Deeper Reasons Why Students Find Vedic Mathematics So Enjoyable

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Abstract

Vedic Mathematics has proved very popular with school students taught according to its prescribed methods. Many reasons have been offered for this: it is new and different; it gives alternative ways of solving mathematics problems, allowing the student to choose between a variety of possible methods to solve a given problem. In India, in particular, it offers means of learning in accordance with ancient principles of instruction, the sutra method, and so on. Here we offer a completely new approach to understanding its popularity: it stimulates the endorphin system. The reason for suggesting this possibility is that students find the approach genuinely enjoyable, strikingly so. Using the Sutras and Upasutras of Vedic Mathematics often causes joy – to an extent seen in few other subjects learned for final school examinations. This paper reviews what is known about the endorphin system. Its purpose is not entirely clear, but stimulating it makes people happy, exhilarated and joyful, consistent with experiences in classes learning according to Vedic Mathematics. One key observation is that supressing the endorphin system in infants leads to autism. It must therefore play an important role in generating healthy attitudes and mental function. A major use of the brain is to decide what to do in novel situations, or how to achieve some new goal. The paper gives reasons why creative thinking may be stimulated through feedback from the endorphin system, based on the very general hypothesis that *endorphin is released to encourage kinds of mental process that will increase competitive success in a competitive environment*. Methods used by Vedic Mathematics generate mental activity in this category. If this reasoning holds, the positive feedback given to teachers using Vedic Mathematics is more deeply explained.

Introduction

Since its introduction by the Shankaracharya of Puri in the 1950's [1], the system of Vedic Mathematics has proved increasingly popular in schools and school systems around the world, and many books have been written about its applications in ways not envisaged by its founder [2-4], including those to improving professional design of computer chips [5].

Among students who have received the opportunity to learn school mathematics according to its prescribed methods, Vedic Mathematics has proved very popular. Many teachers have speculated why this should be the case. Among the reasons that have been offered are its novelty; also the differences between learning mathematics according to conventional teaching, where the student generally receives a single, fixed method for solving a given kind of problem, and the choice of methods that Vedic Mathematics offers for attacking given mathematics problems. [6] Choice permits students to select a favoured method from among a variety of possible ones in order to obtain the answer to a particular problem.

Schools in the United States and the United Kingdom have noticed the enthusiasm with which the various sutras of Vedic Mathematics are treated once they have been understood.

The thirty-two such '*Sutras*', 16 main ones, and 16 subordinate '*Upasutras*'[1], offer enigmatic phrases to indicate a particular method of manipulating figures, or performing other tasks in school mathematics. They follow an ancient form of epigrammatic writing e.g. [7], which possesses a charming appeal that survives to this day, possibly because the human mind seems to enjoy the challenge of figuring out a disguised meaning. Once the light has dawned, and the student has been shown, and 'seen', how the pattern indicated by the Sutra or Upasutra is intended to be applied, its brevity seems to carry a compelling reason for doing so, and for remembering how to do so.

In India, sutras of this kind have been treasured as the means to understanding complex tasks and complex patterns of logical reasoning for time immemorial. Every orthodox ancient 'System of Indian Philosophy' from the famed texts of *Nyaya* [8] to *Vedanta* [9], offers the essential summary of its reasoning and conclusions in the form of *Sutras*. Even the famous advances in conventional mathematics, whereby India's mathematicians led the world at certain times in world history [10], were often expressed in abbreviated verse form [11], the interpretation of which requires considerable expertise to interpret into more mundane modern form or terminology. [12]

In India, this means that learning mathematics by the Shankaracharya's prescribed Vedic methods hold a special appeal: they follow the ancient principles of instruction, as when the student sat near (Upanishad) the teacher, and learned from his lips. [13] The sutra method has its own traditions [7-9], and an extended history. But this does not explain why modern students should respond to it with such enthusiasm. The aim of this paper is to suggest an entirely new idea to explain the inherent exhilaration and happiness that accompany the recognition of a ways of solving problems. In the sections that follow, we shall suggest that discovering or just recognizing an approach to appropriately solving a problem stimulates the endorphin system, a completely new dimension in understanding the power of creative thinking. First, we therefore review the role of the endorphin system in human biology.

