



***PRISM* BRAIN MAPPING**

Development, Factor Structure and Reliability

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Factor Structure and Reliability

Validity Study, June 2014

PRISM has been the subject of previous validity studies in 2003 and 2006 - 2007. The latest validity study, in 2014, was designed to ensure that the ***PRISM*** Inventory was not culturally biased in favour of particular ethnic groups over others. The main focus of that study was to examine the factor structure and reliability of the ***PRISM*** scales across a range of ethnic groups.

REPORT AUTHOR

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Dr Viki holds a PhD in Psychology and is a university Senior Lecturer in Organizational Psychology. He also teaches Entrepreneurship and Research. His PhD thesis was awarded the British Psychological Society's Social Psychology Section Annual Award for the Most Outstanding Thesis in Social Psychology in 2003. During his early academic career, he was a Research Intern at the Dana Farber Institute, Harvard Medical School (Boston USA), a Research Assistant at Harvard University (USA), a Visiting Scholar at the University of Queensland (Australia), a Visiting Scholar at the University of Cape Town (South Africa), a Visiting Scholar at the University of Granada (Spain), and a Research Fellow at Stanford University (USA). He has published over 30 scientific papers.

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Overview

Although **PRISM**'s theoretical base is rooted firmly in the biological basis of behaviour rather than psychology (for more information see '*The Science Behind PRISM*'), its developers have repeatedly subjected it to independent scrutiny over the past twenty years to identify its 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 help to enhance understanding. The purpose of this paper is to summarise the development and application of **PRISM** and to summarize its psychometric validation to date.

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 measures the intensity 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, nor is it for use in making clinical diagnoses or for dealing with mental health issues.

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."

People accept that they are often faced with situations, or with some aspects of their jobs, that require them to modify 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 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 the world of work is not always about living within their ‘comfort zone’ all of the time, and they have the ability to step outside their natural behavioural preferences in order to be successful.

The brain's role in creating behaviour

The **PRISM** model is a graphic representation of how the brain's functional architecture and neural networks interact with brain chemicals such as dopamine, epinephrine, serotonin, testosterone, oxytocin and oestrogen, to create behaviour. Brain chemical levels change for a variety of reasons, including diet, age, overall health and stress. As the chemical levels in the brain change, it follows that so do the behaviours associated with those chemical changes.

However, when considering the **PRISM** model, 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. All our thoughts, emotions and behaviours are the results of many parts of the brain acting together to create a pattern of activity - ‘behaviour’.

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 than the sum of its parts*’. **PRISM** emphasizes the study of behaviour as whole rather than simply focusing on independently functioning, disparate parts.

The **PRISM** model

The basic brain structures that give rise to the **PRISM** model are summarised below by Professor James E Zull, who is Professor of Biology, Biochemistry, and Cognitive Science at Case Western Reserve University, Cleveland, Ohio.

“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 development of *PRISM*

The *PRISM* dimensions of behaviour focus primarily on the behaviours associated with ‘normal’ levels of dopamine, serotonin, testosterone and oestrogen, and a number of independent studies have confirmed the links between these chemicals and the behaviours that make up the *PRISM* scales.

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

Dopamine (*PRISM* Green)

thrill, experience and adventure seeking; boredom susceptibility; and inhibition

(Zuckerman, 2005)

idea generation, and verbal and non-linguistic creativity

(Flaherty, 2005)

energy, social assertiveness, and motivation

(Depue & Collins, 1999)

Oestrogen (*PRISM* Blue)

Empathy, nurturing, social attachments

(Baron-Cohen, 2002; Kendrick, 2000, Pedersen et al., 1992; Taylor et al., 2000)

contextual thinking

(Dabbs & Dabbs, 2000; Fisher, 1999)

mental flexibility

(Skuse et al., 1997)

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

(Mazur, Susman & Edelman, 1997)

Serotonin (*PRISM* Gold)

conscientiousness

(Manuck et al., 1998)

concrete thinking and sustained attention

(Zuckerman 1994)

orderliness

(DeYoung & Gray, 2005)

In 2003, 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, oestrogen, dopamine and serotonin systems. 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.

