson III. Detailed information can be found at his IAP web page. McGrew disseminates information regarding human intelligence and the human brain clock at two professional blogs (IQs Corner; Brain Clock Blog).

BrainClock.net

End of Trip # 1. Stay tuned for the Trip 2 of "Time Travels with the Time Doc" - Topic and date of departure not yet determined