Endorphins and the Endorphin System

Recognition that the human nervous system contains endogenous morphine like molecules was one of the most startling discoveries of late 20th century biology. [14] So pejorative were the associations of morphine, and so strongly did respectable citizens rail against those who used them, that the discovery that the human nervous system contained an entire system devoted to their expression – and their experience (!) – was difficult to assimilate and rationalize. Since that time, other associated discoveries have been made, two in particular that the first author has been directly or indirectly connected with.

The first such discovery, and one that is very revealing, is that if infants are exposed to molecules that interfere with their endorphin functions, their personality development is severely compromised in that they are at greater risk of developing an autistic spectrum disorder. The major pathway, which has been found to lead to autism this way, is the consumption of milk from Holstein Friesian cows [15]. Digestion of milk from HF cows and some other Bos Taurus breeds, but not Indian breeds, Bos Indicus, causes release of a seven member polypeptide from beta casein, Beta Caso-Morphin-7 (BCM7), during digestion. New born and very young infants possess a gut that is designed to absorb small proteins like immunoglobulins directly from their mother's milk in order to strengthen their immune system at the very start of life. A short peptide like BCM7, if released during digestion, is therefore immediately absorbed.

When BCM7 is directly injected into the bloodstream of rats, they are immediately put into an almost schizophrenic state, in which they will damage themselves, and commit vicious aggressive attacks on their neighbours [15]. They seem in great distress, and cannot function. Direct tests show that their endorphin receptors are interfered with, and that the BCM7 enters the receptor, blocking it permanently, but without stimulating any good feelings. The conclusion we propose to draw from these simple observations is that stimulation of endorphin receptors is intimately involved in successful function of both animal and human nervous systems. Their on-going function is a required aspect of normal personal behaviour.

A second observation about autism that may probably relate to endorphins is that stimulating the mirror neuron system seems to be a successful way to treat the condition. The suggestion that this might be the case was first made by no less a scientist than V.S. Ramachandran. [16,17] But successful treatment of autistic children by these means was first achieved by Dr Shanta Radhakrishnan, the principal of a special school for disadvantaged children in Bangalore. Dr Radhakrishnan completed her PhD in medical applications of Yoga, by observing the results of a specially designed program of Yoga for children with autistic spectrum disorders, which she developed and ran for several years at her school with considerable success. [17]

A major design aspect of Dr Radhakrishnan's program was that the child's parents had to be present at every Yoga teaching session, and their role was to put their child into the position adopted by the Yoga instructor directing the class. [17] Clearly, achieving a similar position to the instructor should stimulate the mirror neurons to fire, and their successful firing should, according to presently known laws of nervous system function, cause increased stimulation of the mirror neuron circuits in the future by means of neural plasticity.

The successes achieved by Dr Radhakrishnan on the children in her PhD research [18] were quite extraordinary: all the children showed major improvements on a wide ranging battery of tests covering every aspect of autism deficiencies; so great were the improvements that after two years the study participants were effectively out of the classification of autism. Their parents, in particular, were outspokenly appreciative and complimentary about what the program had achieved. [18] As persons intimately familiar with all their children's behaviour patterns and habits, parents are undoubtedly as good judges as any scientific test.

The implications that we propose to make from this second observation of children with autistic spectrum disorders is that the condition can be helped by stimulating mirror neuron function. From this there is a secondary deduction to make based on the observation that autism can be brought on by, and largely attributed to, failure of the endorphin system to provide its pleasant feelings to please the person in question. Autism thus involves a failure of the mirror neuron system to function, as Ramachandran suggested [15,16], and hypothesized above [17,18]. It is thus very probable that *correct activation of the mirror neuron system is associated with endorphin release, and with all the pleasant feelings associated with it*. With this idea in mind our main proposal follows in the next section.