Some three years later, during 2006-2007, during a totally separate study by Rutgers University, New Jersey, data were collected on all four testosterone, oestrogen, dopamine and serotonin scales in a sample of 39,913 anonymous men and women. 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 oestrogen $r = 0.783$.

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

- (1) Dopamine (Green): 'innovating' and 'initiating',
- (2) Oestrogen (Blue): 'supporting' and 'co-ordinating'
- (3) Testosterone (Red): 'focusing' and 'delivering'
- (4) Serotonin (Gold): 'finishing' and 'evaluating'.

The initial scale consisted of over 250 words, but the work carried out by Kent University during 2006-07 produced the final scale that met the necessary psychometric criteria for good measurement that the developers were looking for. The measure consisted of 8 subscales each fitting into the four-factor model of *PRISM* (two sub-scales per factor). Each subscale consisted of 12 items, resulting in a 96 item scale. The internal consistency scores for the measure are shown in Table 1 & 2 below:

Table 1: Internal Consistencies for the Four Colours

Factor	Cronbach's Alpha
RED	.942
GREEN	.925
GOLD	.936
BLUE	.925

Table 2: Internal Consistencies for the Eight Subscales

Factor	Cronbach's Alpha
RED - FOCUSING	.926
RED - DELIVERING	.896
GREEN - INNOVATING	.918
GREEN - INITIATING	.862
BLUE - SUPPORTING	.887
BLUE - COORDINATING	.881
GOLD - EVALUATING	.860
GOLD - FINISHING	.912

Re-validation Study 2014

Despite the excellent internal consistency results shown above, the **PRISM** developers were aware that the initial research data on which the instrument is based came, primarily, from respondents in North America, the United Kingdom and Australia. It was felt, therefore, that, to reflect the instrument's growing popularity globally, a further study should be undertaken to see what impact, if any, ethnic and cultural issues might have on the tool's **factor structure and reliability**. As result, the developers asked Dr Tendayi Viki to carry out a study to examine if **PRISM** is psychometrically valid in terms of its core eight dimensions.

At the conclusion of the study, Dr Viki reported:

“Based on well-established findings within neuroscience, **PRISM Brain Mapping** distinguishes four main colour dimensions (i.e. **Gold, Red, Green** and **Blue**). Each colour represents an element of a person's preferred behavioural style in the work environment. Individuals that are high in the **Red** dimension are driven to *control their environment and successfully complete tasks regardless of the circumstances and relationships*. The key characteristics of **Blue** are that the individuals are driven to *maintain good relationships with others and a collaborative work environment*. Individuals that score high on the **Green** dimension are *highly innovative, creative, free-spirited and fun loving*. The key characteristics of **Gold** are that the individuals are *highly logical, perfectionist, thoughtful and analytical*.

Within **PRISM**, each of the above colour dimensions is further split into two sub-categories, to provide a more nuanced view of the individual's preferred behaviour. For **Red** the subcategories are *Focusing* (authoritative, forthright) and *Delivering* (determined, self-reliant). For **Green** the subcategories are *Innovating* (inventive, imaginative) and *Initiating* (lively, jovial). For **Blue** the subcategories are *Supporting* (helpful, caring) and *Coordinating* (consultative, collaborative). Finally, for **Gold** the subcategories are *Evaluating* (analytical, prudent) and *finishing* (thorough, perfectionist). These eight dimensions form the basis of the brain map that is produced within the **PRISM** report.

The power of **PRISM** is that it is not a classification tool in the traditional sense. In other words, the tool is not used to classify individuals into only one

dimension. The *PRISM* model recognises that individuals will have characteristics from all eight dimensions to a greater or lesser extent. What is produced is a unique ‘brain map’ that shows the individual’s preferred style of working, and also those behaviours they would rather avoid. In line with the principles of Gestalt Psychology, it is the whole of the ‘brain map’ that is greater than the sum of its parts.

The main goal of the current research project was to further establish the psychometric characteristics of the *PRISM* tool. An initial validation study was conducted in 2006-2007. Since that study, the tool has been refreshed in order to meet the demands of its growing international usage. Furthermore, while the tool has been getting used more and more in international contexts, the initial validation study was conducted mainly in the UK. As such, the main goal of current study was to establish whether the revised version of *PRISM* was psychometrically valid in terms of the core eight dimensions.

