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Exploring the connection between quality management and brain functioning

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Abstract

Purpose – The purpose of this paper is to explore possible connections between brain functioning and quality management.

Design/methodology/approach – Five central principles regarding brain functioning according to neuroscience are conceptually described and related to principles and major concepts in quality management with a special emphasis on Deming's system of profound knowledge.

Findings – The principles are shown to be related in a profound way. The first principle of coherence is closely related to appreciation for a system. The principle of homeostatic feedback loops concerns events that disturb the equilibrium of a system and is related to knowledge about variation. Neural plasticity is related to a theory of knowledge. The last two principles involve emotional and cognitive contributions to decision-making. They are closely related to the element psychology and one of them could lead to a further development of Deming's system of profound knowledge.

Research limitations/implications – The paper adds to the understanding of the role brain integration has for success in quality management efforts. A limitation is that it is difficult to localise higher-order thinking in brain function. Nonetheless, the research is indicative and provocative as a window to stimulate research into the fundamental basis of quality management success.

Practical implications – The findings provide a deeper understanding of profound knowledge in quality management through relating it to how the brain is functioning, which is of value for quality managers and leaders striving for excellence for their organisations.

Originality/value – The connection of brain principles with Deming's profound knowledge has not been elaborated in the literature before.

Keywords Organizational learning, Quality management, Neuroscience, Brain functioning, Coherence, Deming's profound knowledge

Paper type Research paper

Introduction

Organisations can be viewed as a system or network of processes where the goal is to optimise the functioning of the entire system (Deming, 1994/2000). A common example of a well-managed system is an orchestra where each player supports each other creating a larger whole – a system, which is more than the collection of the parts. Earlier Bertalanffy (1969) described a system theory that viewed organisations as living systems, analogous to the cells in the body. Open-system theories model organisations as constantly evolving entities that adapt to on-going experience to optimise their ability to be successful. Rules governing the transformation of systems over time should be general enough to apply across domains such as business, psychology and neuroscience.

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The importance of and the lack of this perspective of systems thinking in quality management have been highlighted by, e.g., Conti (2010). Techniques and tools are important in quality management. However, to successfully apply those tools to transform the organisation a profound basis is needed in values/principles and core values of the organisation (Dahlgaard-Park, 2012; Lagrosen and Lagrosen, 2012). In implementing systems thinking, one can analyse patterns in corporate structure or behaviour to gain insight into the nature of underlying problems. In many ways, systems thinking constitutes a basis for quality management principles as expressed in Deming's system of profound knowledge (Deming, 1994/2000) – a major theoretical framework underpinning quality management theory.

Organisations are composed of individual employees who form teams that work together in larger departments (sales, marketing, finance and management) to govern organisational performance and to get a holistic picture of the performance of the organisation. Organisations are man-made systems. Principles governing organisations could be expected to follow principles in natural systems. Indeed, organisational principles in nature could be used to optimise organisational principles in management. Natural principles have been used to optimise man-made systems. For instance, the Fibonacci sequence has been applied to design fans, mixers and impellers. This streamlined design reduces electricity consumption 15 per cent. Also, the system of vents in termite mounds that cools the mound has been incorporated in a high-rise building in Zimbabwe. This innovative application of air circulation reduces energy consumption 90 per cent (Benyus, 2002).

This paper explores organisational principles in the brain and in quality management. As an organisation reflects the interactions of many individuals, so the brain is an integrated highly dynamic system composed of over 100 billion neurons, each connected with up to 1,000 other neurons. The high level of interconnections between brain circuits create widely distributed networks that form functional modules (mini- and macro-columns) that work together in larger cortical areas (visual, auditory, speech, motor, limbic or executive processes) to govern planning, decision-making and create the unity of conscious experience (McGilchrist, 2009). Thus, exploring principles of brain functioning may give insight into principles for structuring efficient learning organisations and successful quality management. This consideration has not yet been explored.

The purpose of this paper is to better understand underlying principles of quality management, including organisational learning and behaviour, by exploring analogous principles in neuroscience. Deming's (1994/2000) system of profound knowledge within the frame of quality management identified four principles or major concepts that govern changes, development and transformation within organisations. Five major principles of brain functioning are compared to the principles of Deming's profound knowledge. We acknowledge that there are many gaps in the links between behaviour and brain function. However, there are striking parallels between these two large systems – the brain and organisations, that give us a chance to look at quality management from a different point of view.

