Toward a Standard Theory of Personality Psychology

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1. Introduction

When Philip Corr invited contributors to this special issue on the topic of a consensual model of personality, he encouraged us to “think big.”

As indicated in the title, the main message of this article is to encourage psychologists to follow physicists, who have reached what has been described as “perhaps, the pinnacle of human intellectual achievement to date” and “the greatest accomplishment of twentieth-century science” by developing the *Standard Model of Particle Physics* (Oerter, 2006, pages 7, 11).

Philip did say think big!

It took physicists over a hundred years to construct and confirm their *Standard Model*, starting with the seminal work of Nobel Laureate, Ernst Rutherford, in 1911, until what is widely regarded as the crowning moment in the history of the SM, the 2012 discovery of the Higgs Boson.

Who knows how long, if ever, it will take psychologists to build an equivalent theoretical structure? But we can learn a great deal from how physicists went about their work. Perhaps it won't even take as long since I believe we have already made considerable progress in the right direction. That is because we have been using a similar paradigm to Physics since the first half of the 20th century.

During the 1930s Robert S. Woodworth at Columbia University began articulating a Stimulus – Organism – Response (S-O-R) approach to understanding human behaviour. For the particle physics version just plug in *Object* instead of *Organism*.

For simplicity of presentation in the space of a brief journal article let's immediately start thinking of the organism's Personality instead of the entire organism, and try to agree on a minimalist definition of Personality. Over the years there have been hundreds of definitions of personality. So it is easy to get bogged down just trying to define what we are talking about.

My suggestion is to try to reach an initial (perhaps temporary) consensus by using a definition employed consistently from 1946 to 1996 to build what I think can be one of the cornerstones for a consensual Standard Theory of Personality Psychology (STP). This is Structure-Based Systems Theory (SST) named and most fully explained in Cattell (1979, 1980).

The basic definition of personality for SST is:

“Personality is that which permits a prediction of what a person (O) will do (R) in a given situation (S).

Let's proceed with this as a working definition.

The most important word is of course “prediction” for it makes clear that the theory can be evaluated by empirical tests – it is evidence-based.

Turning to a specific example to support the claim that particle physics and personality psychology have been using a similar paradigm, I will focus on Rutherford's seminal discovery of the Proton and compare it to Hans Eysenck's confirmation of Jung's (and others') proposals about the personality factor of Extraversion. It involves a bit of an intellectual stretch, but that is what we are being asked to do here.

Rutherford (with his colleagues Marsdon and Geiger) directed alpha rays (Ss) produced by radon toward a thin sheet of gold (an O) and recorded events (Rs) on a phosphorus-coated detector. When Rutherford observed that some of the alpha rays ricocheted off the gold foil, he compared his surprise to “what it would be like to see a 15 inch artillery shell bounce off a sheet of paper!”

Psychologists like Eysenck have aimed questionnaire items (Ss) at the brains of many different kinds of research participants (Os) and measured how they have responded (Rs) in the form of patterns among the items. Eysenck *et al* have found consistently that some items associate in a manner that is best interpreted as Extraversion – what might be considered the proton of personality psychology.

Rutherford's student at Cambridge, James Chadwick, in 1932 repeated the use of alpha rays (Ss)– this time from polonium – fired at beryllium and paraffin wax (Os), and won his own Nobel Prize for the discovery of patterns on an oscilloscope, which demonstrate the presence of Neutrons.

Eysenck also created questionnaire items (Ss), which he presented to a wide variety of people (Os), and reliably evoked a pattern of responses (Rs) called Neuroticism, which may be thought of as analogous to Rutherford's Neutrons.

Rutherford had earlier hypothesized that, Protons, together with much smaller particles called, Electrons, existed within atoms. The discovery of Neutrons completed the tripartite (PEN) picture of atomic structure that would come to dominate thinking in particle physics for decades. Similarly, Eysenck added another dimension, which he called, Psychoticism. Others have since suggested cogent reasons why Psychopathy might have been a more appropriate term than Psychoticism (Corr, 2010). In either case, Eysenck created measures that led to his

Psychoticism (or Psychopathy), Extraversion and Neuroticism, or PEN, conception of personality. It has played an important role in thinking about the basic structure of personality psychology for a considerable amount of time.

In fact both the PEN models pioneered by Rutherford and Eysenck continue to be useful guides for predicting phenomena in their respective fields.