The Role of the Endorphin System in Moral Behaviour

A major recognition by modern psychologists involved in training children, or even animals, is that good behaviour and successful achievements require appropriate rewards. From this perspective, when a teacher smiles and appears pleased when a student does well, it is more important that expressing displeasure when the student fails to perform. A student who continually seeks to please the teacher will work far more effectively than one who only works out of fear of not doing so, and its possible consequences.

This principle of '*Rewards for Good Behaviour*' is so deep that it must surely be built into the human nervous systems itself – and indeed into animal nervous systems in general.

What could be better placed to achieve such a purpose than the endorphin system? Endorphins give one's feelings a boost. If released as a result of mirror neuron function, it would be the nervous system's way of saying that imitation represents a useful behavioural pattern, long-term persistence in which will serve the person well. Such feedback from the nervous system to the organism would be abundantly valid: from a very early age, babies and young children learn more by imitation (and experimentation) than by instruction.

We therefore come to the major hypothesis of this paper: *endorphin is released to encourage kinds of behaviour that will increase success in life*, i.e. the endorphin system constitutes the body and mind's own positive feedback system, internally validating appropriate behaviour. The suggestion that this may be the case arose by considering the example of how autism resulted from blockage of endorphin system function, and how stimulating mirror neurons reversed it. The next section generalizes this principle to other kinds of behaviour.

The Endorphin System in Human Behaviour: A General Role

Let us start by revisiting the paper's main hypothesis, and then consider other kinds of behavioural pattern that might qualify as worthy of similar reinforcement: *The general role of the endorphin system is to encourage kinds of behaviour that will increase success in life by providing positive feelings as feedback when such behaviour is expressed*.

Similar to the statement above, behaviour patterns of value to achievement and success are reinforced when students receive appropriate rewards for expressing them. In other words, learning good behavioural patterns may be facilitated by positive feedback. This principle is well recognized by child psychologists, and sports psychologists, so it is almost inevitable that over the millions of years of biological evolution nature will have implemented something similar.

Vertebrates emerged from the sea some 380 million years ago; mammalian development was accelerated by the demise of the dinosaurs about 66 million years ago; some warm blooded land animals like birds (related to dinosaurs) and mammals survived the catastrophe, whereas monsters became extinct. Vertebrates tend to be social animals with consequent need for the ability to learn specific patterns of behaviour, and all the social messages that such behavioural patterns encode. Animal behaviour is not simply guided by instinct, but must be learned from practices of the family group into which animals are born, i.e. patterns that have already been structured into forms appropriate to the environment in which they live.

The only practical way for an animal to learn the behavioural practices of their family group is by copying them, an action that will automatically cause mirror neurons to fire. To encourage such copying, the individual should be rewarded in some way. This also applies to adults in the group, who should likewise be programmed to reward imitative behaviour in their offspring and other group members.

Imitation of adults by juveniles will be facilitated if firing the mirror neuron system brings a positive subjective reward. Similarly, recognition of imitation by their young may elicit an appropriate positive response in parents and other adults in the social group if perceiving the imitation makes the adult feel good. This means that the mirror neuron system may stimulate rewards for the young animal on two levels: first and most important, intrinsic because of connections to the endorphin system, as has here been hypothesized, and secondly and secondarily, extrinsic, due to positive feedback from other animals in the group. For these reasons, coupling of the mirror neuron and endorphin systems probably plays a fundamental role in behavioural learning in social animals.

What of other forms of behaviour? What patterns of behaviour might be worth reinforcing by eliciting positive feedback from the endorphin system? In human societies, one can envisage several general patterns for which our species' success would be strengthened by similar kinds of reinforcement process. Clearly, satisfying the basic needs and instincts would qualify: eating, drinking, sleeping, reproducing and rearing offspring. But higher animals consciously living in challenging environments with which they continuously interact need further patterns of behaviour to be reinforced. For example, behaviour patterns that help overcome new and challenging situations, and behaviours that can remove stress so caused, restore health when it is compromised, and maintain optimal function in various ways.

