# CARDIAC COHERENCE, COGNITIVE FUNCTION AND ENHANCING SAFETY PERFORMANCE USING THE HEARTMATH® SYSTEM

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## Executive Summary

The HeartMath® System is a series of techniques supported by a PC based Interactive Learning System. By using this System, individuals are able to fundamentally manage their behaviour and performance, particularly when under pressure, through the process of generating cardiac coherence. Cardiac coherence is achieved when the frequency of the signal generated by the cardiovascular system is exactly at 0.1Hz. Earlier research in the US has proved the correlation between cardiac coherence and cortical facilitation. Our research trial, undertaken and monitored by CDR Ltd, has demonstrated statistically significant improvement in various aspects of cognitive performance - in particular, significant improvement in Quality of Memory a score reflecting both working memory (short-term) and episodic memory (long-term). Furthermore, prior to the study there were was no relationship between cardiac coherence and any of the performance measures, whereas after using the System for seven weeks, a highly significant correlation was identified between cardiac coherence and Quality of Memory (the probability of this relationship occurring by chance being less than 1 in 10,000). Statistically reliable correlations were also found between coherence and the time taken to retrieve information from memory, the ability to sustain attention, and the ability to correctly identify targets in a rapid information-processing task.

These results suggest that any environment that requires people to process information quickly, recall information or pay attention over extended periods of time will benefit from using the HeartMath® System.


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A series of tools and techniques now collectively known as the HeartMath® System have been developed that enable people to systematically self generate and sustain a psychophysiological coherence mode. The primary focus of these techniques is on the intentional generation of a sustained positive emotional shift, which, in turn, allows a cardiac coherence mode to emerge naturally and which acts as a driver to reinforce the inherent associations between psychophysiological coherence states and positive feelings. It can be shown that the intentional application of these positive emotion-focused coherence-building techniques, on a consistent


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basis, effectively facilitates a re patterning process whereby coherence becomes increasingly familiar to the brain and nervous system, and this progressively becomes established in the neural architecture as a new and stable psychophysiological baseline or norm. The amount of information travelling through the afferent nerves between the heart and the brain increases during cardiac coherence, and an examination of the role that cardiac afferent input plays in the neural pathways involved in cognitive performance and intentional behaviour has been studied. Experiments have shown that reaction times are significantly improved in the coherence state. The studies showed such cognitive performance can be improved by maintaining psychophysiological coherence prior to performing a task and that there appears to be a carry-over effect of the coherence mode on subsequent cognitive performance. Furthermore, the findings also suggest a physiological link between positive emotions and improvements in functions such as motor skills, focused attention and discrimination.

Disruptions to cognitive function are directly linked to failures of a huge variety of everyday tasks. For example, there is no doubt concerning the requirement for adequate levels of cognitive function to enable someone to be classified as fit to drive a vehicle, and there is little or no argument when patients with severe cognitive disruptions such as Alzheimer's disease are prevented from driving. Alcohol is known to disrupt major aspects of cognitive function, and alcohol levels of drivers are directly linked to road accidents. There are a number of core domains of cognitive function, which are essential for the adequate performance of everyday tasks, from the simple to the highly complex. These include attention, vigilance, working memory, episodic memory, skilled coordination etc. There is a huge literature showing that drugs, ageing, fatigue and stress all lead to impairments in these aspects cognitive function, and all are directly associated with an increased risk of failure to adequately perform a wide variety of tasks.

These core domains of cognitive function can be assessed using validated psychological tasks. These are ideally automated to provide the proper control of stimulus presentation and the precise recording of responses. The Cognitive Drug Research (CDR) system, developed by Professor Keith Wesnes and his team is an automated set of tests which for the last 20 years has been the most widely used automated system in any area of clinical research. It is used to evaluate compounds, which can reverse fatigue and cognitive impairment, in fields ranging from shift-work sleep disorder to Alzheimer's disease. It is also routinely used worldwide in drug development to determine the extent to which novel medicines may compromise everyday cognitive function. The system has also been used to assess safety concerns to a wide range of factors including exposure to magnetic fields, sleep deprivation, mobile telephones, $CO_2$ levels in classrooms, solvent exposure, mercury exposure, cardiac bypass surgery, anaesthesia and shift work. The CDR system can therefore measure the level of functioning of core domains of cognition, and help assess the risk of failure to perform various tasks.

