

Neuroeconomics and Human Resource Development

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Abstract

Objective: Neuroeconomic game trials have detected a present-bias in human decision making which represents a serious shortcoming facing the long termed nature of complex problems in a globalized economy i.e. regional residual poverty, ecological threats and personal stress. So far, the evidence-based findings on human resource development (HRD) seem not to match these huge challenges. The aim of this study is to identify cost-effective means of mental training to recover sufficiently from the present bias to enable more sustainable decisions.

Data and Method: Firstly, an elaborated explanation of the dynamics of the present-bias is based on a recent neuroeconomic model (NeM). Secondly, results reviewing research in ‘Randomized meditation relaxation trials’ are presented as evidence for a potential recovery from the present-bias.

Results:

I. NeM explains human resources (the Power of Concentration) as a function of 1) intelligence, 2) education and 3) autonomic insecurity. The root of insecurity is the present bias as located in the basal activation of Amygdala - a key center in our emotional arousal (limbic system) as shaped in the elder stone-age with many acute threats.

II. In-depth-relaxation counterbalancing emotional arousal by Amygdala is evidenced by *medical meditation* (MM) which is defined as a period of 15-20 minutes combining: *Logical relaxation, muscular relaxation and sensory deprivation with the anchoring of associations.*

III. Various settings both within medical care and at the level of NGOs fulfill the criteria of MM i.e. Transcendental meditation (TM), Mindfulness meditation, General relaxation procedure (Harvard), ACEM Meditation and Autogenic Training.

IV. Broad health effects of regular medical meditation are evidenced by RCT and even reviews/meta-analysis in more MM settings:

- Recovery from basal anxiety /Stabilization of plasma cortisol
- Independence of stimulants
- Reduction of BP increasing life expectancy
- Savings on health care expenses

Discussion: MM is both healthy and economic for individuals representing a great dissemination potential (health economic dominance). An important meditative side effect is a longer time horizon in decision making as required to meet the global challenges in study as confirmed by an intercultural neuroeconomic comparative study between Asian and Western cultures. However, a cultural barrier in the Western cultural tradition against meditative introversion has to be overcome to reach a level of sustainable development. In order to support the dissemination of non-dogmatic MM, an international scientific monitoring program for various competing medical meditation settings might be useful. Western psychology rooted in the Western humanities seems unable to carry out this responsibility. A scientific discipline to integrate Eastern and Western psychology might be economic psychology.

Conclusion: Neuroeconomics explain how pragmatic de-stressing by MM adds extra years to a normal life and saves health care expenses for a moderate meditation course fee. So, medical meditation prevails as a dominant de-stressing intervention serving a wider goal of more long termed decision making. However, even a feasible private ‘investment’ as MM does not necessarily disseminate rapidly due to financial, disciplinary and cultural barriers. In order to overcome such barriers a 3-step dissemination program for universities is recommended. Such program may run as an international multicenter-study. Economic psychologists with interest in the field are asked to contact the author.

1 Introduction

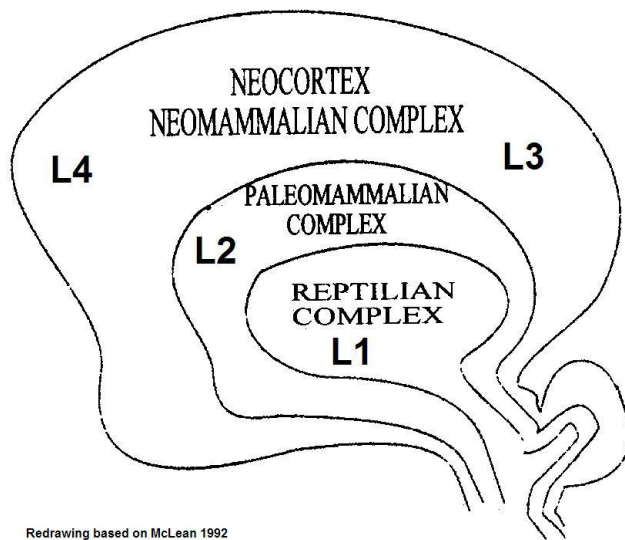
Classical economic man as traced back to Pareto 1906 pursues his best self-interest reasoning to adapt to the conditions of life i.e. budget restriction. He is often referred to as a Robinson Crusoe in the 1719-novel of Daniel Defoe living a simple rationality on a comprehensible island. Neoclassical economic man is not that isolated, but lives in society pursuing his best interest by bounded or procedural rationality [Simon, 1978]. However, in the last decade neuroimaging technologies i.e. by functional magnetic resonance tomography (fMRI) tracking the blood flow in the brain have become sufficiently sensitive to detect neural activity during ordinary thinking, feeling and decision-making. The detailed resolution by fMRI is a limitation regarding the broader brain mechanisms, too. So, EEG is still useful for research as a broader measure of mechanisms of integration. This line of neuroeconomic research is synthesized in a neural model (NeM) by Larsen (2008) which concludes a formula for the Power of Concentration (**C**).

