# THE NEUROSCIENCE OF CONATION

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# Abstract

Kolbe and Wigton used a protocol developed for an earlier study by ASU that identified neuropathway patterns related to conative energy in the brain in a resting state (Kolbe & Balthazard, 2010), to identify the location in the brain from which conative energy appears to originate.  While testing their hypothesis that tracking brain activity during dysfunctional tasks would validate the existence of conative stress, Kolbe and Wigton identified the area where conation appears to generate the most electrical activity in the brain. The protocol kept subjects focused on conative activities and the electrical activity was monitored using quantitative electroencephalography (qEEG). The low resolution electromagnetic tomography (LORETA) analysis showed highly focused and consistent patterns in the brain activity of subjects while striving toward goals through their natural conative methods of problem solving compared to a resting state.

# Executive Summary

Conation has long been thought to be the third domain of the mind, working in conjunction with cognition and affect (emotion) to form the tripartite of mental processing (Hilgard, 1980). Centuries ago, philosophers identified conation as the driving force for all human action, reaction and interaction, and more recently have considered it an innate precognitive mental process in the brain (Kolbe, 1997).

Kolbe (1997) has postulated that conative energy in the brain is stimulated by emotions that cause human beings to take volitional or self-directed action. The result, Kolbe believed, would be seen as free flowing mental energy in the brain induced by purposeful striving. She further postulated that when the brain was not free to follow its innate conative activations, widespread efforts would result in dysfunctional efforts and lack of goal attainment. As has been the case with the majority of brain research, most research previously dealing with possible conative actions were based on dysfunctional activities (Reitan & Wolfson, 2005). Kolbe's three decades of behavioral research has focused primarily on the use of conative strengths to improve functionality.

Wigton, a neuroscientist specializing in quantitative electroencephalography (qEEG) and neurotherapy, evaluated Kolbe's previous brain study (Kolbe & Balthazard, 2010) and believed that recent advances in neuroscience-based approaches to brain functionality would facilitate further scientific assessment of Kolbe's theories. Kolbe and Wigton decided to study the brain activity of people while in states where they were free to strive toward goals in their own ways, and when they were required to strive (or opt out of striving) in ways that would require efforts that did not fit their presumed natural ways of problem solving. These two different conditions were compared to a resting state condition.

Although Kolbe's protocol, used in the earlier study by ASU, led to the discovery of neuropathway patterns related to conative energy in the brain in a resting state (Kolbe & Balthazard, 2010) that study did not identify the location in the brain from which conative energy originates. While testing their hypothesis that tracking brain activity during dysfunctional tasks would validate the existence of conative stress, Kolbe and Wigton were also able to identify what they believe to be an area where conation generates a significant amount of electrical activity in the brain. Kolbe's protocol kept subjects focused on conative activities and the electrical activity that was generated in the brain was later analyzed by Wigton.

When the brain activity of subjects while striving toward goals through their natural conative methods of problem solving was compared to the resting state, the area of origination of that energy became evident and was highly focused. When the protocol required the subjects to work against their conative grain, their stress or dysfunctionality was also traceable. While it originated in the same location in the brain, the energy spread out from that location, using a great deal more energy. That added energy led to self-reported and observable stress on the part of the participants. The stress was predicted by previously validated conative testing (Kolbe, Young, & Gerdes, 2008).

Review of the data in this study shows that conative activity, similar to cognitive and affective activity, likely originates in at least one specific area in the brain. This region is generally in the area of the occipital lobe and is not near to or directly connected to the area previously believed to be the originating site of conative energy.

Further investigation is necessary to confirm these findings as well as the assumption that the degree to which the originating areas continue to house conative or purposeful activity relates to the degree of function verses any dysfunction of conative actions. If this assumption proves to be true, further investigation of this area of the brain might be conducted among persons with ADHD, autism, and burn-out or breakdowns in work-related situations to determine whether such neural dysfunctions are partially or fully associated with conative causes. Such research might explore whether training that tries to force changes to natural brain activity lead to dysfunction instead of the desired improvements in functioning. The researchers believe that this study opens the possibility for neurological corroboration of the existence of the conative faculty of the mind which might lead to further research to improve various quality of life issues.