The CDR system has recently been used in an independent study of the cognitive effects of the HeartMath® techniques in healthy volunteers[1]. In this study, a group of 18 volunteers aged 23 to 53 (mean 31) received extensive practice and familiarisation on the CDR tests, and underwent a full pre-study cognitive assessment. The group were then trained on the HeartMath® tools, and used them up to four times a week over a seven week period. The Figure below shows the power spectrum before (left) and after the seven week period (right), indicting the degree to which the


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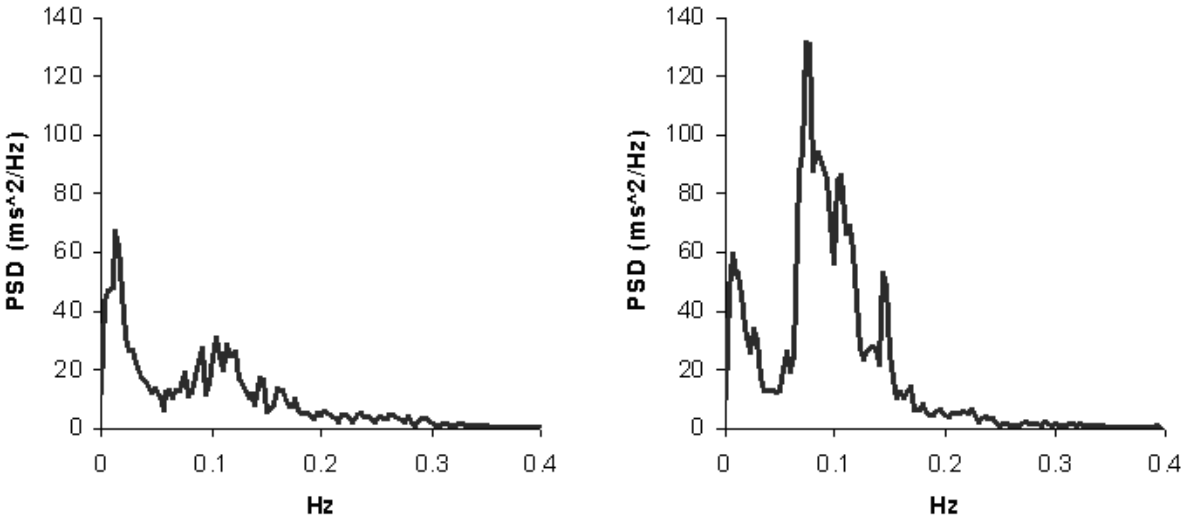
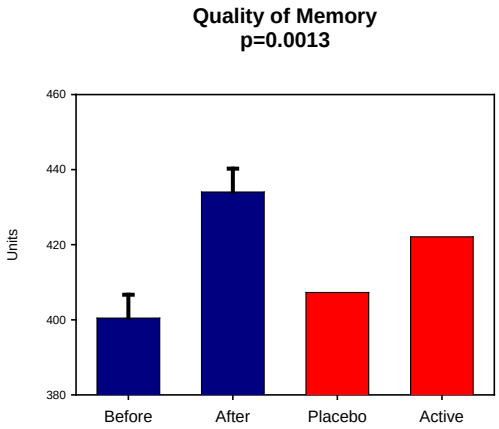
group were able to achieve coherence as illustrated below by the peak and increase in power spectral density at 0.1 Hz, the frequency of cardiac coherence.



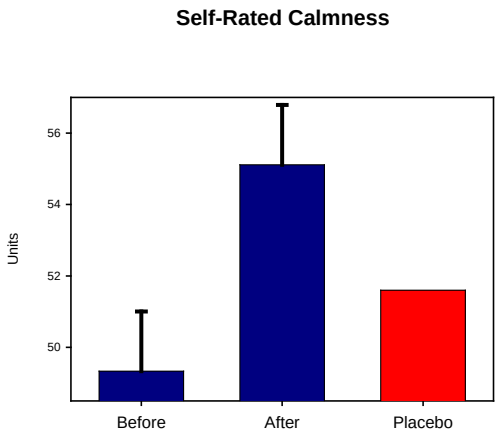

Cognitive function testing was repeated after this seven week period. The group showed a large and highly statistically reliable improvement in overall memory function (p=0.0013). This improvement plotted below as the blue bars for before and after was seen in a measure which combined the accuracy scores from six of the nine CDR tests (Quality of Memory), and reflected the ability to store and subsequently retrieve information from both short-term and long-term memory.



