# The Development of the *PRISM* Measurement Scales

# THE *PRISM* MODEL

# AND

# THE DEVELOPMENT OF ITS MEASUREMENT SCALES

A brief introduction to the *PRISM* System's biological roots

# THE *PRISM* MODEL AND THE DEVELOPMENT OF ITS MEASUREMENT SCALES

"Learn as much as possible about how the brain works. This is the most important factor in getting smart and staying smart. Everything we think and everything we choose to do alters our brain and fundamentally changes who we are - a process that continues until the end of our lives."

**Professor Richard Restak**
Neuro-psychiatrist and Clinical Professor of Neurology
The George Washington University Medical Center

"If it's our job as parents and educators to develop young minds, shouldn't we know how the brain works? If we want our schools to be successful learning institutions, it is essential that both parents and educators become keenly aware of the best information and that they are regularly using that very same information."

**Dr Kenneth A Wesson**
Stanford Research Institute

## Background

***PRISM*** has its origins in an initiative known as 'The Decade of the Brain' which was launched in 1990 by President George H. W. Bush. That initiative was part of a larger effort involving a wide range of agencies, including The National Institute of Mental Health of the National Institutes of Health, *"to enhance public awareness of the benefits to be derived from brain research"*.

Neuroscience is the study of the brain and its functions. Although we often think of behaviour as somewhat separate from our body, the two are closely related. In fact, the brain is what causes us to behave in certain ways, and behavioural neuroscience (also referred to as personality neuroscience) is a bridge in understanding the relationship. Behavioural neuroscience then, is the study of how a person's brain influences that individual's behaviour.

Neuroscience research has made its greatest contributions to the study of human behaviour by highlighting the mechanisms that underlie behavioural observations made earlier by psychologists. It has also made important contributions to our understanding of behaviour by demonstrating that the brain is far more 'plastic' at all ages than previously thought - and thus that the speed and extent by which experience and behaviour can shape the brain is greater than almost anyone imagined. In other words, rather than showing that biology is destiny, neuroscience research has been at the forefront of demonstrating the powerful role of experience throughout life.

As part of the survival process, the brain enables us to adapt to our environment i.e. to learn. The brain is constantly changing and everything we do changes our brain - this allows us continuously to take account of what is going on around us and to store memories to use in the future. Indeed, every single thing we hear, feel, smell touch and see, and every thought we think, is the result of brain processes.

***PRISM*** is based on the indisputable fact that all behaviour is created in the brain and that the brain's main role is to ensure that the species – animal or human – survives. To achieve this, our brain not only attempts to protect us from perceived threats to our wellbeing, but also it looks for 'reward'. In this context, 'reward' can mean a range of benefits such as food and shelter, or social interaction with others. It is the brain's response to our external and internal world that results in what we call 'behaviour'

Although ***PRISM's*** theoretical base is rooted firmly in the biological basis of behaviour rather than psychology, its developers have repeatedly subjected it to independent academic scrutiny over the past twenty years to identify the psychometric properties of the instrument. Also, because most potential users are more familiar with psychometric terminology and measurement methods than they are with the language of neuroscience, psychometric comparisons and terminology help to enhance understanding. The purpose of this paper is to summarise the development and application of ***PRISM*** and to summarise its psychometric validation to date.

We are well aware that, to facilitate understanding, some of our explanations of the relevant neuroscientific principles which underpin *PRISM* are deliberately presented as a layperson's interpretation and not an academic description of the relevant topic.

All such explanations are, however, made in good faith on the basis of the findings of published, peer-reviewed, scientific journals and books relating to neuroscience and brain related texts and articles at the time of publication. In so doing, we pay due tribute to the numerous neuroscientists whose life-long work is providing us with a deeper understanding of ourselves.

***PRISM*** **w**as initially the subject of an independent validity study in 2006 - 2007. The latest validity study in 2014 was designed to ensure that ***PRISM*** worked effectively across a wide range of cultures and did not disadvantage individuals from ethnic groups.

**Introduction**

It is important to bear in mind that the validity of any assessment tool must begin with having a clear understanding of what the instrument is designed to do, as well as what it is not designed to do.

***PRISM*** is an online integrated system that creates an inventory of a person's self-expressed behaviour preferences and how those behaviours are observed by others. It is not a psychometric 'test' of personality that needs to be administered, scored or interpreted solely by people who are professional psychologists, neither is it intended for use in making clinical diagnoses, nor for dealing with mental health issues. Despite this, all *PRISM* users are required undertake a formal programme of training and successfully complete a practical and written assessment, approved by the publishers, before they can have access to it and use its applications.

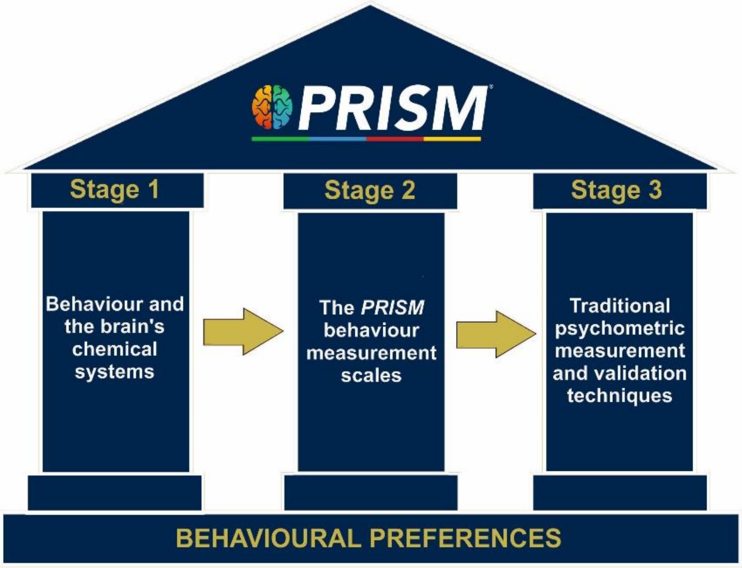
*PRISM* has been developed in three distinct stages:

**Stage 1:** Identifying, from some 130 published research studies, the specific behaviours associated with four brain chemical systems. It is important to note that all the information used during this Stage was obtained from a wide range of acknowledged experts in the relevant sciences and not from any one individual. The number and nature of those studies enhances both the validity of their own findings and the validity of the *PRISM* measurement scales which are based on those findings.