A second goal of the research was to conduct the study using a more diverse and larger sample compared to the initial validation study. All these are important improvements to *PRISM* that make the tool more relevant for use in various contexts.”

Methodology

“We conducted a large-scale study in order to reach the final scale reported in this paper. 1124 participants took part in the study. Of the participants, 590 were female and 534 were male. Their ages ranged from 15 years to 61 years, with 94% of the participants being 50 years old or younger. The ethnic mix of the participants ranged from Arabic, African, European, Chinese, Japanese, Indian and Pakistani. This ethnic mix is more diverse than the sample from our initial validation study.”

Table 3: Participant Ethnicity

Ethnicity	Frequency	Percent
Arab	108	9.6
Bangladeshi	49	4.4
Black African	49	4.4
Black Caribbean	55	4.9
Black Other	36	3.2
Chinese	114	10.1
Coloured African	43	3.8
Indian	126	11.2
Japanese	77	6.9
Mixed Race	2	.2
Pakistani	45	4.0
White	420	37.4

“The sample was also diverse with regards to education levels, as shown in Table 4 below. This was different from the first validation study, which was conducted mostly among undergraduate students at a university in the UK.”

Table 4: Participant Education

Ethnicity	Frequency	Percent
Non-Graduate	158	14.1
Bachelor Degree	566	50.4
Master’s Degree	252	22.4
Professional Degree	133	11.8
Doctorate	9	0.8
Not Specified	6	0.5

“During the research, participants were presented with the words and phrases in the *PRISM* Brain Mapping scale. They were requested to indicate the extent to which each word or phrase was an accurate description of their preferred behaviour in work environments (1 = *Least Like Me* to 5 = *Most Like Me*).”

Findings

“Factor analysis was performed on the data using SPSS. We required the programme to search for eight factors using the Varimax rotation. This analysis produced the pattern of eight factors that are consistent with the *PRISM* model. Factor loadings ranged from .59 to .86 across all eight factors. As shown in Table 5 below, these factors are clearly identifiable as Red Focusing, Red Delivering, Green Innovating, Green Initiating, Blue Supporting, Blue Coordinating, Gold Finishing and Gold Evaluating. The word items assessing each colour are also clearly related to each subscale providing validity for the theoretical underpinnings of the *PRISM* model. The factor-loadings below are relatively high and the fact that the eight predicted factors emerged from this international data set provides further evidence of the validity of *PRISM* Brain Mapping.

We then ran correlational analyses on the data to examine the relationships among the eight dimensions. The findings of this analysis generally supported the *PRISM* model. The strongest positive correlations we obtained were between any two sub-scales that belonged to the same colour group within *PRISM*. These correlations are highlighted in red in Table 6 below. These findings offer support for the eight dimensions and also the four dimensions that the colours represent.”

Table 5: Factor Analysis Data

Colour	Dimension	Factor Loadings
Green	Innovating	0.731 – 0.842
	Initiating	0.692 – 0.857
Blue	Supporting	0.639 – 0.787
	Co-ordinating	0.599 – 0.767
Red	Focusing	0.648 – 0.775
	Delivering	0.623 – 0.722
Gold	Finishing	0.747 – 0.863
	Evaluating	0.658 – 0.751