Quality management

Transformations in organisations involve changes in both organisational and individual core values (Atkinson, 1990; Harung, 1996; Park Dahlgaard *et al.*, 1998; Lagrosen and Lagrosen, 2005). According to Schein (1992) the deepest level of the culture is the underlying assumptions. Those are unconscious, taken-for-granted beliefs, perceptions, thoughts and feelings. Frequently the organisational values are on

the level of espoused values but examples exist when they touch the deeper level of culture, the individual core values including, trust, respect and honesty (Palmberg and Garvare, 2006). Such organisations have stated increased productivity, quality and sustainable benefits in several areas.

Transformation in organisations can be understood in terms of organisational learning. Genuine and profound learning in an organisation will influence its core values (Argyris, 1993; Argyris and Schön, 1996).

Profound knowledge in quality management

Profound knowledge, viewed by Deming (1994/2000) is based on four principles or major concepts which are supporting and enhancing each other: appreciation for a system, knowledge about variation, theory of knowledge and psychology. Thus the system of profound knowledge is holistic in that the various components interact with each other and cannot be separated (McNary, 1997). Managers applying Deming's system of profound knowledge might manage employees through informal feedback and coaching (McNary, 1997; Gapp, 2002).

Appreciation for a system

This highlights the need for managers to understand the relationships between functions and activities. Deming (1994/2000) define a system as "a network of interdependent components trying to fulfil an aim". Failure to obtain the long-term objective causes loss to everyone in the system, the customers, employees, suppliers, shareholders and the environment. Fundamental to system optimisation is co-operation where no competition exists among components. A constancy of purpose is crucial and with a common aim optimisation – moving the system towards its goal so that everyone benefits – becomes possible. Seeing major interrelationships underlying a problem lead to new insight into what might be done (Senge, 1990).

Knowledge about variation

Variation is present in every aspect of life. There are two causes of variation, special and common. Special causes of variation in a process, product or service are those causes which lie outside the system preventing its performance to be constant e.g. different operators, shifts or procedures. On the other hand, common causes is inherent in a system and emerges ones the special causes have been eliminated, and are a result of the poor system of work. If managers confuse the two types of variation matters could actually make worse (Deming, 1994/2000).

Theory of knowledge

Deming (1994/2000) emphasises the importance of theory in understanding knowledge, for knowledge is built on theory and aid in predictions of, e.g., customer needs. Yet, theories require adjustment as new knowledge is discovered and they give meaning to experience since they are a systematic summation of previous experiences based on predictions. Interpretation of data from a test or experiment is prediction and there is no prediction in an unstable system. Deming (1994/2000) emphasises that management is much a matter of prediction. When planning there is a need to understand the consequences of different actions. This is prediction. Without a theory there is no possibility to weave the information into a picture of the piece of reality we are interested in. Also, knowledge itself is relative, as it is based on measurement or observation that changes depending on different characteristics and conditions.

Psychology

Deming (1994/2000) emphasised that psychology helps in understanding people and all interactions between people and circumstances, between a manager and his people and between any systems of management. In addition, since people are different from one another these differences should be used for optimisation of everyone's abilities and inclinations (Deming, 1994/2000). It is important to take into account the power of the emotional reality and culture as well (Goleman *et al.*, 2002).

Basic principles of brain functioning

Neuroscience describes basic principles of brain functioning, including: coherence; homeostatic feedback loops; neural plasticity; emotional and cognitive contributions to decision-making; and habitual and intentional thinking and acting. These brain principles can be seen parallel to Deming's principles/major concepts of profound knowledge and organisational learning. This is an exploratory analysis that recognises the gaps in our understanding of the brain and behaviour. However, comparing two different systems offers the chance to look at quality management from a different perspective.

Coherence

Coherence is the name given to brain waves that rise and fall in a stable pattern. Coherence between different brain areas has been proposed as a physiological mechanism to bind perceptions into the unity of conscious experience. A conscious experience requires that sensory input be combined to form a concrete picture of the experience; and the concrete picture be combined with emotions, prior experiences and plans to create our reality. Experimentally, a short burst in coherent brain waves lasting less than one second is seen just before subjects recognise an object (Singer, 1999; Von Stein and Sarnthein, 2000). Higher coherence between low and high brain wave frequencies also supports performing more complex tasks. More holistic brain functioning is required for more holistic thinking.