## Conative Theory

Ancient philosophers were the first to comment on the existence of a three-part mind with separate faculties for thinking, feeling, and doing. Different from cognition and affect, conation is a universal drive that converts deeply imbedded human instincts into the actions that comprise an individual's *modus operandi* (MO), or the way one works, accomplishes tasks, and engages in creative problem solving (Kolbe, 1997). Kolbe's work spans more than 30 years and case studies from education, health, business and government environments have tracked the ways in which conation or volition influences human actions, reactions and interactions. Based upon close to one million data points, Kolbe's work has demonstrated that conative strengths do not change, are equally distributed by gender, age and race, and that working contrary to them causes a type of stress that differs from affective or cognitive stress.

Validated by over three decades of behavioral and assessment research (Kolbe Corp, 2002; Kolbe & Gerdes, 2007; Kolbe, Young, & Gerdes, 2008; Lingard, Timmerman & Berry, 2005) the Kolbe A™ Index has proven to be both predictive of human performance and prescriptive in the maximizing of conative strengths. This instrument can identify and quantify an individual's MO based on a unique algorithm tied to a distinct set of innate Action Modes®. In the Kolbe system there are four Action Modes that make up a person's MO and identify how one instinctively takes action. The Fact Finder (FF) Action Mode is how one gathers and shares information, the Follow Through (FT) Action Mode is how one designs and arranges, the Quick Start (QS) Action Mode is how one deals with risk and uncertainty, and the Implementor (IM) Action Mode is how one handles space and tangible objects. The Kolbe A Index is an assessment that identifies which particular mode a person is most likely to engage first, and which mode they are likely to engage least, when problem solving. The Action Mode that a person is likely to engage first is considered their Initiate mode; and the mode that a person is likely to engage in least is considered their Resist or Prevent mode. For an in depth discussion of the Action Modes the reader is directed to the works of Kolbe (1997; 2003; 2004).

In this study participants solved problems in ways that allowed them to work both in accordance with, as well as contrary to, their natural innate conative make up. The authors hypothesized that participants would experience conative stress when forced to work against their natural grain and that this stress would have a uniquely detectable electroencephalographic (EEG; aka brainwave) difference from a resting state condition. Additionally, when the EEG data collected while subjects were working in their natural conative Action Mode was also analyzed, a distinctive region of interest in the brain was identified as showing a maximum increased electrical activity in that area. This is the first study to identify a specific pattern of brain activity associated with defined conative actions.

## Participants

All participants had taken the Kolbe A Index and knew their results prior to participating in the research. A total of 33 individuals were included from an overall pool of 41 participants; the data files excluded were either for technical reasons related to poor EEG quality or to ensure an even distribution of Action Modes. Most of the participants were recruited from the community of the greater metropolitan area of Phoenix, Arizona; however some subjects had traveled from other areas of the country. Ages ranged from 18 to 70, with a mean age of 46; there were 15 male and 18 female participants. Among those with a Kolbe Initiate distribution there were 9 FF, 7 FT, 7 QS, 7 IM; among the Prevent distributions there were 7 FF, 6 FT, 9 QS, 8 IM. All participants read, agreed to, and signed an informed consent prior to administration of the protocol.

## Protocol and Materials

There were three essential parts to the protocol that was administered to all participants in the same order; baseline recordings in a resting state, tasks in accordance with conative strengths, and tasks contrary to conative strengths. The task portion of the protocol was modeled after a team-building exercise developed by Kolbe called "Glop Shop." This exercise has been used with highly functional individuals in workplace, academic, and training environments over a period of twenty years, for the purpose of demonstrating the predictive validity of the conative test results in real-time situations (Kolbe, 2004). Central to this exercise is the use of a bag of unrelated objects of the type that would be found in a kitchen or catch-all drawer (i.e. the Glop).