**Stage 2:** Creating, from the data collected at Stage 1, the scales necessary to enable the instrument to become an accurate and reliable method of measuring the relevant behaviours identified at Stage 1.

**Stage 3**: Using external sources to validate, by traditional psychometric methods, the measurement scales identified at Stage 2.

It should be noted that, although this paper focuses primarily on Stage 3 activities, the publishers feel that it is also necessary, in the interests of clarity, to refer to some of the activities undertaken at Stages 1 & 2. It is accepted that much of the information relating to the biological underpinnings of the specific behaviours are already well referenced and validated. Moreover, the ipsative and normative measurement techniques used by *PRISM* are also already well known and widely accepted, and require no further validation.




**Why was *PRISM* created?**

***PRISM*** was created, in keeping with the principles of the 'Decade of the Brain' initiative, to make use of some of the more recent discoveries of neuroscience and to present them in a simplified and practical way to enhance both personal and organisational performance. Some of those discoveries have challenged traditional thinking on human behaviour. One of those key discoveries is 'neuroplasticity' i.e. the brain's capacity for physical self-change in the light of experiences.

For example, for decades scientists maintained that once its physical connections were completed during childhood, the brain had become hardwired and remained like that for life. Now, thanks to the latest brain imaging technology, we have proof that development is a continuous, unending process. All our experiences, thoughts, actions and emotions constantly change the makeup of our brain. This discovery has profound implications for both personal and organizational development.

For example, you can increase the power of your brain through your own efforts. The brain's ability to change in response to experience is the key to understanding the brain's development. The good news is that no matter how old you are, you can still take an active part in influencing brain plasticity. The brain is dependent on your experiences and continues to evolve throughout your lifespan.

In order to improve our brain, it's necessary to understand how it works. If you decide to become a *PRISM* Practitioner, you will learn how the brain is organised, how it develops, and how messages are transmitted through the brain's electrochemical pathways. Neuroscientists say that "brain cells that fire together wire together." This is known as 'Hebb's Law'. Hebb, a Canadian psychologist, established that principle, implying that changes of biochemical processes in one brain cell (neuron) can stimulate neighbouring simultaneously activated neurons. If we think of brain circuits as 'friendships': those that are maintained and enriched will endure, while those that are neglected are likely to disappear.

The brain's capacity to learn and to change is considerable, but one obstacle to change is that the brain's 'fight and flight' survival mechanism tends to adapt a negative approach to situations that are new or that create uncertainty.

Indeed, the brain's resistance to change was well illustrated in 2007 by Dr Edward Miller, Dean of the Medical School at Johns Hopkins University. He pointed out that about 600,000 people in the United States have bypasses every year, and 1.3 million heart patients have angioplasties. Two years later, 90% of them **have not** changed their lifestyle. Even though they know they have a very serious illness and they know they really need to change their lifestyle they don't. The message is clear, if people are not prepared to make changes to the lifestyle when their lives are at risk, it is even more unlikely that they will willingly engage in change when they face less threatening circumstances.

One of the reasons that change is difficult involves a neural phenomenon called ‘conditioning.’ Conditioning refers to an automatic process that has been set up in the brain in response to a stimulus. The fundamental principle is that the human brain sets itself into patterns of behaviour once that behaviour has been learned. We can think of conditioned behaviours as ‘habit memory’. On account of these habit memory systems, we repeat patterns of behaviour in our lives. These responses become very ingrained, and even after an initial change, people often revert to the old way of doing things. As result, the individual’s response to the change is often one of negativity.

As professional sportspeople know only too well, negative thoughts lead to negative performance. Automobile tycoon, Henry Ford, aptly summed up this approach when he said: *“Whether you think you can or you can’t, you’re right!”*

A key *PRISM* principle is that people function best when they are able to make the most of their natural preferences and abilities. When our day-to-day life prevents us from using our natural abilities, our capacity for achieving our potential is diminished, as is our ability to find satisfaction in our relationships and work. When this does not occur the brain is forced to spend large amounts of time functioning from areas requiring significantly greater expenditures of energy. In other words, the brain is forced to *overstate or falsify its strengths.* Indeed, falsifying natural behaviour is so costly that over time it can lead to stress, chronic anxiety and exhaustion. Research by Professor Richard Haier, Professor of Psychology at the University of California, School of Medicine, showed that the brain needs to work much harder when not using the person’s natural preferences.

Such a demand on the brain requires considerably greater amounts of energy and oxygen. Over time, this could also throw off the person’s innate homeostatic balance in the area of oxygen usage and distribution. Normally the brain uses approximately 20% of the oxygen taken in through the lungs. This leaves about 80% for the rest of the body where it is utilized in the process of metabolism and in providing energy, both at the cellular level and overall. As more and more oxygen is demanded by the brain that is falsifying type, less and less is available to keep the rest of the body up to speed. A variety of symptoms can result (e.g., fatigue, digestive problems, listlessness). Indeed, over time, the oxygen imbalance can contribute to the person’s body shifting from anabolic to catabolic functioning.

Against the background set out above, ***PRISM*** was designed to help people to increase their self-awareness, and to help them to understand more about how the mind and brain can work in partnership to enable and motivate them to take better control of their lives and to enhance their performance. Clearly, it has much to offer businesses when used as part of interventions such as coaching for performance or enhancing leadership skills. After all, if the brain were not capable of changing itself or being changed by the intervention of the mind, all learning interventions would be pointless.