Homeostatic feedback loops

The brain is structured in feedback loops – parallel connections between brain areas so that each brain area keeps the other active (Edelman and Tononi, 2000). Feedback circuits maintain synchronous time-locked patterns of activity that integrate output from different brain areas and last for 100 s of milliseconds or longer – long enough to lead to sensory experience or to generate an intended template for action. By introducing previous brain states into current processes, feedback circuits allow the brain to "speak to itself", a necessary basis for memory and thought (Edelman *et al.*, 2011).

These parallel circuits provide a set-point for functioning – a stable state reflecting the sum of previous experiences. Each new experience is added to the on-going hum in brain circuits moving the new central point a little higher or lower, but always in relation to the set-point defined by on-going activity. The brain adapts to on-going processes and thus has the inherent capacity for stability in the midst of daily variation.

Neural plasticity – experience changes the brain

Sensory input creates a wave of electrical activity throughout the brain that results in conscious experience. As this wave of activation travels from neuron to neuron, the number of connections between individual cells increases or decreases. Experimentally, the brains of experienced taxi cab drivers are thicker in the areas needed to navigate a

taxi through traffic (Maguire *et al.*, 2000). In violin players, the brain area that controls the left hand, which creates chords, is thicker than the brain area that controls the right hand that holds the bow (Elbert *et al.*, 1995). Professional athletes have thicker brain areas in the motor cortex than non-athletic controls (Wei *et al.*, 2011).

The functioning of individual neurons gives rise to conscious experience. At the same time our intentions and expectations change how individual neurons function. Thus, with each decision we make, we choose for an experience, and we choose for a resulting pattern of brain connectivity that we take into the future. On-going experiences daily re-organise brain circuits, which affects one's development and overall perception.

Brain areas underlying emotions and cognition both contribute to decision-making

Can decisions be made purely through rationale assessment of a situation? No. The brain is wired to quickly evaluate the safety/danger of a situation and to colour thinking with those emotions. Damasio (1996) describes how the body automatically encodes the emotional value of an experience – danger, fear, positivity – in our body, called a "somatic marker". Somatic markers include the tightness in the stomach and a dry throat in a dangerous situation. Later, when we are in a similar situation, this somatic marker will be activated. You do not remember the details of the experience, but the body state will influence you and you may turn away from that situation.

This automatic response to experience is called the "low road" of processing. In the low road of processing, sensations proceed from the senses directly to the emotional system – primarily to the amygdala. This leads to an automatic response before you are even aware of the situation. The low road of processing is an early warning system of possible danger (Damasio, 1996).

On the other side is the high road of processing, conscious consideration of the details of experience. The low road emotional response is automatic and is very fast. The outcome of low road processing is added to and colours high road processing of the stimulus. These two roads of processing continually interact. The low road is stereotypic and automatic; it is fast, and proceeds unconsciously. The high road is thoughtful and controlled; it is slow and involves conscious attention to the details of experience. By working together, these two modes of processing provide first an early warning of possible danger, and second a means to adjust behaviour to the immediate situation. Thus, they are guiding one's behaviour.

Summary of the brain

Five main points about brain functioning have been discussed. First, the brain uses coherence to bind together the output from different brain areas into a whole experience. Second, feedback loops in the brain act as homeostatic set-points to maintain inner balance in the midst of outer forces. Third, brain circuits are daily being re-organised by on-going experience to support better decision-making tomorrow – we are literally creating brain circuits, which determine our reality. Fourth, feelings that are automatically generated colour how we consciously evaluate a situation. And fifth, the brain stores frequent responses in the habit centre that guides 90 per cent of responses. Evaluation circuits become active when the habitual response does not fit a novel situation. These five points will be next explored in terms of quality management emphasising Deming's system of profound knowledge, learning, behaviour and organisational development and functioning.

Connection of brain principles to profound knowledge

Brain coherence could reflect "appreciation for a system"

Deming's first characteristic of profound knowledge is appreciation for a system – managers need to understand the relationships between functions and activities. A management system is a network of interdependent components that need to function in an orderly manner.