NeM has an obvious application explaining the special dynamics related to integrated homecare (IHC) for disabled chronic patients as a relaxation effect deliberating the limbic system, see the IHC-website: www.integratedhomecare.eu . However, if relaxation at home helps disabled chronic patients to better rehabilitation, maybe, even deeper relaxation might help to prevent the occurrence at all of these chronic conditions. On this background the present project aims to review scientific evidence on the health benefit of relaxation procedures and discuss the self-management problems that may arise from this path of human resource development (HRD).

2 A neuroeconomic methodology

NeM [Larsen, 2008] is based on a phylogenetic structure of the brain (L1-4) which combines the models of Luria [1973] and McLean [1992] as summarized in figure 1.

Figure 1 Relative location of brain levels 1-4



Using a neurocybernetic terminology L1 is the client ruled by instincts i.e. the fight-or-flight-response as developed at the Reptile state of evolution. Higher levels of the brain (L2-4) serve to improve survival modifying the basal instinctual pattern of behaviour. Figure 2 summarizes the dopaminergic reward system at L2 which is a limbic structure (L) representing our biological heritage from Mammals [Alcaro et al, 2007]. This activity is indicated by the degree of desynchronization of the EEG (β/α -ratio) which originates from the sensory integration centre in Thalamus that generates the synchronizing α -waves [Hanzlmayr et al, 2007].

Figure 2 Flow-chart of Mesolimbic Dopamine Activity (L2)

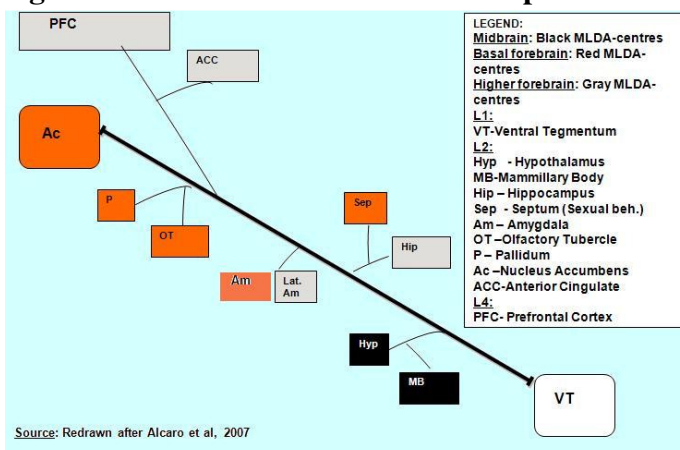
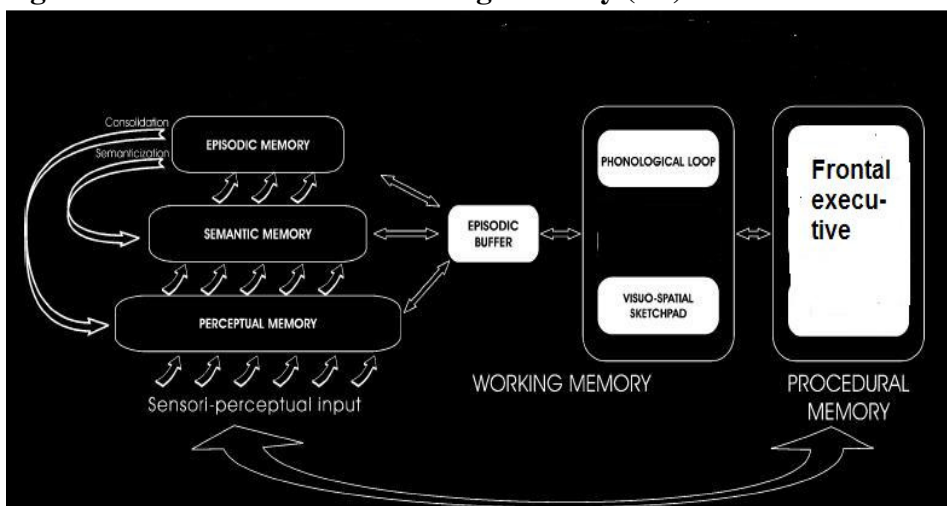