**Why does *PRISM* measure behaviour rather than personality?**

People often treat personality and behaviour as being the same, but they are clearly different. Their relative significance is well summarised by Professor Robin Stuart-Kotze**.**

Professor Stuart-Kotze is an eminent Canadian organisational psychologist who has held Professorships or Visiting Professorships at a number of universities in Canada and at Warwick, Aston and Oxford in the United Kingdom. He says:

> *“It is absolutely critical not to confuse behaviour with personality. Personality is what you are; behaviour is what you do, and it’s what you do that makes a difference.*

*However, most people believe that personality determines how individuals act, and it's very difficult to shake that belief. Personality testing is widely used in recruiting, with the underlying assumption that it will predict how people will behave in a job, and therefore will determine their performance. But if personality were the key to performance, then how can you explain the success of three people with very different personalities?*

*A critical difference between behaviour and personality is that personality is essentially fixed at an early age and after that it changes very little.*

*The definitive research into the relationship between personality and behaviour was conducted by Stanford professor Walter Mischel. Studying the correlation between personality tests and people's actual behaviour, he found that less than 10 percent of the variance in a person's behaviour is explained by personality. The driver of people's behaviour, he observed, is in fact the situations in which they find themselves - and most importantly, that their behaviour changes as the situation changes."*

Dr Meredith Belbin, who created the Belbin Team Strengths Inventory, is a visiting Professor and Honorary Fellow of Henley Management College. He says:

*"A behavioural test investigates propensities towards certain kinds of behaviour and styles of interaction with others, rather than measuring personality traits. Behaviour is regarded as more changeable than personality, since we can adapt our behaviour depending on what is required of us in a given situation or role.*

*Behaviour is also observable. This means that it affects, and is affected by, those around us. This makes the process of understanding and adapting our actions a democratic one: whilst we wouldn't ask others to tell us about our personalities, we often remark on one another's behaviour."*

https://www.belbin.com/about/behavioural-vs-psychometric-tests/

People accept that they are often faced with situations, or with some aspects of their jobs, that require them to modify, sometimes very quickly, their preferred behaviour. Perhaps they feel that they need to be more 'forceful' than they normally feel comfortable being, or maybe they feel they need to be more empathetic than normal when dealing with a sensitive relationship issue. The inescapable fact is that people can and do deal with the demands of their everyday life by adopting, or borrowing, behaviours that they feel will enable them to achieve their objectives. Most people do this without much effort. They fully accept that life is not always about living within their comfort zone all of the time, and that they have the ability to step outside their personal instinctive behaviours in order to be successful.

**Types of Personality Tests**

The aim of many psychometric personality tests is to acquire an accurate description of an individual's 'personality'. Over the years, popular commercial instruments have been classified into two main measurement methods: 'normative' and 'ipsative'.

**Normative Tests**

Those known as 'normative', measure a specific personality trait so that it can be compared with established patterns of so-called 'normality' for other people's scores for the same trait. This was designed to enable recruiters and others to compare one candidate's results with other job applicants, particular groups and/or populations. A normative test is based on a Likert-type scale. For example, a questionnaire might present the candidate with a statement such as: *'I pay close attention to small* *details'* and then ask him or her to rate the statement on a scale of 1 - 5 (e.g., 1 = *Very accurate* – 5 = *Very inaccurate*) in terms of how accurately that statement reflects how he or she actually behaves.

One obvious problem with such tests is that they can inadvertently influence users to respond according to what they regard as being "socially desirable". Social desirability bias refers to the fact that in self-perception reports, people will often respond inaccurately to such tests to present themselves in the best possible light and to help them to achieve their personal objectives e.g. gain employment. Social desirability bias can take the form of over-stating 'good behaviour' or under-reporting 'bad' or 'undesirable' behaviour. For example, even though there are no 'right' or 'wrong' answers to such questionnaires, job applicants are much more likely to want to be seen to possess the personality traits that they consider would be favoured by the potential employer. In other words, the job applicants are likely to be motivated to select 'socially desirable' answers in order to increase their chances of being hired. This is sometimes referred to as 'faking good'. It is very understandable for human beings to want to present themselves to others in the best possible light and that should be borne in mind when using normative self-perception profiling tools.

Clearly, there is likely to be a much greater tendency for people to use socially desirable behaviour when in a public setting, such as at work, than there is when in a private setting, such as at home with members of their immediate family.

**Ipsative Assessments**

The social desirability weakness of the normative assessments led, in part, to the development of ipsative instruments that are based on what are known as forced choice questions and responses. Instruments constructed with an ipsative approach present users with options that are equal in perceived popularity, so that their choice is less likely to be influenced by social desirability. In this type of questionnaire, respondents are asked to choose between two or more equally positive or negative options. For example, they could be asked to indicate which items are 'most like' them and which are 'least like' them. As a result, by asking a candidate to select one of the two options, the question is more likely to 'force' out the 'true' behavioural preferences of the candidate. Because the candidate cannot make himself or herself 'look good' on both statements, the faking-good tendency is considerably reduced.

The results are typically presented in charts depicting the 'most like' scores as how an individual thinks he or she should, or needs to, behave to achieve their objectives: 'least like' scores as the individual's true motivations, and a combined profile that identifies the difference between the 'most like' and 'least like' results to describe the individual's likely normal behaviour. The selections of 'most like' and 'least like' are not measurements of different things, they simply reflect different aspects of self-perception. 'Most like' choices are more prone to be influenced by social desirability needs and 'least like' choices less so.

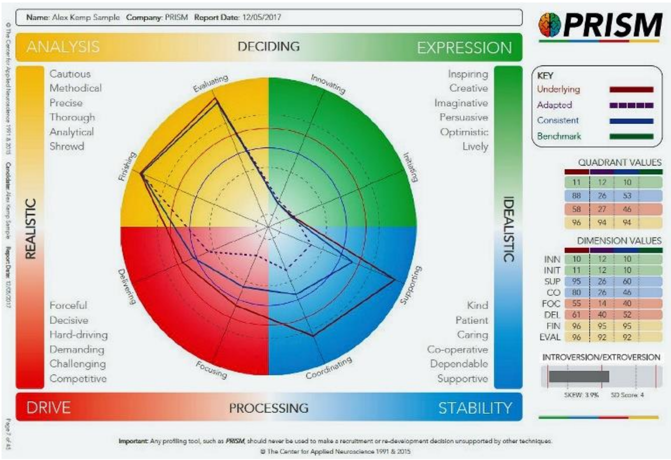
In addition to normative and ipsative assessments, there is now a growing interest in what is known as a 'nipsative' type assessment. This combines both the normative and ipsative assessment scoring methods into one assessment and requires the individual both to indicate their level of agreement with each statement, as well as to rank the statements in terms of their agreement with them.