During the task portion of the protocol the subjects were first presented with the Glop and as a way to assist them in getting accustomed to the materials they were asked to select a favorite item. Next the participants were requested to perform two tasks that were consistent with their conative Initiate mode and would induce functional conative actions (FCA). After resting from this activity they were asked to rate their level of stress and level of satisfaction with their performance, both on a scale of 1 to 5, with 5 being highest. The participants were then requested to perform two tasks which were in opposition to their Prevent mode and would induce dysfunctional conative actions (DCA). After resting from this activity they were again asked to rate their level of stress and level of satisfaction with their performance, both on a scale of 1 to 5, with 5 being highest.

## EEG Collection and Analysis

All aspects of the EEG acquisition and analysis were conducted by the same investigator who is experienced in acquisition and editing clinical EEG for quantitative EEG processing. Baseline EEG was collected in the waking-relaxed state for three minutes each for the eyes-closed and eyes-open conditions during which the subjects were sitting in an upright relaxed position and given instructions to remain still, inhibit eye movements, blinks, and muscle activity from forehead, neck and jaws. EEG data was then recorded during the active part of the protocol which consisted of alternating periods of tasks and rest periods. All EEG data was recorded with the same equipment (Discovery-24E; Brainmaster Technologies, Bedford, OH) with an input impedance of 1000GOhms, a sampling rate of 256 Hz, and an A/D conversion of 24 bits resolution for 19 channels. Electrodes were placed using an electrode cap (Electro-Cap Inc; Eaton, OH) with appropriate conductive gel, in a placement pattern according to the international 10-20 system referenced to linked ears. Electrode impedances were balanced and under 10kV for all electrodes. Data was recorded in a digital format with a low-pass filter of 50 Hz and a high-pass filter of 0.5 Hz. All recorded EEG data was carefully screened for technical and biological artifacts; elimination of artifacts was conducted by means of visually selecting the most artifact-free data as possible into non-overlapping epochs for submission to a fast Fourier transformation (FFT) procedure. After the editing process the FCA and DCA condition EEG streams had an average of 16 and 22 2s epochs respectively; the baseline condition streams had an average 30 2s epochs. All steps of sampling and data analysis were the same for all subjects. The analysis of the EEG files was made by means of NeuroGuide software (Version 2.6.7 Applied Neuroscience Inc.; St. Petersburg, FL). The absolute power for surface potentials was digitally filtered and analyzed for eight frequency bands: delta (1-4 Hz), theta (4-8 Hz), alpha (8-12 Hz), beta1 (12-15 Hz), beta2 (15-18 Hz), beta3 (18-25 Hz), high beta (25-30 Hz), and gamma (30-40 Hz). Statistical analysis was performed in the form of paired t-tests between each task condition and the eyes open baseline condition. Then data was also analyzed by way of the Neuroguide LORETA software.