Systems thinking is a holistic viewpoint seeing deeper patterns, which enable sustainable solutions rather than short-term fixes. The brain accomplishes this through aligning the firing of different brain areas and different tasks, called coherence. Management systems accomplish this by emphasising co-operation and a common aim or shared vision – that moves the system towards its goal so that everyone benefits. This is a win-win situation.

Leadership commitment is needed for any quality management system to evolve. The leader must allocate resources for growth of employees and the company as a whole, and provide the tools to optimise the flow of information throughout the system. In the brain, the frontal areas – the CEO of the brain – are connected to all other brain areas and coordinate the long range functioning of different brain areas during task processing. Structurally, feedback loops are necessary for efficient information flow in management systems and between brain areas, which is reflected in the degree of coherence. Feedback loops are closely related to systems thinking, which according the Senge (2006) is the language of circles where all influences are both causes and effects. The next section elaborates on the importance of feedback loops in management systems.

Homeostatic feedback loops in the brain are analogous to function of "knowledge of variation" in a system

Deming's second characteristic of profound knowledge is knowledge of variation, from both external and internal causes (Deming, 1994/2000). Events around us are constantly changing. Natural day-to-day variation can disrupt the smooth expression of planning and performance.

While it is important to identify the source of variation, the problem may not be variation itself. The problem may be lack of stability in the midst of a constantly changing environment. One way to deal with unwanted variation by building in insensitivity for sources of unwanted variation in production and processes is done in Taguchi-methods or robust construction (Taguchi, 1995).

This is similar to how the brain achieves stability in the midst of daily variations. Feedback loops in the brain add new experiences into the sum of past experiences. The set-point of the brain is not a static, arbitrary point but represents adaptation to on-going processes. Specific experiences that are very different from the dynamically created set-point result in a small change in overall reverberations in brain feedback loops. This gives a built-in ballast to deal with a changing business and organisational environment. Balancing feedback processes underlie all goal-oriented behaviour (Senge, 1990). The process of homeostasis in organisations includes production and materials ordering processes that adjust in response to changes in incoming orders. When dealing with problems of dynamic complexity feedback processes are crucial (Senge, 1990). Improving quality, lowering total costs and satisfying customers in a sustainable manner is a dynamic problem (Senge, 1990).

Neural plasticity and the impact of "theory of knowledge"

Deming's third characteristic of profound knowledge is the Theory of Knowledge – underlying theories give meaning to specific experiences. Each new observation or

knowledge gained changes the theory that is context. The new observation helps to express in concrete form the abstract principles of the theory. And the theory helps to give meaning and application to the knowledge. As each new observation changes a theory, it supports continual development of the theory. Interactions between new information (content) and knowledge (context) accurately describes the dynamics of neural plasticity in brain circuits. Each new experience simultaneously gives knowledge of the outside world, and when added to the on-going brain activation changes brain circuits to more readily respond the next time the situation arises. This process involves feedback loops discussed earlier. Many small shifts over time lead to major restructuring of theories in management, and brain circuits in neural science. This leads to a completely different way of perceiving the world.

Social constructionist theories identify parallel mechanisms of plasticity in organisational change. Weick (1979) suggests that organisations do not have an objective existence; rather they are social constructions, which are constantly created by those who are observing and participating in them. In social constructivist models, change in the environment creates change in individuals in an active process called "enactment" that in turn changes the organisation. Enactment comprises two processes, selection and retention, which enable individuals to create an understandable structure of their experiences. The basis for structure-making is cause maps that have resulted from previous experiences. Through the enactment process these cause maps are altered or reinforced.

Similarly, brain circuits are daily being re-organised by on-going experience to support better decision-making tomorrow – we are literally creating brain circuits, which determine our reality.

Psychology: emotional and cognitive factors shape organisation behaviour

As Deming states, optimisation of a system demands understanding the people involved in the system. One step deeper is to understand how individuals make decisions. A guiding principle of human thinking is that both emotions and thinking contribute to decision-making. In the brain, the unconscious emotional system – the low road – tags specific experiences and responses and colours our final decisions.