**The Brain's Role in Creating Behaviour**

The ***PRISM*** model is a 'schema' of the human brain. A schema is a diagrammatic representation of a complex system (such as the brain) to aid understanding. The first use of schemas as a concept was in 1932 by a British psychologist, Frederic Bartlett, as part of his learning theory.

The *PRISM* schema provides a highly simplified, graphical representation of how the brain's functional architecture and four of its chemical systems: dopamine, serotonin, testosterone and estrogen, interact to create specific behaviour groupings. Brain chemical levels change from time to time for a variety of reasons, including diet, age, overall health and stress. As the chemical levels in the brain change, it follows that so too do the behaviours associated with those chemical changes

Although behaviour is produced by the interaction of specific chemicals and networks, it is important to bear in mind that no one part of the brain does solely one thing and no one part of the brain acts alone. While many functions are, indeed, associated with particular areas, each function nonetheless depends on interactions in widely distributed networks involving many different areas. It follows, therefore, that *PRISM* does not subscribe to the once widely held belief that people are either 'right-brained' or 'left-brained'. This was commonly referred to as 'brain dominance' - a theory now totally discounted by neuroscientists.




Although behaviour is produced by the interaction of specific chemicals and networks in the brain this is, however, complicated by many factors: different levels of these chemicals can produce different effects; these substances do different things in different brain parts; each substance interacts with others in different ways under different circumstances; each substance harmonises with many other bodily systems and brain circuits, setting up complex chain reactions.

The relationship between the mind and the brain is also important. The mind has great causal effects on how the brain functions. Research now shows that we can, through conscious effort, not only change the way we think, feel and behave when we are stressed, but we can also change the programming and chemistry of the brain. This knowledge is now being used to great effect in the coaching of top sports people.

The brain structures that give rise to the ***PRISM*** model are summarised below by Professor James E Zull, Professor of Biology, Biochemistry, and Cognitive Science at Case Western Reserve University, Cleveland, Ohio. In his book, '*The Art of Changing the Brain'*, he states:

> *"The cerebral cortex of the brain has three key functions. They are: sensing, integrating, and motor (i.e. movement)."*
>
> *"The sensing function refers to the receipt of signals from the outside world. In people, these signals are picked up by the sense organs; eyes, ears, skin, mouth, and nose. They are then sent on to special regions of the brain for each of the senses. These signals come in small bits and have no meaning in their raw form. They are just little individual pulses of electrical energy coming in from the sense organs."*
>
> *"Integration means that these individual signals get added up so that whatever is being sensed is recognized in the sum of all these signals. The small bits merge into bigger patterns that become meaningful things like images or language. For example, they get added up in ways that generate a plan for what action is needed and where the action is needed."*
>
> *"Finally, the motor function is the execution of those plans and ideas by the body. Ultimately, motor signals are sent to the muscles that contract and relax in coordinated ways to create sophisticated movements. Importantly, we should*

*realise that even speaking and writing fit in here because they involve some of the most sophisticated patterns of muscle contractions that the body carries out."*

*"There is a functional difference between the back and front integrative cortex. Sensory input to the brain, input from the outside world, goes predominantly to the back half. This part of the cortex is heavily involved in long-term memory - the past. It is the part where our knowledge of both the inanimate and living world is mapped. It is where we remember people and their personalities. And it is the part where connections are made between different past experiences. Much of what is there came from the outside world."*

*"The front integrative cortex is about the future. It is where we develop ideas and abstract hypotheses. New things appear, and plans are developed here. It is where we organize our thoughts into bigger pictures that seem to make sense. Things are weighed here; it is where we decide to do or not to do something. It is where we take charge. Creating takes place in the front cortex. This part of the cortex is most active in solving problems, creating ideas, and assembling those ideas into the symbolic form that we call language. In addition, this part of the brain oversees everything, makes decisions and monitors its own progress."*

*"It is clear that the brain is wired so that the front and back talk to each other and that evolution placed great value on these connections."*

*"Generally, the receiving and remembering part of the brain is located towards the back, and that which generates ideas and actions is in the front. Metaphorically, we might say that the brain turns its back on the past and points towards the future."*

**The brain's chemical mix that relates to *PRISM***

In 1984 David Keirsey, an American psychologist and professor emeritus at California State University, reduced an existing theory on personalities to four elementary personality *types*. He defined the four types as *the Artisan, the Guardian, the Rational, and the Idealist*. Scientists now generally regard the word '*type*' as wholly inappropriate when classifying human behaviour because it refers to categories rather than dimensions or scales, terms commonly used by psychologists, or behaviour syndromes, the term used by behaviour geneticists.

The American psychiatrist and geneticist Robert Cloninger (Cloninger et al 1994) hypothesized that there were four genetically independent, behaviour dimensions: novelty seeking, harm avoidance, reward dependence, and persistence. Although all four are descriptively similar to the four primary dimensions of behaviour measured by *PRISM*, it is important to understand how such behaviours are created by the brain.

The brain communicates with itself by transmitting chemical information from one neuron, or nerve cell, to another. There are approximately 100,000 chemical reactions taking place in a human brain every second. Most of these chemicals are known as neurotransmitters and are involved in passing and modulating signals between neurons and other cells. Neurotransmitters play a major role in shaping everyday life and behaviour. Their exact numbers are unknown, but more than 200 chemical messengers have been uniquely identified to date.