Figure 3 on L3 summarizes evidence on the working memory of Baddeley [Eustache and Legrange, 2008]. The centre of the phonological loop is identified as the semantic memory (**R**) in Superior Temporal Sulcus [Hein et al, 2008]. R is indicated by **Φ-waves** in the EEG.

The Visuo-spatial sketchpad or intuition (**I as a function of α**) is identified in the Intraparietal lobe [Cantlon, 2006]. Two different AHA-experiences related to semantic and intuitive recognition, respectively, is documented by fMRI [Kounios et al, 2006].

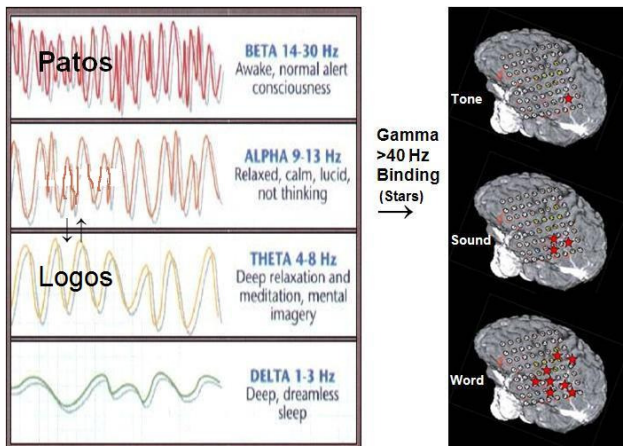
Figure 3 Flow-chart of the Working Memory (L3)



Source: Redrawing based on Eustache and Desgranges, 2008.

Figure 4 summarizes the dynamics of the tripartite structure of the frontal executive (**C**) at L4 as indicated by the effect on the patterns of brain waves that are well-known in the EEG [Bechara et al 2000, Beer et al 2007, Robertson et al 2007]. The centre of voluntary action in the ventromedial prefrontal cortex integrates the orbitofrontal utility centre (**U**) and the dorsolateral prefrontal analytical centre (**A**) as indicated by **γ-waves** in the EEG [Canolty et al, 2006].

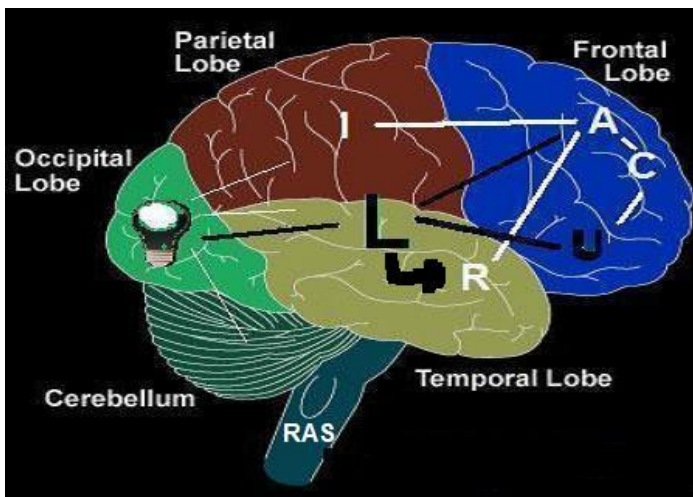
Figure 4 Power of Concentration (L4)



Source: Redrawing based on Canolty et al, 2006.

Figure 5 summarizes the model of integration across brain levels referring to classical terms for these meta-functions [Aristotle, 5th Century B.C., Mohanty et al 2007, Camerer et al 2005].