## Low Resolution Electromagnetic Tomography (LORETA) Analysis

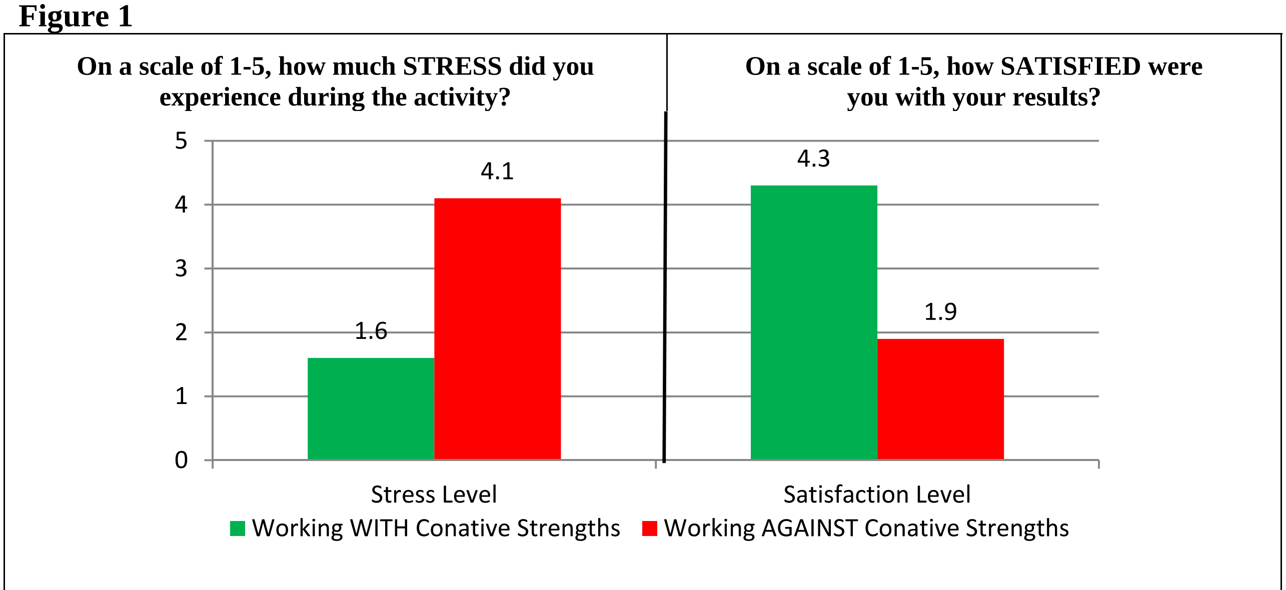
The method used for displaying the study results is low resolution electromagnetic tomography (LORETA) which is a relatively new way of analyzing EEG data. LORETA is a software package that creates a 3-dimensional representation of where electrical activity is occurring in the brain based on EEG recorded at the scalp which indicates the neuronal generators of that activity (Cannon, 2012; Sherlin, 2009). This 3D imagery is plotted onto a three-shell spherical head model co-registered on a standardized MRI atlas (Talairach & Tournoux, 1988) which allows for a 3-coordinate location identifier with an X, Y, & Z coordinate value to indicate where the absolute maximum activity is located. Results are frequently reported in terms of a region of interest (ROI) where the generalized maximal energy is found among a grid of 2,394 different voxels in the model area; with each voxel being a 7 millimeter sized cube space (Pascual-Marqui et al., 1994). These voxels can be conceptualized as individual units of energy. Statistical analysis can be applied on a voxel by voxel basis among individuals or between groups of individuals. The LORETA electrical activity values were calculated within the Neuroguide software and then paired t-tests were conducted between the experimental and baseline conditions by means of voxel by voxel comparisons. The results of the t-test comparisons were then transformed into 3-D images using the Neuroguide joined LORETA-Key viewer software (Key Institute for Brain-Mind Research; Zurich, Switzerland). LORETA data was analyzed by single Hz bands, in the eight frequency bands defined above, and in a total 1-40 Hz band.

## Results

### Self-Reports of Stress and Satisfaction

After the participants completed the FCA and DCA tasks they were asked to rate their level of stress and satisfaction on a scale of 1 to 5, with 5 being the highest. For the FCA condition participants' responses averaged 1.6 for stress and 4.3 for satisfaction and are significant at $p < 0.0001$. For the DCA condition the participants' responses averaged 4.1 for stress and 1.9 for satisfaction and are significant at $p < 0.0001$. Figure 1 provides a graphical representation of these results. For the DCA condition, when the participants were working against their conative grain, they reported much higher stress and lower satisfaction as compared to the FCA condition 97% of the time. We believe these results support our premise that the subjects were in a functional and productive state while engaging in the FCA tasks and were in a dysfunctional state and experienced significant stress while working on the DCA tasks.

**Figure 1**



**On a scale of 1-5, how much STRESS did you experience during the activity?**

**On a scale of 1-5, how SATISFIED were you with your results?**

When working against conative strengths, subjects reported higher stress and lower satisfaction 97% of the time. P < 0.0001 for both FCA and DCA conditions.