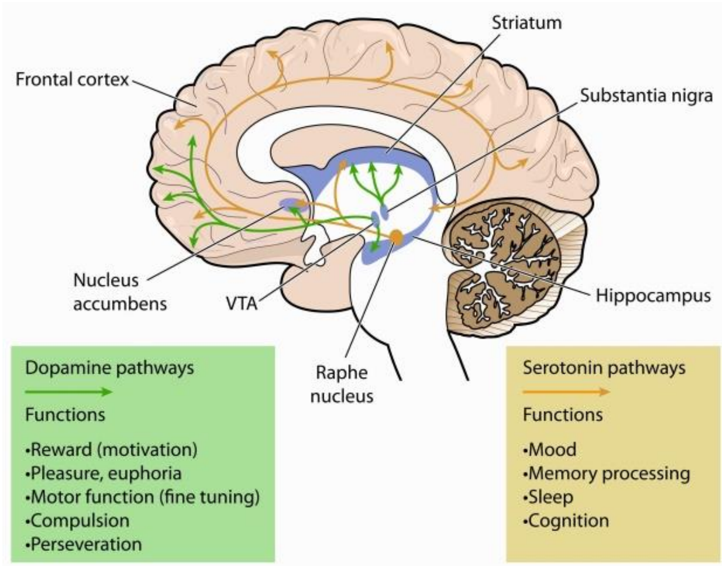
Other brain chemicals, known as hormones, are released into the bloodstream by the endocrine glands found throughout the body. They carry messages that produce certain effects in the body, much as the neurotransmitters do. In fact, there are many substances such as norepinephrine that function both as neurotransmitters and hormones. Norepinephrine, epinephrine, and other hormones produced by the adrenal gland are involved in the "fight or flight" response of the body to stress.

The brain plays an important role in regulating the release of hormones, and if hormone levels get out of balance (as neurotransmitter levels sometimes do), it can have an impact on how the brain functions and therefore on how a person feels and behaves. The chemicals are programmed to process any incoming information and creating a corresponding response. This process takes at an extremely rapid pace. For example, research by Massachusetts Institute of Technology has shown that in the transmission space between two neurons (the synaptic gap) an estimated 2,000 to 5,000 molecules of the neurotransmitter glutamate are deposited there in about 1 millisecond.

Although neurotransmitters have two main functions – excitation and inhibition – things are not that simple. Many neurotransmitters do not trigger fast excitation or inhibition, but initiate quite slow metabolic processes in neurons, causing lasting changes in the strength of synaptic connections. Neurotransmitters can also initiate the switching ON and OFF of important genes, which can cause long-term change in neuronal synaptic properties.

Drawing links between brain chemicals and behaviour is a fascinating and complicated exercise, with potentially far-reaching social implications. The following paragraphs highlight just some of the complex issues arising from the interaction of the four brain chemical systems that form the basis for the *PRISM* measurement scales.

*PRISM* theory focuses on behaviours with known genetic underpinnings that contribute specifically to the *PRISM* four primary behaviour dimensions. The activity of and interactions between chemical systems are governed by many factors, including the amount of production of the neurotransmitter or hormone; the enzymes controlling the production of each neurochemical; the sensitivity and/or number of postsynaptic receptors that receive the chemical; the sensitivity of presynaptic receptors that regulate the production of the neurochemical through a negative feedback system; and catabolism mechanisms regulated by enzymes. Moreover, different combinations of neurochemicals can produce the same net behaviour in different people. Although the full biological profile for each behaviour constellation discussed is unknown, this paper is based on data that indicate that these biological constellations are significantly different from one another and contribute to who we are.




For example, two enzymes, catechol-o-methyltransferase and monoamine oxidase are involved in sensation seeking. Remembered by their acronyms, COMT and MAO; these enzymes break down dopamine, norepinephrine and serotonin. A tiny variation in the COMT gene is associated with seeking novelty (Drabant et al. 2006). MAO comes in two varieties: MAOa regulates norepinephrine and serotonin; MAOb controls dopamine. Variations in both systems can contribute to sensation seeking (Zuckerman 1994; Johansson et al. 1983; Meyer-Lindenberg et al. 2006; Sostek et al. 1981).

Elevated activity of testosterone may play a role in sensation seeking because testosterone lowers MAO levels in the brain, thereby raising the impact of dopamine (Zuckerman 1994). Testosterone contributes to some aspects of novelty seeking, particularly the craving for action adventure (Zuckerman 1994). Sensation seekers have lower levels of norepinephrine. Norepinephrine activates when a person experiences any kind of novelty, enabling them to focus their attention, and sensation seekers may seek arousing stimuli to trigger this chemical system and thus alleviate monotony (Zuckerman 1994). Sensation seeking and impulsivity both have been associated with an underactive serotonin system as well (Zuckerman 1994; Manuck et al. 2000). This is to be expected because elevated dopamine activity suppresses serotonin circuits and serotonin activity suppresses dopamine (Stahl 2000). Focus is also associated with norepinephrine and testosterone, although the role of testosterone is most likely the result of activity in the dopamine system. Testosterone and dopamine have a positive correlation: elevated activity in each system elevates activity in the other.

During 2006-2007, Professor Helen Fisher from Rutgers University in New York collected data on all four testosterone, estrogen, dopamine and serotonin scales (Fisher et al., 2010) from a sample of 39,913 anonymous men and women using the Fisher Temperament Inventory (FTI)

The FTI scales were referred to as:

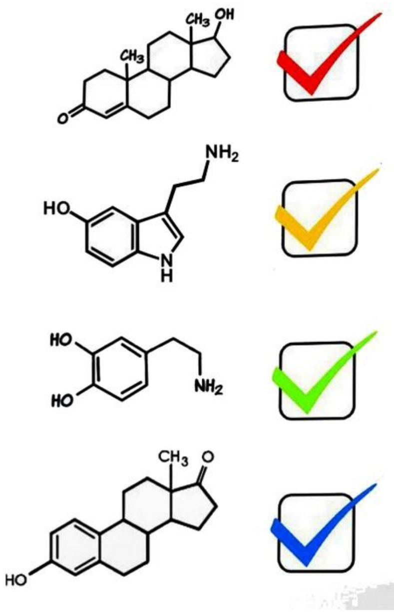
*'Analytical/Tough-minded'* (testosterone),
*'Prosocial/Empathetic'* (estrogen),
*'Cautious/Social Norm Compliant '* (serotonin) and
*'Curious/Energetic'* (dopamine).