How a person manages his or her own and others' emotions in the workplace can have a profound impact on job performance and satisfaction (Carouso and Wolfe, 2001). Recent research has shown that managing fatigue and stress leads to more positive emotions regarding one's job situation and organisation (Park *et al.*, 2012). Self-insight (to distinguish the emotional signals in ones' own body) is considered to be a prerequisite for empathy (Goleman, 1998). Goleman *et al.* (2002) argue that self-awareness is the foundation for self-management and social awareness and these together allows effective relationship management. Self-aware leaders are attuned to their guiding values and can often intuit the best course of action, seeing the big picture in a complex situation (Goleman *et al.*, 2002). This facilitates a leader to sense the actual shared values in an organisation and to help prioritising tasks.

Discussion and conclusion

Fundamental principles of brain functioning can be seen to be analogous to the four principles of Deming's system of profound knowledge and resonate with related theories in organisation learning. Also, these brain principles are naturally interconnected, as are principles in Deming's system (see, e.g. Stepanovich, 2004; Edgeman and Fraley, 2008).

These brain principles – coherence, homeostatic feedback loops, neural plasticity and emotional awareness – optimise mind/brain responses.

Coherence is crucial for effective holistic brain functioning and is closely related to systems thinking where a holistic viewpoint is a key feature. High brain coherence is reported in world-class athletes (Harung *et al.*, 2011), classical musicians (Travis *et al.*, 2011) and top-level managers (Harung and Travis, 2012). In the individual manager, coherence in brain functioning would be the foundation for coherence in thinking and planning. In organisations, coherence is expressed in the alignment of teams and thereby the functioning of organisations. Creating coherence as a business practice will, in the system's language, integrate individual components into an optimised system. Otherwise the components will revert back to more selfish independence which will finally destroy the system (Deming, 1994/2000).

Feedback loops in the brain are critical for successful interaction with the environment. They maintain physiological balance and stability by keeping each response tied to internal set-points. Feedback loops in organisations determine how variations in a system can be optimised. For instance, feedback can reinforce or counteract (balance) different actions (Senge, 1990). Feedback builds "structures" to respond to recurring needs. In addition, the dynamics of lasting-shifts in an organisation can be viewed as a feedback structure; motivation to behaviour to culture (Zohar and Marshall, 2004).

Deming (1994/2000) emphasises theory as central to the ability to learn and improve since theory provides the context for taking individual actions. Theory is about the connections among phenomena (Merton, 1967; Sutton and Staw, 1995), like a story relating why acts, structures, events and thoughts occur. Theory gives emphasis to the nature of causal relationships and forms the foundation for learning. This can be mirrored to the neural plasticity of the brain since for each decision we make we both choose for an experience as well as for a resulting pattern of brain connectivity – the basis of future actions.

Optimisation of a system demands understanding the people involved in the system of processes and psychology is a vital element in this (Deming, 1994/2000). Understanding people implies knowledge of intrinsic and extrinsic motivation. Sound core values are considered as an entrance to not only employee motivation but also to commitment, effective communication and relationships (Dahlgaard-Park, 2012; Lagrosen and Lagrosen, 2012). The discussion also brought out the critical impact that intuition, deep emotions and fine feelings have in guiding rational decisions. This process is critical when making decisions with insufficient information.

Implication for management

Certain connections between brain functioning and management principles have been shown. It is important for all organisations to try to develop the full potential of the employees.

With a broader perspective of the human dimension through insights in brain functioning from neuroscience, principles and profound knowledge in quality management could be more thoroughly applied and developed.

Interventions that increase brain integration including coherence of the employees may in turn lead to better decision-making. One such intervention may be the Transcendental Meditation technique which have been found to promote higher levels of frontal EEG coherence (Travis and Arenander, 2006; Travis *et al.*, 2010) as well as increased behavioural and emotional coping skills (Nidich *et al.*, 2009). This could also be useful when recruiting for finding the right people on, e.g. leading-related positions in the organization.

References

Argyris, C. (1993), *Knowledge for Action, a Guide to Overcoming Barriers to Organizational Change*, Jossey-Bass Publishers, San Francisco, CA.

Argyris, C. and Schön, D.A. (1996), *Organizational Learning II, Theory, Method, and Practice*, Addison-Wesley, Reading.