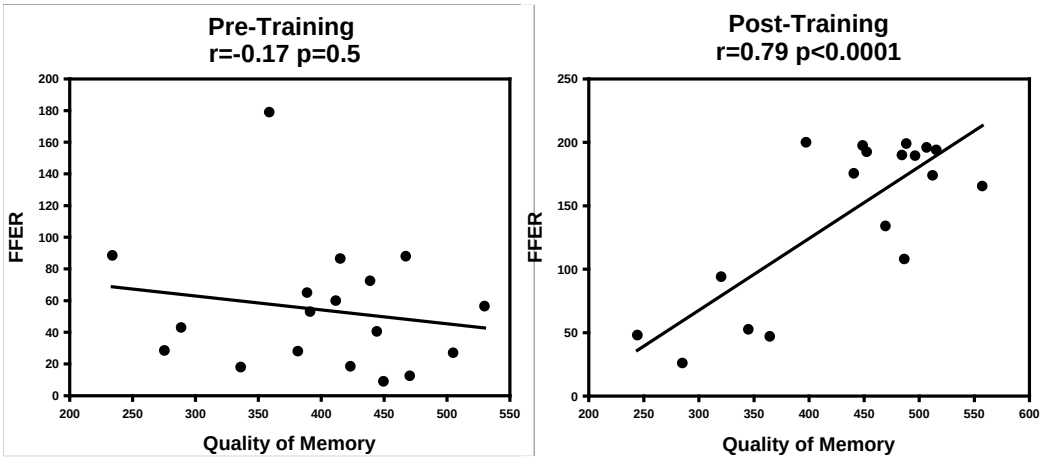

The improvement due to the use of the techniques was substantial. To illustrate this, the two bars in red are from a landmark clinical trial of a combination of gingko and ginseng on the memory of healthy volunteers[2]. The placebo bar illustrates the improvements seen in this study due to the volunteers' knowledge that they were taking part in a study of a memory enhancer, although these volunteers actually received an inert substance. The active bar is for the volunteers who did receive the active treatment, and shows the benefit it produced. The ginkgo/ginseng combination

is now marketed on the basis of this evidence in the UK as Actimind and is sold in high street pharmacies including Boots. Clearly the memory improvement with HeartMath® was more substantial than this.

The volunteers also reported feeling more calm over the seven weeks, and again this change cannot be attributed to suggestion as can be seen from the red bar from a clinical trial[2].




Another very important finding from this study was that levels of performance at the start of the study showed no relationship to the degree of coherence prior to HeartMath® training. However after seven weeks, cardiac coherence became directly related to performance. This is illustrated first for the Quality of Memory.




The figures above show for each of the 18 volunteers, the FFER score, a measure of cardiac coherence, plotted against the Quality of memory score. There was clearly no relationship between coherence and memory performance prior to training, as illustrated by the non-significant correlation coefficient (r=-0.17) in the left-hand figure. However after training, a very clear relationship between memory and the degree of coherence is evident, the probability of this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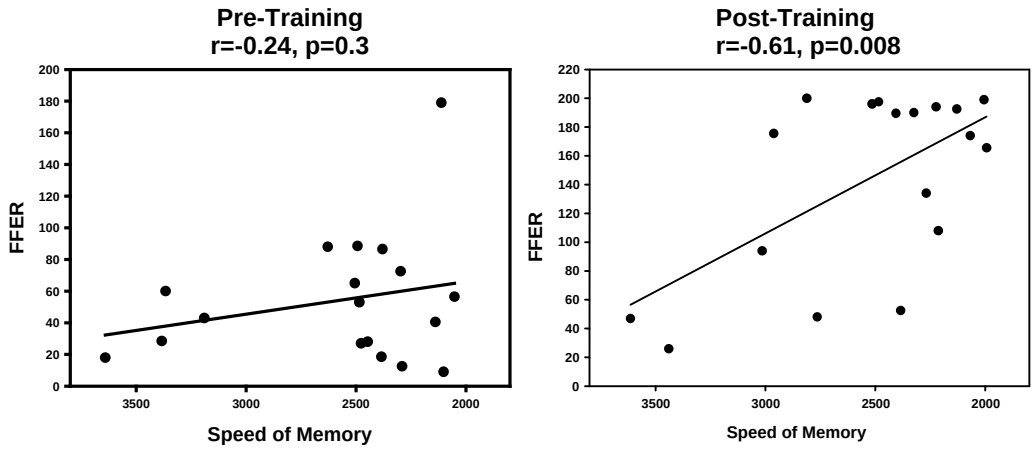
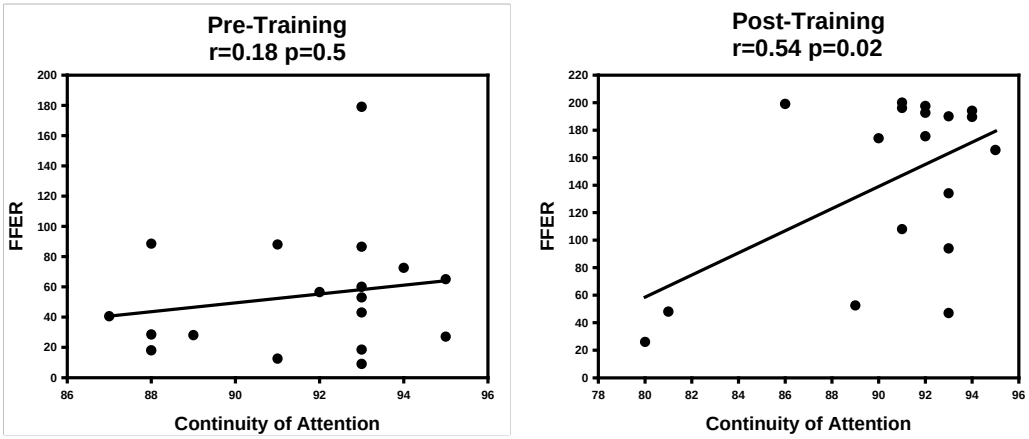
relationship occurring by chance being less that 1 in 10,000. Thus besides the group showing an overall benefit to memory, this ties the benefit directly to the degree to which the individuals were able to achieve coherence after the seven weeks.