For example, nervous systems are designed so that deeply resting promotes removal of the stress from adverse events, and that of associated memories like the slaughter of another member of the social group. Elephants mourn the loss of a fellow group member for a period of two days following a death. Reports from ancient traditions, particularly those in India, affirm that deep rest to the mind induced by meditation is accompanied by an intensified sense of inner happiness, the neurochemical nature of which still remains unstudied. Another pattern of behaviour that merits positive reinforcement is when an animal recognizes a solution to an unfamiliar problem, and to that we now turn.

The Endorphin System and Creative Thinking

Creative thinking is much valued in human society. We live in an age where inventiveness is highly rewarded, because whole societies may benefit. New technologies are protected by patents. Inventors like the founders of Apple and Google, not to speak of Microsoft, are some of the most richly rewarded people on the planet – and for good reason, their inventions have changed the lives of vast numbers of people, often making them happier and more at ease.

Great inventions either tackle problems that most people consider insoluble, or they create opportunities that no one has realised are possible. We all take the internet for granted, but the amount of information now available for download is far more than any human can digest in a life time. Similarly, the amount of entertainment in the form of films and music is far greater than a lifetime of viewing or listening can take in.

Creative thinking works in everyone to a greater or lesser extent. At some time in our lives all of us are faced by situations with which we are not familiar, and we all need to be able to take such eventualities in our stride. Living life in the world as we find it requires more than a healthy routine to keep up with the day-to-day humdrum; it also requires initiative to do new things, and the ability to deal with the unexpected, and to succeed when doing so. Creative thinking when faced by unanticipated new situations is a capacity of intrinsic value to life in the world and worthy of encouragement.

Clearly the world rewards capacity to deal with such problems creatively – it provides good external feedback, and extrinsic rewards, and does so even for life in the wild. It therefore seems reasonable to hypothesize that nature offers some *intrinsic* reward to encourage the process of creative thinking. Consideration of the creative arts would seem to confirm the hypothesis. Leaders in fields like painting, music, sculpture and architecture and other activities requiring creative design, engineering or composition, report that forming and implementing their creative ideas brings high *intrinsic* enjoyment. Whether creation or performance, all such activities employ inherent human creative capacities.

From a practical viewpoint, there is high intrinsic value to any species for a member to actively create new ideas, and to implement useful new actions and activities, approaches. How to respond if the rainy season is delayed? What to do if an ocean current is temporarily reversed? Living creatures have had to tackle such questions for millions of years. In dealing with climate change or preserving endangered species, humans do the same today.

Because of these historical needs dating back through the history of life, the mind has been inherently structured to encourage creative thinking. Our assertion in this paper is that it does so by giving positive feedback, special rewards of an inherently pleasurable nature, probably in the form of endorphin release. This is certainly not a modern development. As suggested, generating new ideas that can be appropriately applied in the life of their species is important for all animals living in challenging environments requiring new kinds of adaptation. We apply new ideas through our systems of science and technology, and all forms of art and communication. Those engaged in such processes find them delightful and rewarding.

Creative insights are universally recognised to bring a special form of pleasure. Even putting one's attention on another person's artistic or literary creations may bring something of the same – the viewer may experience a vicarious sense of the original creator's creative talent. It is probable that nature has long encouraged such activities in those who are capable of them. What better way than by releasing endorphin when an appropriate new idea is generated? And in seeing through its implementation!

We all know that when mathematics and problem solving is taught in a way that stifles creativity, the process generates relatively low levels of enthusiasm in the student, if any, more likely boredom. Whereas, when the same tasks are taught in a way that encourages use of students' inherent creative potential, they respond quite differently – with refreshing levels of enthusiasm. In light of the foregoing, we suggest that they are experiencing the brain's intrinsic reward for using creative thinking processes – a healthy shot of endorphin from the endorphin system, and a corresponding sense of bliss in the mind.