Respondents ranged in age from 18 to 88 years (*M* = 37.0; SD = 12.6); 56.4% were female (*N* = 22,521). The survey was based on a 56-item inventory containing four 14-item scales. All individuals expressed their preferences on all four behaviour dimensions. The Cronbach's alpha internal consistency coefficient in the sample was: dopamine r = 0.791; serotonin r = 0.793; testosterone r = 0.809 and estrogen r = 0.783.

Brown et al., (2013) used magnetic resonance studies (fMRI) to investigate whether the FTI measured brain activity affected by four broad neural systems associated with dopamine, serotonin, testosterone and estrogen.

The study found that:

Scores for the Curious/Energetic (dopamine) dimension co-varied with activation in a region of the substantia nigra, consistent with the prediction that this dimension reflects activity in the dopamine system.




Scores for the Cautious/Social Norm Compliant (serotonin) dimension correlated with activation in the ventrolateral prefrontal cortex in regions associated with social norm compliance, a trait linked with the serotonin system.

Scores on the Analytical/Tough-minded (testosterone) scale co-varied with activity in regions of the occipital and parietal cortices associated with visual acuity and mathematical thinking, traits linked with testosterone. Also, testosterone contributes to brain architecture in these areas.

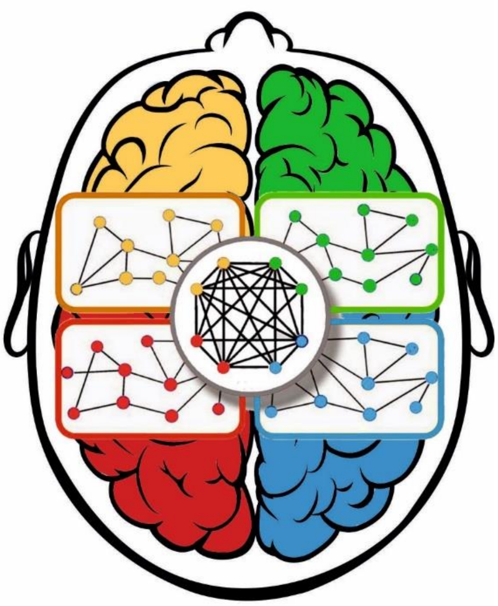
Scores on the Prosocial/Empathetic (estrogen) scale correlated with activity in regions of the inferior frontal gyrus, anterior insula and fusiform gyrus. These are regions associated with mirror neurons or empathy, a trait linked with the estrogen/oxytocin system, and where estrogen contributes to brain architecture.

Although *PRISM* was created some three years before the Fisher Temperament Inventory, the size of the FTI sample data was also significantly greater than the *PRISM* one. The Rutgers University study does, however, provide further indirect corroboration for the concept on which *PRISM* measurement scales were created. In addition, the FTI was probably the first measure of behaviour in the world to be partially validated by two fMRI brain-scanning studies, rather than finding physiological correlates for proposed traits established by other means.

**The Development of *PRISM***

As already highlighted above, ***PRISM*** is not the work of any one individual. It has drawn on the collective works of many individuals in the fields of neuroscience and psychology to create a model that is easy to understand, yet one that is accurate and robust in its output.

The brain is a dynamic, electro-chemical system - widely regarded as probably the most complex in the known universe. All our thoughts, emotions and actions are the results of many parts of the brain acting together to create patterns of activity. Despite this, areas of the brain do have specialised functions, and the ***PRISM*** model reflects, in particular, the activities associated with the right and left hemispheres, and the frontal lobes and the posterior lobes.



The longitudinal fissure divides the brain into the two hemispheres and the central and lateral sulci divide the frontal lobes (including the motor cortex) from the parietal, occipital and temporal lobes (including the somatosensory cortex). These four blocks are represented in the ***PRISM*** model by the Green, Blue, Red and Gold quadrants.

On a broad level the brain lends itself to partitioning, based largely on its anatomical structure. All proposed divisions within the brain are, however, highly artificial and are created in response to the human need to separate things into neat, easily understandable units.

With that caveat in mind, the ***PRISM*** quadrant model provides users with a useful schema that they can refer to when they are visualising how their brains are organised. ***PRISM*** is, therefore, based on scientific principles and facts which have been simplified into a workable model to facilitate understanding.

The quadrant model represents the right and left hemispheres of the brain, plus the frontal lobes and the posterior lobes. The 'maps' that are overlaid on the model are designed to show the intensity of a respondent's self-expressed preferences for the relevant behaviours and not the precise location of those behaviours.

In some respects, the ***PRISM*** method of presenting behaviour by using 'maps' that are visual representations of a person's behavioural preferences is in keeping with the principle of Gestalt psychology. This principle maintains that '*the whole is different from the sum of its parts'*. ***PRISM*** emphasises the study of behaviour as a whole rather than simply focusing on independently functioning, disparate parts.

The information provided below is provided to give an insight into how the ***PRISM*** concept was developed.