Similar relationships emerged for other aspects of performance. Below, the time taken to retrieve information from both short and long term memory showed an identical pattern. Thus not only were the volunteers who achieved more coherence better able to retrieve information from memory, they could also retrieve it more quickly, a very important effect.




Attention also showed the same effect, as is illustrated below for an index called continuity of attention, which reflects the ability to sustain attention over extended periods.




Finally a measure of performance under high pressure, rapid information processing accuracy, showed the same pattern, as can be seen below.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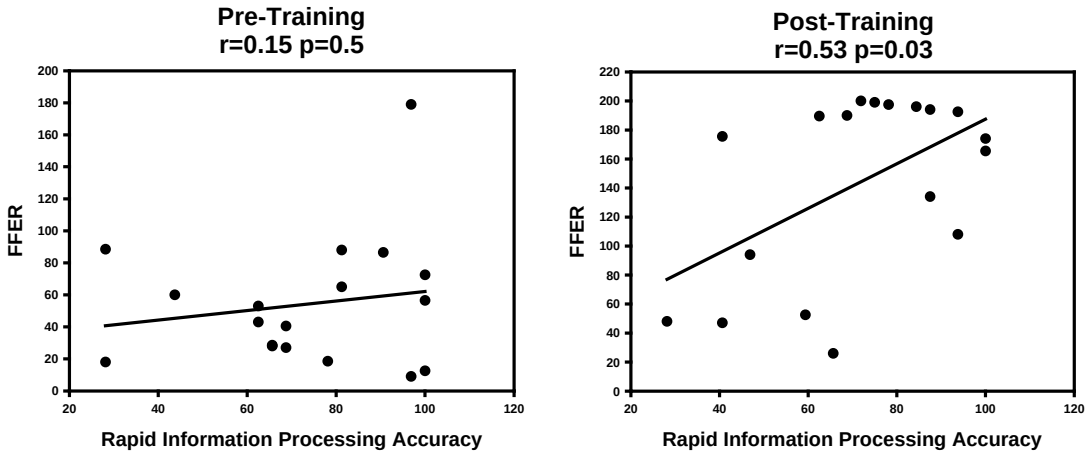


This development of a direct relationship of cardiac coherence with cognitive function is a powerful demonstration of the utility of the HeartMath® technique, particularly considering that these volunteers had been performing well within the normal range prior to the study. The relevance of these aspects of cognitive function to the successful completion of many complex activities such as those crucial in safety critical environments cannot be underscored, and illustrate the benefits which can emerge from this technique.

A larger trial is currently underway to investigate determine whether children with attention deficit hyperactivity disorder (ADHD) will show similar benefits due to HeartMath® training.

[1]Bradford EJ, Wesnes KA, Brett D (2005) Effects of peak performance training on cognitive function. Journal of Psychopharmacology 19 (Supplement): A44.

[2]Wesnes KA, Ward T, McGinty A, Petrini O (2000). The memory enhancing effects of a ginkgo biloba/ panax ginseng combination in healthy middle aged volunteers. Psychopharmacology 152: 353-361.


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