## Brain Activity Results

For the FCA condition we calculated the difference in brain activity between when the participants engaged in conative strength activities and the resting state. For the condition of DCA we calculated the difference between when the subjects were engaged in activity working against their conative strength and the resting state. The findings of maximal activity were consistent for all but the delta frequency bands, for the single Hz frequencies of 3 Hz through 40 Hz, and in the 1-40 Hz band; therefore for illustrative purposes results are reported in terms of the total power band of 1-40 Hz.

LORETA provides calculation results in terms of a t-statistic for each voxel comparison to form a statistical map of 2,394 individual voxels (Cannon, 2012). The level of statistical significance, or p-value, is then calculated based on the degrees of freedom for the experimental design, and a critical threshold value is established based on the maximum activity calculated for the voxels compared (Cannon, 2012). In this study, while the activation area with a statistical significance for $p = 0.05$ and $t = 2.0$ encompassed most brain regions, the maximum t-value for the FCA voxel activation was $t = 8.59$. We established a critical t-value for both experimental conditions to be $t = 8.0$ which then set the region of interest (ROI) for both experimental conditions as the area of activity with the maximum energy, $t_{crit} >= 8.0$, which is significant at $p <= 0.00000001$.

There was a consistent theme for results for both the FCA and DCA conditions. From all methods of LORETA data analysis, overwhelmingly the recurring area for primary localization of conative activity was in the brain structures of the Lingual Gyrus and Fusiform Gyrus, Brodmann Areas 19 and 18, and the Talairach coordinates of X= -24, Y= -60, Z= -6 and X= -24, Y= -81, Z= -13. Table 1 provides a summary of these findings.

**Table 1**

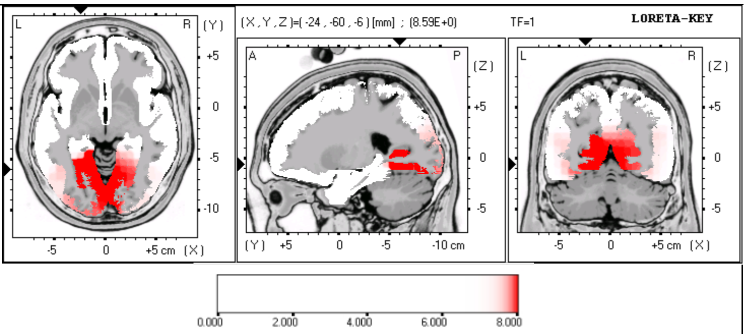
| | Brain Structure | Brodmann Area | Talaraich Coordinates |
|---|---|---|---|
| Primary | Lingual Gyrus | 19 | X= -24, Y= -60, Z= -6 |
| Secondary | Fusiform Gyrus | 18 | X= -24, Y= -81, Z= -13 |

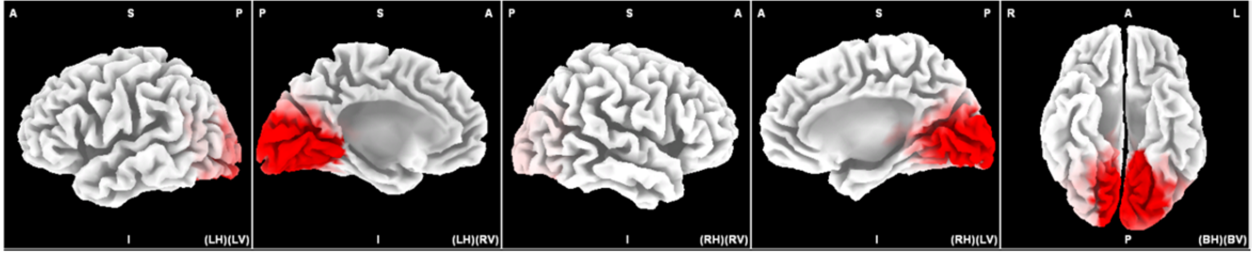
Summary of localization findings for the maximal electrical activity for both FCA and DCA conditions.