## The brain hemispheres

The different functions of the two hemispheres are well summarised by Dr Iain McGilchrist, a Fellow of the Royal College of Psychiatrists and former Research Fellow in neuroimaging at the Johns Hopkins Hospital in Baltimore. He highlights some of the key differences between the two brain hemispheres as follows:

**The left hemisphere**:

is not impressed by empathy
needs certainty and to be right
applies linear, sequential analysis to achieve clarity
is competitive and its concern, its prime motivation, is power
is, by comparison with the right hemisphere, emotionally neutral
focally suppresses meanings that are not currently relevant
tends to deal more with pieces of information in isolation
takes the single solution that seems best to fit what it already knows and latches onto it.
reads emotions by interpreting the lower part of the face - it looks not at the eyes, but at the mouth

**The right hemisphere**:

is involved in the experience of emotions of all kinds
is especially important for flexibility of thought
is constantly searching for patterns of things
has by far the preponderance of emotional understanding
is in general more intimately connected with the limbic system
deals with incomplete information and tolerates uncertainty
is particularly well equipped to deal with passions, sense of humour, metaphoric and symbolic understanding, and all imaginative and intuitive processes

Dr McGilchrist adds:

> *"What is new must first be presented in the right hemisphere before it can come into focus for the left. Not just new experiences, but the learning of new information or new skills also engages the right hemisphere attention more than the left. The right frontal lobe is especially important for flexibility of thought.*
>
> *Empathy, social understanding, humour, metaphor, more subtle emotional understanding, the appreciation of individuals, the reading of faces, and much else go on in the right hemisphere. Fascinatingly there is clear evidence that the left hemisphere alone codes for machines and tools – even in left-handers, who would be using their right hemisphere to use tools and build machines in daily life.*
>
> *The two hemispheres are linked by a 'bridge', known as the corpus callosum that has an 'excitatory' function i.e. it enables the two hemispheres to communicate with each other. However, the main purpose of a large number of these connections is actually to inhibit - in other words to stop the other hemisphere interfering. The corpus callosum's excitatory and inhibitory roles are, therefore both necessary for normal human functioning."*

'The Master and His Emissary' Yale University Press; 2nd edition (15 Jun. 2012)

It is important to bear in mind that the brain is not only divided into hemispheres, it is also asymmetrical. There are subtle, but significant, observable differences at every level. The two hemispheres are different sizes, shapes, and weights (the right hemisphere is bigger and heavier in all social mammals); have different gyri (ridges) conformations on the surface, and in places different arrangement of the cells (cytoarchitecture); different proportions of grey matter to white, different sensitivity to neuroendocrine influences, and rely on different preponderances of neurotransmitters. And in psychometric testing they consistently yield different results, which is in keeping with something any neurologist will point out: when there is damage to one hemisphere or the other, through injury, tumor or stroke, there are consistent differences in what happens to the subject and his or her world depending on which hemisphere suffers the lesion.

Despite these differences, the bottom line is that neither *PRISM* nor neuroscientists subscribe to the popular theory of brain dominance. A study in 2013 led by Dr. Jeff Anderson, director of the fMRI Neurosurgical Mapping Service at the University of Utah, concluded that:

> *"It's absolutely true that some brain functions occur in one or the other side of the brain, language tends to be on the left, attention more on the right. But the brain isn't as clear-cut as it has sometimes been made out to be."*

For example, most people have a preference for using either their right hand or their left hand, but that does not prevent them from using both hands.

**The brain lobes**

The following comments by leading neuroscientists reflect some of the fundamental theory that underpins the ***PRISM*** graphic model:

**Professor John J Ratey, Clinical Professor of Psychiatry, Harvard Medical School**

> *"The back of the brain is the sensory or input half, which receives input from the outside world and sorts, processes, and stores all of our sensory representations. In the front of the brain, the cortex is devoted to the processing of motor programs or output - we use this area to react to the input data. It is here we plan, strategise, and sculpt our responses to the world, and it is this area that has been adapted for use in abstract thinking and planning."*

**Professor Elkhonon Goldberg, Clinical Professor of Neurology at New York University School of Medicine and Director of the Institute of Neuropsychology and Cognitive Performance**

> *"The frontal lobes perform the most advanced and complex functions in all of the brain, the so-called executive functions. They are linked to intentionality, purposefulness, and complex decision making. Motivation, drive, foresight, and clear vision of one's goals are central to success in any walk of life. All these prerequisites of success are controlled by the frontal lobes.*
>
> *Our ability to accomplish our goals depends on our ability to critically appraise our own actions and the actions of those around us. This ability rests with the frontal lobes. In a complex society such as ours, a different talent comes to the fore, the leadership talent. Of all the forms of talent, the ability to lead is the most mysterious and the most profound. In human history the leadership talent has had the greatest impact on the destinies of others and on personal success. There is an intimate relationship between leadership and the frontal lobes.*
>
> *Intelligence and creativity are inseparable yet not the same. Each of us has known people who are bright, intelligent, thoughtful and barren. Creativity*

*requires the ability to embrace novelty. The frontal lobes play a critical role in dealing with novelty.*

*Frontal lobes define us as social beings. It is more than coincidence that the biological maturation of the frontal lobes takes place at the age that has been codified in virtually all developed cultures as the beginning of adulthood. But poor development of, or damage to, the frontal lobes may produce behaviour devoid of social constraints and sense of responsibility. "*

**Professor Richard Restak, Clinical Professor of Neurology at George Washington University Medical Center, Washington DC**

*"Extensively linked to the emotion-mediating limbic system is the prefrontal cortex, which controls fear and aggression. This dual function is useful because fear and aggression are intimately connected. Recent brain research indicates that the prefrontal cortex and the limbic system coexist in a delicate balance. When emotions threaten to get out of control, the prefrontal cortex springs into action and restores the balance. In fact, activity in the prefrontal cortex is an indicator of an imbalance between the limbic system and the prefrontal lobes."*

**Professor Joseph Le Doux Professor of Neuroscience and Psychology, New York University**

*"The sensory - or input - regions of the cortex are located posterior to the central sulcus and the Sylvian Fissure, in the parietal, temporal, and occipital lobes. This 'back of the brain' large region, encompassing three cortical lobes, is not simply a site for processing sensory information. It is also the region of the cortex for associative processes, where information from the various senses is 'bound together' for higher order processing."*

**Professor Sam Wang, Professor of Neuroscience and Molecular Biology, Princeton University**

*All in all, the left side of the brain seems to have an intense need for logic and order – so intense that if something doesn't make sense, it usually responds by inventing some plausible explanation.*

*The right side is much more literal and truthful when it reports what happened. It controls spatial perception and the analysis of objects by touch, and excels at visual-motor tasks."*

## Neural correlates of the four primary *PRISM* dimensions

Initially, the four primary dimensions of *PRISM* behavioural traits were identified and extracted from existing scientific literature, each one associated with one of four broad neural systems: the dopamine, serotonin, testosterone and estrogen system. The findings of additional studies were added and the *PRISM* scales were refined as the relevant new literature became available.