Figure 5 Neuroeconomic Flowchart across L1-4



LU is a bottom-up meta-function forming passions (Patos)
 RIA is the working memory system controlled by dlPFC (Logos)
 c is the voluntary integrator controlling both Logos and Patos

Finally, Formula C is derived from the complexity of brain waves comparing Patos (LU) and Logos (RIA) for identification of the path of maximal utility:

- | | | |
|-----|--|--|
| (1) | $RIA = \alpha * \Phi * \gamma$ | [Logos linking L3 and L4] |
| (2) | $LU = \beta / \alpha / \gamma$ | [Patos linking L2 and L4] |
| (3) | $C = \alpha * \Phi * \gamma - \beta / \alpha / \gamma$ | [Prediction Error between Logos and Patos] |

The formula for C (3) is verified by the neuroeconomic ultimatum game where the buyer can reject an offer i.e. an amount of money. If the buyer rejects, both players receive nothing. The Ultimatum Game is correlated with a simultaneous brain activity in both Logos and Patos [Sanfey et al, 2003] confirming the concept of economic man maximizing expected utility by integration of Patos or preferences within a logical framework i.e. a budget restriction. However, this refers to the neoclassical concept of bounded or procedural rationality [Simon, 1978] as human preferences include social values [Sanfey, 2007]. This operation of economic man enables an empirical verification i.e. by games on inter-temporal choice. A probabilistic study of economic choices finds a typical bias against risk and uncertainty [Takahashi et al, 2007]. This constitutes a *present-bias* ($C < 0$) favouring immediate instead of future rewards more than justified by rational discounting [McLure et al 2004 and Loewenstein et al 2008]. The present-bias varies with the general financial situation: risk-taking decreases after gains and increases after losses [Smith, 2002]. The present bias is explained by NeM as rooted in the basal activation of Amygdala - a key center in our emotional arousal (**L**) - as shaped in the elder stone-age with many acute threats.

For practical interpretation of *Formula C* (3), the complexity $\alpha * \gamma$ might be related to the coefficient of intelligence (i.e. as $IQ^{1/2}$) which is supposed to be relatively inflexible beyond the age of 5. $0 < \Phi < 1$ is an indicator of the level of education which with more or less complete primary education and a relatively free access to tertiary education in the industrialized world has limited potential for further improvements in the industrialized world, only. β is a neurological indicator of autonomic arousal or *stress*. So, the options for improvement of C are related to reduction of β . Here is home rehabilitation an important application which in comparison with hospital rehabilitation is associated with a decline in β as demonstrated by reduction of the Blood Pressure improving the efficacy of rehabilitation , see the European Commission FP7.project www.integratedhomecare.eu .

In the search of further applications it is relevant that α and β are closely interrelated ($\alpha+\beta=1$). So, reinforcement of α which is associated with relaxation should be as efficient as reduction of β . On this background Medline has been searched for evidence on the efficacy of ‘randomized relaxation trial’¹. Medio 2009 in all 3.000 items pubs up by such search. Limiting the search to ‘randomized meditation relaxation trial’ to sharpen focus to a specific relaxation procedure accessible to a large share of the population limits the number of items to 65. This sample includes 22 RCT on meditation whereof 20 are included in a recent review [Arias et al, 2006]. Also, it identifies a very recent review of the effect of ‘relaxation training for anxiety’ [Manzoni et al, 2008] which addresses a key aspect of NeM.

¹ This part is partly based on a previous grant from ViFAB – a Danish parallel to the American NICAM.

3 Review of review results on health effects of relaxation procedures

Limbic activity (β/α) might be stabilized by in-depth-relaxation as evidenced by an early review and meta-analysis [Epeley et al, 1989]. A recent review on ‘Relaxation training for anxiety’ [Manzoni et al, 2008] concludes this line of research from a meta-analysis including 27 studies ‘a consistent and significant efficacy of relaxation training in reducing anxiety’. Efficacy is concluded to be best for 1) meditation, 2) among volunteers and 3) that are long term users. A specific line of research in meditation practices is reviewed, too, concluding [Arias et al, 2006]: ‘The results support the safety and potential benefits of meditation practices for treating certain illnesses, particularly in non-psychotic mood and anxiety disorders’.

3.1 Short term or episodic effects of MM

A specific definition of *medical meditation* (MM) is advanced: According to this definition MM requires a period of 15-20 minutes with 1) Muscular relaxation i.e. sitting relaxed in a chair, 2) Logical relaxation or open-mindedness, 3) Sensory deprivation i.e. eyes closed and 4) Mental anchoring i.e. by a sound word (mantra) [Cardoso et al, 2002]. The short term effect of MM (during the training period) is a significant wakeful relaxation as expected from the principle of biological homeostasis and evidenced by more studies [Benson and Klipper 1975, Travis and Wallace 1999], see table 1.