The Talairach coordinates with the maximum increase in energy between the FCA condition and the resting state was at X= -24, Y= -60, Z= -6 with a t-value of 8.59 and is significant at p = 0.0. In its most functional state, when compared to a resting state, conation was found to use a smaller or specific amount of energy in the brain, and the ROI encompassed a total of only 100 voxels, or 4% of all 2,394 voxels. Figure 2 shows where the net brain activity occurred when participants were induced to strive toward a goal using the materials according to their natural conative strengths.

**Figure 2**

LORETA images showing the cumulative representation of the significant differences between the FCA condition and the resting state in all frequencies. Red indicates the ROI and represents an increase in electrical activity in 100 voxels; 4% of all voxels. The maximal activity is at (X= -24 , Y= -60 , Z= -6) BA 19 and 18, Lingual Gyrus and Fusiform Gyrus ($p <= 0.0000001$; $t_{crit} >= 8.0$)



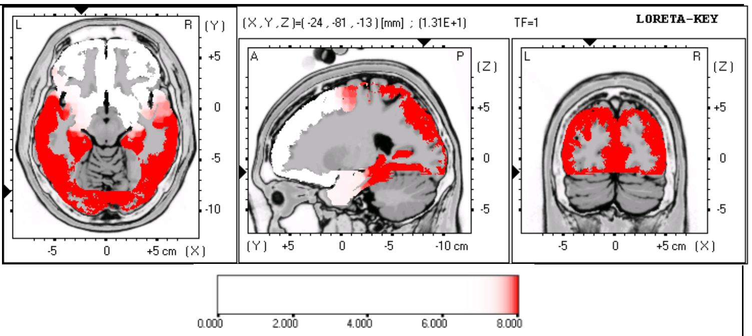


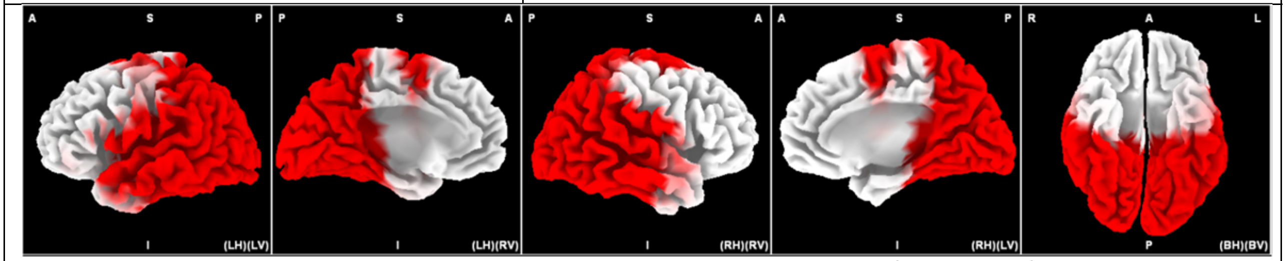
Structural anatomy is shown in gray scale (A anterior, P posterior, S superior, I inferior, LH left hemisphere, RH right hemisphere, BH both hemispheres, LV left view, RV right view, BV bottom view).

The Talairach coordinates with the maximum increase in energy between the DCA condition and the resting state was at X= -24, Y= -81, Z= -13 with a t-value of 13.10 and is significant at p = 0.0. For the DCA condition, when compared to a resting state, the amount of energy activation was greatly increased. While it originated in the same area in the brain, the energy spread out from that location, using a great deal more energy. When participants were required to operate contrary to their innate conative strengths, a total of 1151 voxels were activated, or 48% of all 2,394 voxels. This is a 12 fold increase in activity over the FCA condition. Figure 3 shows where the net brain activity occurred when participants were induced to strive toward a goal using the materials in a manner contrary to their natural conative strengths.