Applying these ideas to Vedic Mathematics offers a possible explanation for why learning mathematics through its epigrammatic procedures is more enjoyable than learning the fixed routines of ordinary, conventional mathematics education. If endorphin release is a normal reward by the nervous system for creative thinking, then the methods of Vedic Mathematics, involving creative thinking in its procedures, will inevitably prove more enjoyable than solving problems the conventional way using fixed methods. Processes that are routine and repetitive are known ultimately to be boring for a person. If creative processes identifying possible procedures, and then choosing between them, release endorphins, then the methods of Vedic Mathematics should definitely release them.

There is considerable evidence that animals and humans can communicate through ideas directly from brain to brain without the use of language. Evidence for this provided by many kinds of observation of animal behaviours, ranging from pet dogs to wild elephants. [20,21] Animal communicators such as Anna Breytenbach use such methods in their professional work (www.animalspirit.org, www.youtube.com/watch?v=wL--zc1KIxk); they communicate ideas in the mind from the level of feelings and the 'heart' rather than through language and the senses. As indicated by the above references, their success is well attested. What does this tell us about animal and human cognition? That *ideas are more fundamental than language*. Generating ideas is therefore something that the mind should be able to encourage. It should be able to make a habit of it. Endorphins are well placed to do so, so our proposal that their release is used to provide operational feedback to encourage creative thinking processes seems a natural extension of what is already known about them.

Discussion

As we have emphasized above, students find the approach of Vedic Mathematics enjoyable – often remarkably so. Systematic, repeated observations require systematic explanation. Reasons should be offered why learning to apply Sutras and Upasutras of Vedic Mathematics is enjoyable for all students. No other academic subject in the school final exam syllabus seems to offer such pleasurable rewards.

Here, we have reviewed some knowledge of the endorphin system. Although its purpose may not have been fully worked out, it is known that stimulating it makes people happy and calm, even euphoric i.e. similar to the kind of experiences seen in mathematics classes taught using the procedures of Vedic Mathematics. Making connections between the two fields, endorphin neurophysiology on one hand, and educational psychology on the other, is natural.

Logically, the reasoning was presented in 3 steps: a first key observation that supressing the endorphin system in infants leads to autism. Our first conclusion was therefore that that system must play an important role in generating healthy attitudes and mental function. Secondly, we considered another major use of the brain: deciding on courses of action in novel situations, or how to achieve some new goal. Thirdly, the paper offers reasons why such creative processes thinking should be stimulated through appropriate intrinsic rewards. Next from consideration of the apparent repression of the endorphin system in the first step, we made a very general hypothesis about the natural roles of feedback from the endorphin system: *Endorphin is released to encourage kinds of mental process that will increase competitive success in a competitive environment*. Finally we used the observation that methods used by Vedic Mathematics generate mental activity in this category; they should therefore stimulate endorphin release. This line of reasoning more deeply explains the remarkable positive feedback given by students to teachers using Vedic Mathematics.

Future research might consider further behavioural patterns that may stimulate endorphin release. These could include humour, which 'tickles', scientific discoveries that enthral, and meditation experiences of peace. In his 2002 Nobel lecture, Sulston noted the fun of science (http://www.nobelprize.org/nobel_prizes /medicine/laureates/2002/sulston-lecture.pdf see the final paragraph). An old chestnut of a joke asks, "What is the difference between a joker, a scientist, and a mystic?" Answer: "The joker says, 'Ha-ha'; the scientist says, 'Aha'; and the mystic says, 'Aaaaa….'! Might not all three constitute further examples of endorphin stimulation? Stimulating happiness, gaining insights and deeper understanding, and gaining access to deep peace 'passing human understanding', all merit such an intrinsic reward.

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