Table 1. Effects of medical meditation during the meditation period

1. Emotional relaxation (β/α) as indicated by increased galvanic skin resistance
2. Slow and light respiration
3. Decreasing lactate in the blood
Source: [Benson and Klipper 1975, Travis and Wallace 1999]

3.2 Intermediate effects of MM

Mid-term effects of MM (after 3-6 months of regular practice) are the release of chronic stresses in the limbic system [Takahashi et al, 2004] as demonstrated by an RCT of the effect on the 'stresshormone' cortisol [MacLean et al, 1997] and addiction to alcohol, nicotine and drug abuse as evidenced by a review and statistical meta-analysis of meditation trials (including 15 RCT) [Alexander et al, 1994]. Most of the evidence on the mid-term-effects of MM refers to Transcendental Meditation (TM). However, reviews with meta-analysis of controlled trials indicate analogue effects of other meditation settings as Mindfulness Meditation (MFM) [Grossmann et al, 2002]. Both TM and MFM are rooted in the religious tradition. However, post-religious meditation settings demonstrate analogue effects i.e. 'The general relaxation procedure' [Benson and Klipper, 1975], ACEM Meditation [Solberg et al, 2000] and Autogenic Training [Stetter, 1998]. The compliance of meditating persons to this type of effects is confirmed by a query on the Internet [Larsen, 2008].

3.3 Long term effects of MM

The long term effects of MM relate to improved cardio-vascular health i.e. as concluded from a meta-analysis of randomized trials on the effect of TM on the blood pressure [Anderson et al, 2008]. The effect is calculated to 5 mmHg on the systolic and 3 mmHg on the diastole, respectively. These effects indicate a corresponding prolongation of life expectancy by MM as confirmed by an RCT on TM [Schneider et al, 2005]. The improvement of general health by MM may cause a decrease in health expenditures as concluded by a controlled long term follow-up on government payments to physicians in Quebec [Herron and Hillis, 2000]. As MM combines savings on health care expenses with de-stressing benefits as reduced anxiety, less use of stimulants and a lower blood pressure it prevails as a health economic dominant intervention.

3.4 Broad conclusion on effects of MM

In conclusion, the promotion of in-depth-relaxation-procedures as MM for the sake of general health is associated economic savings and may have an important positive side-effect providing the mental capacity to overcome human long term threats to sustainable development.

4 Discussion of barriers to MM

NeM operates the neoclassical concept of economic man. In healthcare the relative facilitation of the limbic system (L) explains why integrated homecare (IHC) appears as a dominant form of rehabilitation for disabled chronic patients and why in-depth-relaxation (MM) towards our inherent present-bias is a dominant health intervention, too. However, despite the health economic dominance these interventions face severe barriers to implementation at financial, disciplinary and cultural levels.

Regarding IHC a specific ongoing research project granted by the European Commission through the FP7-Health-Program aims to complete the evidence base and facilitate dissemination, see www.integratedhomecare.eu . Regarding MM the barriers and the means to overcome them need further analysis.

4.1 Financial barriers

Regarding MM it is mostly taught by NGOs offering private courses on market conditions with a typical cost level of a few hundred Euros. These are moderate costs compared to the benefits from extra and more healthy years of living [Schneider et al, 2005] with less expenses for health care [Herron and Hillis, 2000] wherefore MM is a feasible private project. Especially, this applies as good pension schemes become more and more common in the industrialized world.

4.2 Disciplinary barriers

Regarding MM as compared to IHC it is a problem that not even a subordinated group of health professionals in the medical / paramedical system represent the core knowledge on personal in-depth-relaxation. In a modern scientific understanding, meditation is a kind of alternative therapy.

A few researchers in TM claim a long term de-personalization effect i.e. an investigation based on 6 qualitative interviews [Casilio, 1990]. However, an early investigation from the Swedish Department of Social Services concludes, that, in reality, the occurrence of psychiatric diseases is extremely rare among persons practicing meditation compared to the normal population [Ottoson, 1977]. So, an impartial assessment should be in favor of the conclusion in a recent review saying that 'MM is a safe intervention' [Arias et al, 2006].

Taking into consideration that MM is 1) relatively safe i.e. compared to pharmaceutical interventions [Arias et al, 2006], 2) depends on a voluntary motivation [Manzoni et al, 2008] and 3) is a feasible private long term investment in itself [Herron and Hillis, 2000], it is hypothesized that it is preferable that meditation courses remain as a market-based NGO-health-activity instead of being part of the medical care system based on reductionist specialization.