Table 6: Correlations among the Eight Subscales

Correlations

	Innovating	Initiating	Supporting	Coordinating	Focusing	Delivering	Finishing	Evaluating
Innovating								
Pearson Correlation	1	.322**	.058	.205**	-.056	.156**	-.386**	-.140**
Sig. (2-tailed)		.000	.053	.000	.060	.000	.000	.000
N	1124	1124	1124	1124	1124	1124	1124	1124
Initiating								
Pearson Correlation	.322**	1	.224**	.243**	-.067*	.001	-.343**	-.350**
Sig. (2-tailed)	.000		.000	.000	.025	.970	.000	.000
N	1124	1124	1124	1124	1124	1124	1124	1124
Supporting								
Pearson Correlation	.058	.224**	1	.449**	-.352**	-.315**	.088**	.099**
Sig. (2-tailed)	.053	.000		.000	.000	.000	.003	.001
N	1124	1124	1124	1124	1124	1124	1124	1124
Coordinating								
Pearson Correlation	.205**	.243**	.449**	1	-.280**	-.206**	-.047	.090**
Sig. (2-tailed)	.000	.000	.000		.000	.000	.116	.003
N	1124	1124	1124	1124	1124	1124	1124	1124
Focusing								
Pearson Correlation	-.056	-.067*	-.352**	-.280**	1	.528**	.056	.146**
Sig. (2-tailed)	.060	.025	.000	.000		.000	.060	.000
N	1124	1124	1124	1124	1124	1124	1124	1124
Delivering								
Pearson Correlation	.156**	.001	-.315**	-.206**	.528**	1	-.118**	.109**
Sig. (2-tailed)	.000	.970	.000	.000	.000		.000	.000
N	1124	1124	1124	1124	1124	1124	1124	1124
Finishing								
Pearson Correlation	-.386**	-.343**	.088**	-.047	.056	-.118**	1	.511**
Sig. (2-tailed)	.000	.000	.003	.116	.060	.000		.000
N	1124	1124	1124	1124	1124	1124	1124	1124
Evaluating								
Pearson Correlation	-.140**	-.350**	.099**	.090**	.146**	.109**	.511**	1
Sig. (2-tailed)	.000	.000	.001	.003	.000	.000	.000	
N	1124	1124	1124	1124	1124	1124	1124	1124

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

“As in the previous validation study, we also ran reliability analyses using Cronbach’s Alpha. This analysis produced results indicating very high levels of internal consistency for the subscales. For the four main subscales the reliability scores were above .94. This is a very high level of internal consistency. We also analysed the data for the eight subscales, and these were also highly reliable with internal consistency scores above .92. Overall, these findings give us confidence about the internal consistency of the *PRISM* subscales and suggest that *PRISM* is a highly reliable measurement instrument (see Table 7 and Table 8 below).”

Table 7: Internal Consistencies for the Four Colours

Factor	Cronbach’s Alpha
RED	.948
GREEN	.957
BLUE	.949
GOLD	.965

Table 8: Internal Consistencies for the Eight Subscales

Factor	Cronbach’s Alpha
RED FOCUSING	.942
RED DELIVERING	.925
GREEN INNOVATING	.965
GREEN INNITIATING	.966
BLUE SUPPORTING	.947
BLUE COORDINATING	.938
GOLD EVALUATING	.949
GOLD FINISHING	.974

“There are no significant differences by gender at all across all eight dimensions; this means the *PRISM* scale works well for both genders.”

Table 9: Analysis of Variance (ANOVA)

		Sum of Squares	df	Mean Square	F	Sig.
Green_Inno	Between Groups	.007	1	.007	.015	.904
	Within Groups	568.870	1122	.507		
	Total	568.878	1123			
Green_Inni	Between Groups	.308	1	.308	.515	.473
	Within Groups	671.386	1122	.598		
	Total	671.694	1123			
Blue_Supp	Between Groups	.001	1	.001	.002	.961
	Within Groups	368.751	1122	.329		
	Total	368.752	1123			
Blue_Coor	Between Groups	.092	1	.092	.319	.572
	Within Groups	324.152	1122	.289		
	Total	324.244	1123			
Red_Focus	Between Groups	.517	1	.517	1.260	.262
	Within Groups	460.319	1122	.410		
	Total	460.836	1123			
Red_Deliv	Between Groups	.136	1	.136	.455	.500
	Within Groups	336.111	1122	.300		
	Total	336.247	1123			
Gold_Finishing	Between Groups	1.097	1	1.097	1.503	.220
	Within Groups	818.347	1122	.729		
	Total	819.443	1123			
Gold_Evaluating	Between Groups	.517	1	.517	1.258	.262
	Within Groups	460.751	1122	.411		
	Total	461.267	1123			

Conclusions

“The findings from this study provide strong support for the validity and reliability of the English version of the *PRISM* Brain Mapping scale. These findings are further strengthened by the international and cross-cultural nature of the sample that was used in this study.”

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