Atkinson, P.E. (1990), *Creating Culture Change, The Key to Successful Total Quality Management*, IFS Ltd, Bedford.

Benyus, J. (2002), *Biomimicry, Innovation Inspired by Nature*, Harper Perennia, New York, NY.

Bertalanffy, L.V. (1969), *General System Theory*, George Braziller, New York, NY.

Carouso, D.R. and Wolfe, C.J. (2001), "Emotional intelligence in the workplace", in Ciarrochi, J., Forgas, J.P. and Mayer, J.D. (Eds), *Emotional Intelligence in Everyday Life, A Scientific Inquiry*, Taylor & Francis, Philadelphia, PA.

Conti, T. (2010), "Systems thinking in quality management", *The TQM Journal*, Vol. 22 No. 4, pp. 352-368.

Dahlgaard-Park, S.M. (2012), "Core values-the entrance to human satisfaction and commitment", *Total Quality Management*, Vol. 23 No. 2, pp. 197-219.

Damasio, A.R. (1996), "The somatic marker hypothesis and the possible functions of the prefrontal cortex", *Philos Trans R Soc Lond B Biol Sci*, Vol. 351 No. 1346, pp. 1413-1420.

Deming, W.E. (1994/2000), *The New Economics for Industry, Government, Education*, MIT Press, Cambridge, MA.

Edelman, G.M. and Tononi, G. (2000), *A Universe of Consciousness: How Matter Becomes Imagination*, Basic Books, New York, NY.

Edelman, G.M., Gally, J.A. and Baars, B.J. (2011), "Biology of consciousness", *Frontiers of Psychology*, Vol. 2 No. 4, pp. 1-7.

Edgeman, R. and Fraley, L. (2008), "A system of profound consciousness: building beyond deming", *Total Quality Management and Business Excellence*, Vol. 19 Nos 7/8, pp. 683-707.

Elbert, T., Pantev, C., Wienbruch, C., Rockstroh, B. and Taub, E. (1995), "Increased cortical representation of the fingers of the left hand in string players", *Science*, Vol. 270 No. 5234, pp. 305-307.

Gapp, R. (2002), "The influence the system of profound knowledge has on the development of leadership and management within an organisation", *Managerial Auditing Journal*, Vol. 17 No. 6, pp. 338-342.

Goleman, D. (1998), *Working with Emotional Intelligence*, Brockman, Inc., New York, NY.

Goleman, D., Boyatzis, R. and McKee, A. (2002), *Primal Leadership, Realizing the Power of Emotional Intelligence*, Harvard Business School Press, Boston, MA.

Harung, H. (1996), "A world-leading learning organisation: a case study of tomra systems, Oslo, Norway", *The Learning Organisation*, Vol. 3 No. 4, pp. 22-35.

Harung, H.S. and Travis, F. (2012), "Higher mind-brain development in successful leaders: testing a unified theory of performance", *Cognitive Processing*, Vol. 13 No. 2, pp. 171-181.

Harung, H.S., Travis, F., Pensgaard, A.M., Boes, R., Cook-Greuter, S. and Daley, K. (2011), "High levels of brain integration in world-class Norwegian athletes: towards a brain measure of performance capacity in sports", *Scandinavian Journal of Exercise and Sport*, Vol. 21 No. 1, pp. 32-41.

Lagrosen, S. and Lagrosen, Y. (2012), "Trust and quality management: perspectives from marketing and organisational learning", *Total Quality Management*, Vol. 23 No. 1, pp. 13-26.

Lagrosen, Y. and Lagrosen, S. (2005), "The effects of quality management, a survey of swedish quality professionals", *International Journal of Operations and Production Management*, Vol. 25 No. 10, pp. 940-952.

McGilchrist, I. (2009), *The Master and His Emissary. The Divided Brain and the Making of the Western World*, Yale University Press, New Haven, CT and London.

McNary, L. (1997), "The system of profound knowledge: a revised profile of managerial leadership", *Leadership & Organization Development Journal*, Vol. 18 No. 5, pp. 229-235.

Maguire, E.A., Gadian, D.G., Johnsrude, I.S., Good, C.D. and Ashburner, J. (2000), "Navigationrelated structural change in the hippocampi of taxi drivers", *Proc Natl Acad Sci USA*, Vol. 97 No. 8, pp. 4398-4403.