Here is a sample of just a few of the 130 or more studies that relate to the behaviours that are associated with specific ***PRISM*** behaviours:

**Dopamine** (***PRISM*** Green)
*thrill, experience and adventure seeking; boredom susceptibility; and disinhibition* (Zuckerman, 2005)
*idea generation, and verbal and non-linguistic creativity* (Flaherty, 2005)
*energy, social assertiveness, and motivation* (Depue& Collins, 1999;
*curiosity* (Zuckerman and Kuhlman, 2000)

**Estrogen** (***PRISM*** Blue)
*Empathy, nurturing, social attachments* (Baron-Cohen, 2002; Kendrick, 2000, Pedersen et al., 1992; Taylor et al., 2000).
*the drive to make social attachments* (Carter, 1998; Edelstein et al., 2010),
*mental flexibility* (Skuse et al., 1997).
*empathy and nurturing* (Knickmeyer et al., 2006)
*generosity and trust* (Kosfeld et al., 2005)

**Testosterone** (***PRISM*** Red)
*being less polite, respectful, considerate or friendly* (Dabbs, 1997; Harris, Rushton, Hampson, & Jackson, 1996)
*being more confident, forthright and bold* (Nyborg, 1994).
*drive for rank, the tendency to create dominance hierarchies* (e.g., Mazur, Susman & Edelbrock, 1997)
*enhanced self-assurance* (Zilioli and Watson, 2013)
*reduced empathy* (Knickmeyer et al., 2006).

**Serotonin** (***PRISM*** Gold)
conscientiousness (Manuck et al., 1998; DeYoung et al., 2002, 2010; DeYoung and Gray, 2009,
*concrete thinking and sustained attention*(Zuckerman 1994),
*orderliness* (DeYoung & Gray, 2005)
*self-control and self-regulation* (Linnoila et al., 1994; Manuck et al., 1998)
*precision and interest in details* (Cloninger et al., 1991)

In 2002, the ***PRISM*** developers created a self-perception questionnaire which was developed for both online and paper & pencil administration. The 32-item measure contained four 8-item scales to investigate the behavioural characteristics associated with testosterone, estrogen, dopamine and serotonin systems, which they labelled for ease of understanding as Red, Blue, Green and Gold respectively. A Likert-like 4-point scale was used, providing participants with the options: 0: strongly disagree, 1: disagree, 2: agree, 3: strongly agree.

The questionnaire was completed anonymously by 4,237 anonymous men and women whose ages ranged from 19 to 60 years of age. The Cronbach's alpha internal consistency coefficient scores obtained from the sample averaged 0.8 for the four groups.

Human behaviour is, of course, mediated by many factors and can be only indirectly associated with neurochemical data. But the scales consistently demonstrated significant correlations in the predicted direction with many other neurochemically-mediated behaviours, providing strong evidence that the FTI measured aspects of behaviour associated with neurochemistry.

Having re-examined the results of their initial survey in 2003, the ***PRISM*** developers identified two distinct clusters of behaviours within each system. Using factor analysis, each primary scale was broken down into two sub-scales:

| | |
|---|---|
| (1) Dopamine (Green): | ‘innovating’ and ‘initiating’ |
| (2) Estrogen (Blue): | ‘supporting’ and ‘co-ordinating’ |
| (3) Testosterone (Red): | ‘focusing’ and ‘delivering’ |
| (4) Serotonin (Gold): | ‘finishing’ and ‘evaluating’ |

Since its inception, the ***PRISM*** developers have enhanced and refined the ***PRISM*** measurement scales to achieve the highest possible standards of measurement. The instrument has also been subjected to a number of independent validity studies. The most recent was conducted in 2014. A copy of the of that study’s conclusions is available as a download document from the ***PRISM*** website.

In terms of business, it is clearly very beneficial to possess at least an overview of brain structures and functions, in order to get a better understanding of why and how people act the way they do. If we can understand the brain, we can have a better understanding of the behaviours of our customers and the people we work with, as well as discover ways of making the workplace a better place to be. This is the core base of everything we do as humans, employees and leaders. Already there are signs that research is proving very valuable in making the sales and marketing functions more effective. Here are just two other very brief examples of how neuroscience could be used effectively to improve business performance:

In one study, Professor Barbara Sahakian of Cambridge University found entrepreneurs were better adapted to taking "hot" decisions, such as making a risky investment than their more managerial-style counterparts.

Dr Shai Vyakarnam, Director of the Centre for Entrepreneurial Learning, Judge Business School, commented:

> *"This research suggests that when engaged in teaching entrepreneurship, the focus should be on risk tolerance as opposed to the more traditional focus on risk mitigation. If we train potential entrepreneurs to reframe their decisions this may in turn encourage greater entrepreneurial activity. This can be further enhanced by placing these entrepreneurs in a culture which normalizes a more risk-tolerant type of decision making."*

On this study, although entrepreneurs and managers both made good quality decisions, entrepreneurs were significantly riskier. Entrepreneurs also showed superior cognitive flexibility and higher ratings on questionnaires which measure impulsivity. These cognitive processes are intimately linked to brain neurochemistry, particularly to the neurotransmitter dopamine

Source: *https://www.cam.ac.uk/research/news/risky-decision-making-essential-to-entrepreneurialism*

Dolby Laboratories have also been using neuroscience with great effect to change and improve the performance management of their employees. For more information on that initiative see: *http://on-the-mark.com/dolby-webinar-recording/*

*If you would like to know more about PRISM and how to make the best use of it, please visit our website at: www.prismbrainmapping.com*

*or email us at: info@prismbrainmapping.com*

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