Regarding psychological research, it seems crucial that Western psychology originating from Freud and Jung is more therapeutic serving patients than evolutionary as Eastern psychology serving the development of excellence by free clients. The discipline of economic psychology aiming a broad-minded approach to an evidence-based understanding of economic behavior may be a forum for future integration of Eastern and Western psychology. An outline of a neuroeconomic self-training program within the scope of economic psychology is shown in table 2. A cognitive training based on table 2 which integrated values of pragmatism, empathy and endurance in a reinforcing way should be an appropriate mindset for the planning of a sustainable development.

Table 2. Neuroeconomic self-training programme

Objective	Indicator	Means of training
Pragmatism (Versatile Φ by γ)	Capacity in Positivism	Education in empirical science
Empathy ((γ ↓)→ β/α ↓→ C ↑)	Capacity of association in dialogue	Relaxation, yoga and meditation
Endurance (RAS↓→ β/α ↓→ C ↑)	Capacity to stabilize stressors	Physical fitness by exercise

4.3 Cultural barriers

Regarding MM it is very characteristic that women are much more interested in relaxation procedures than men, and persons with a tertiary level of education are much more interested than persons with less education. So, the societal trends in industrialized countries having more and more women in business life and more and more persons reaching a tertiary level of education facilitate a rapid growth in the dissemination of MM. Moreover, globalization and the related development from mono- to multicultural societies favor the use of MM which is known as a minority activity in all larger cultural traditions. Also, it serves the acceptability of relaxation procedures that they are applied both inside the medical care system and in general adult education by NGOs.

4.4 Preliminary dissemination program to overcome barriers to MM

To overcome the barriers described above is proposed an international multicenter project along the following lines among universities with resources in economic psychology:

1. Organization of an annual Campus-meeting where students are presented to NeM and the derived self-training program in figure 6. At such meeting local NGOs offering meditation courses should be allowed to present themselves if they 1) declare themselves as open to

positivistic research and 2) assure all their students general human rights i.e. the right to withdraw from classes without any successive sanctions.

{Such meeting has been tried out at Southern Danish University in collaboration between the author and the international association of students of economics (AISEC).

The attendance to the meeting was at the level of other local AISEC-meetings and with a good satisfaction among participants }

2. Provide some simple biofeedback instruments for free or cheap rent for meditation students as a means to a primary self-check of the efficacy of their meditation courses.

{Especially, a simple GSR-meter is effective to check the correct execution of relaxation procedures, which I have done myself in groups practicing various relaxation procedures. A simple Blood Pressure Meter is relevant to check long term benefits. Also, α -feedback instruments are used to reinforce meditative states. However, to use such instruments as stand-alone biofeedback training without the proper learning of a relaxation procedure is not recommended }

3. An annual web-based follow-up of the outcome for students taking a recommended meditation course.

{Such query by the Internet indicates a compliance to relaxation procedures which is at the same level as that of persons jogging or doing fitness classes [Larsen, 2008]}

4. Besides the standard program (Items 1-3) each participating centre might specialize in some specific aspect of the over-all program

The consortium might apply for funding from international research bodies, like the FP7-program of the European Commission and the American NICAM.

5 Conclusion

The neuroeconomic model (NeM) explains human resources (the Power of Concentration) as a function of 1) intelligence ($\alpha*\gamma$), 2) education (Φ) and 3) stress (β). Within healthcare this finding explains why the transfer of part of the rehabilitation from hospitals to the home of the patient has an extra efficacy as we are more relaxed in our home. Actually, this is confirmed by the FP7-IHC-project for large groups of patients with chronic conditions as stroke, HF and COPD.

In the present study, it is documented that regular in-depth-relaxation by medical meditation (MM) reinforcing α -waves gradually may move our mood in a more positive direction increasing C to the benefit of both health and creativity. This is confirmed by a series of controlled and even randomized trials for different meditation settings which are taught both inside the medical care system and by private NGOs.

However, even a feasible private ‘investment’ as MM does not necessarily disseminate rapidly due to financial, disciplinary and cultural barriers. In order to overcome such barriers a 3-step dissemination program for universities is recommended. Such program may run as an international multicenter-study wherefore economic psychologists with interest in the field are asked to contact the author.

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