Merton, R.K. (1967), *On Theoretical Sociology: Five Essays, Old and New. Including Part 1 of Social Theory and Social Structure*, Free Press, New York, NY.

Nidich, S.I., Rainforth, M.V., Haaga, D.A., Hagelin, J., Salerno, J.W., Travis, F., Tanner, M., Gaylord-King, C., Grosswald, S. and Schneider, R.H. (2009), "A randomized controlled trial on effects of the transcendental meditation program on blood pressure, psychological distress, and coping in young adults", *American Journal of Hypertension*, Vol. 22 No. 12, pp. 1326-1331.

Palmberg, K. and Garvare, R. (2006), "Sustained quality management: how to receive the Swedish quality award twice", *International Journal of Quality and Reliability Management*, Vol. 23 No. 1, pp. 42-59.

Park Dahlgaard, S.M., Dahlgaard, J.J. and Edgeman, R. (1998), "Core values: the precondition for business excellence", *Total Quality Management*, Vol. 9 Nos 4/5, pp. 51-56.

Park, H., Jung Kang, M. and Son, S. (2012), "Factors affecting quality and performance – a case study of Korean aircraft maintenance unit", *Total Quality Management*, Vol. 23 No. 2, pp. 197-219.

Schein, V.H. (1992), *Organizational Culture and Leadership*, Jossey-Bass Publishers, San Francisco, CA.

Senge, P.M. (1990), *The Fifth Discipline: The Art and Practice of the Learning Organization*, Currency Doubleday, New York, NY.

Singer, W. (1999), "Neuronal synchrony: a versatile code for the definition of relations?", *Neuron*, Vol. 24 No. 1, pp. 49-65.

Stepanovich, P. (2004), "Using system dynamics to illustrate deming's system of profound knowledge", *Total Quality Management*, Vol. 15 No. 3, pp. 379-389.

Sutton, R.I. and Staw, B.M. (1995), "What theory is not", *Administrative Science Quarterly*, Vol. 40 No. 3, pp. 371-384.

Taguchi, S. (1995), "Taguchi's quality engineering philosophy and methodology", in Eureka, W.E. and Ryan, N.E. (Eds), *Quality Up, Costs Down – A Managers Guide to Taguchi Methods and QFD*, ASI Press, New York, NY.

Travis, F. and Arenander, A. (2006), "Cross-sectional and longitudinal study of effects of transcendental meditation practice on interhemispheric frontal asymmetry and frontal coherence", *International Journal of Neuroscience*, Vol. 116 No. 12, pp. 1519-1538.

Travis, F., Harung, H. and Lagrosen, Y. (2011), "Moral development, peak experiences and brain patterns in professional and amateur classical musicians: support for a unified theory of performance", *Consciousness and Cognition*, Vol. 20 No. 4, pp. 1256-1264.

Travis, F., Haaga, D.H., Hagelin, J., Tanner, M., Nidich, A., Gaylord-King, S., Grosswald, S., Rainforth, M. and Schneider, R. (2010), "A self-referral default brain state: patterns of coherence, power, and eloreta sources during eyes-closed rest and the transcendental meditation practice", *Cognitive Processes*, Vol. 11 No. 1, pp. 21-30.

Von Stein, A. and Sarnthein, J. (2000), "Different frequencies for different scales of cortical integration: from local gamma to long range alpha/theta synchronization", *International Journal of Psychophysiology*, Vol. 38 No. 3, pp. 301-313.

Wei, G., Zhang, Y., Jiang, T. and Luo, J. (2011), "Increased cortical thickness in sports experts: a comparison of diving players within the controls", *PLoS ONE*, Vol. 6 No. 2, e17112. doi: 17110.11371/journal.pone.0017112.

Weick, K.E. (1979), *The Social Psychology of Organizing*, Addison-Wesley Publishing Company, Reading.

Zohar, D. and Marshall, I. (2004), *Spiritual Capital*, Bloomsbury Publishing Plc., London.

Further reading

Lagrosen, Y., Travis, F. and Lagrosen, S. (2012), "Brain integration as a driver for quality management success", *International Journal of Quality and Service Sciences*, Vol. 4 No. 3, pp. 253-269.

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