**Figure 3**

LORETA images showing the cumulative representation of the significant differences between the DCA condition and the resting state in all frequencies. Red indicates the ROI and represents an increase in electrical activity in 1151 voxels; 48% of all voxels. The maximal activity is at (X= -24 , Y= -81 , Z= -13) BA 19 and 18, Lingual Gyrus and Fusiform Gyrus ($p <= 0.0000001$; $t_{crit} >= 8.0$)





Structural anatomy is shown in gray scale (A anterior, P posterior, S superior, I inferior, LH left hemisphere, RH right hemisphere, BH both hemispheres, LV left view, RV right view, BV bottom view).

## Discussion

Early brain studies of conation presumed it originated in a region behind the frontal lobe in the supplementary motor area (Goldberg, 1985). However, the results of this study suggest a different location for the origination of this specific conative activity in the brain. We found when individuals were engaged in tasks congruent with their conative strengths, did not find them to be stressful, and were satisfied with their efforts, there was a corresponding region of electrical activity in the Lingual Gyrus and Fusiform Gyrus; an area in the back lower portion of the brain. When those same individuals were presented tasks that were contrary to their conative strength they reported a great deal of stress and dissatisfaction with their efforts, which corresponded with activity originating in the same area, however, there was a wide dispersion of excessive energy expended. In short, when they engaged in purposeful conative activity a degree of brain energy was used; however being forced to work against their conative grain created a high degree of stress and excessive activation of brain energy. Yet this increased activity resulted in dissatisfaction with their efforts. Therefore, we believe conative stress results in an inefficient allocation of brain resources.

Insights emerging from this mapping of intrinsic brain activity have provided us a framework for understanding functional and dysfunctional aspects of behavior as neuropsychological efficiencies and inefficiencies. From this arise many questions and areas to consider for future research. As such, two types of issues emerge; those related to conative stress and those related to physical and mental health domains.

Indications are that working against their conative grain leads human beings to stress-related problems. Studies need to be done on the impact of such conative stress and on methods for reducing both the causes and the negative effects of it. Does the inefficient use of the brain when it is required (by self, others or external circumstances) to work contrary to its intrinsic nature of conative activity cause mental fatigue? Does this lead to a specific form of mental stress and what is often termed burn-out? Can this be tied to increased error rates, accidents, memory lapses, lack of focus and other behavioral problems that have been misidentified as having primarily cognitive or affective causes?

## Implications for Further Research

If conative misidentifications could be avoided, it is possible that further research might identify improved methods for dealing with brain damage to the cognitive areas of the brain, and to changed educational and medical practices related to mental health issues. If further research confirms the location of conative activity to be as separate and deeply embedded as this initial study suggests, it may be possible to identify new neural pathways that individuals with damage to the frontal lobe could utilize in recovery/redirection of problem solving processes.

This research implies the possibility that some so-called learning disabilities or syndromes that are now classified as Attention Deficit Hyperactivity Disorder (ADHD) or other similar disorders, are actually signs of potentially healthy conative energy in the brain being blocked from functioning according to natural brain activity. This research may also have ramifications for the study of autism which may involve a lack of appropriate reactions/interactions and conative functionality.

Decades of behavioral research have confirmed that human beings have a set of traits that determine specific ways of acting, reacting and interacting. These innate patterns of behavior have proven to differ in type, but not in degree of significance among individuals. These differences have been proven to have no relationship to levels of intelligence, gender, age, race or social style. They have seemed to function as an independent source of energy, yet in conjunction with the affective and cognitive faculties of the mind. Such comparisons and findings could support Kolbe’s theory that the freedom to use natural brain energy is essential in volitional actions, reactions, and interactions that relate to higher levels of functionality.

Accurate identification of conative brain function may have important implications for education, training and managing the mental potential of human beings of all ages. For example, future research might focus on whether current teaching methods require excessive and inappropriate amounts of brain activity for some students and not others; why businesses, government (including the military) tries to train many individuals to work against their conative grain when it will make them far less efficient and effective, and why any leader would assign people to tasks that require some people to strive in ways that lead to the inefficient use of their brains. The scientific corroboration of the ancient philosophers’ recognition of conation as the force behind volitional actions may allow modern science to discover the ways in which that conative force operates and can be better protected and utilized to improve the quality of human life.

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