However, important new developments have occurred with both models.

In particle physics, during the 1930s, several other subatomic particles were discovered, garnering Nobel trips to Sweden for more scientists. The positron and muon were pinpointed using cosmic rays as Ss, and cloud chambers to detect Rs, within hydrogen atoms as Os. After World War 2, technical breakthroughs in the ability to control nuclear reactions produced an explosion of findings in identifying novel subatomic particles. By 1955 Willis Lamb was joking in his Nobel acceptance speech about how he had heard that “the finder of a new elementary particle used to be rewarded by a Nobel Prize, but such a discovery now ought to be punished by a \$10,000 fine.” As if things weren’t complicated enough, within the following decade hundreds of more particles were reported, creating what became known as a veritable “subatomic zoo.”

Fortunately, in 1964, other physicists came to the rescue by proposing the organizing concept of “quarks.” Experimental confirmation of the existence of quarks in 1968 was an extraordinarily challenging effort, but it turned out to be one of the most significant events in establishing a general consensus about the Standard Model of Particle Physics.

It is not possible to go into detail here about all that is now known about quarks except to take note that they are essentially invisible (Riordan, 2018). It took thousands of physicists around the planet working until 1995 to get a glimpse of one of the six quarks that have been discovered, the massive “top quark,” and then for only about 1 zillionth of a second.

Similarly, it has been extremely difficult to replicate quark-like structures, called “source traits” (Gillis & Boyle, 2019) that I believe are important in moving toward a Standard Theory of Personality Psychology.

Section 2 Pursuing a personality consensus via source traits

The main reason it has been a problem to observe quarks is that they are always found in groups of two, or threes, and sometimes even in fives. Rutherford's protons are hadrons comprised of two "up quarks" together with one "down quark" as illustrated in Figure 1.

Figure 1. Protons are hadrons, composed of 2 up quarks and 1 down quark, held together by the strong force carried by gluon particles represented by arrows.

Analogously, as shown in Figure 2, Eysenck's extraversion seems to be made up of at least three source traits, labelled in Structure-based Systems Theory as A (warmth), F (liveliness) and H (venturesome), which have a strong tendency to be found together within the personalities of human beings (Cattell & Nichols, 1972).

Figure 2. Extraversion consists of Factor A, Factor F and Factor H source traits held together by an unknown force or forces (possibly genetic factors such as transcription factors).

Before going further with this analogy, let's pause and consider that extraversion is also an important part of other approaches to personality psychology, notably, the Five Factor Model (FFM) where it lies at the centre of its mnemonic acronym, OCEAN, standing for Open-mindedness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism.

In the PEN system, and the FFM, Extraversion is estimated directly by means of first order factor analyses of questionnaire items, extracting 3 and 5 factors respectively. In contrast, the SST measure of Extraversion is obtained by doing a first order factor analysis of items, and then following it up with a second order factor analysis of the resulting 15 source traits from the initial factor analysis.

Recently I calculated estimates of Extraversion from a sample of 555 "famous people" and found exceptionally clear evidence supporting the equivalence of measures obtained via PEN, FFM and SST methodologies. The results of the SST first order are shown in Table 1.

Table 1

Rotated factor pattern loading of 16PF primary factors

	Factors															
Parcels	A	C	E	F	G	H	I	L	M	N	O	Q1	Q2	Q3	Q4	
A1	45															
A2	57															
A3	61															
C1		52														
C2		88														
C3		66														
E1			80													
E2			70													
E3			72													
F1				78												
F2				61												
F3				75												
G1					40											
G2					62											
G3					72											
H1						79										
H2						71										
H3						96										
I1							77									
I2							89									
I3							75									
L1								74								
L2								75								
L3								55								
M1									77							
M2									82							
M3									67							
N1										72						
N2										53						
N3										97						
O1											75					
O2											78					
O3											64					

	A	C	E	F	G	H	I	L	M	N	O	Q1	Q2	Q3	Q4
Q11												82			
Q12												64			
Q13												56			
Q14												51			
Q21													77		
Q22													99		
Q23													81		
Q31														78	
Q32														88	
Q33														63	
Q41															66
Q42															91
Q43															86

Note: Decimal points and values below 35 were omitted

A file containing the data upon which this analysis is based has been stored in the Harvard Dataverse (Gillis, 2016).

The validity coefficients between the Extraversion measures obtained using the PEN, FFM and SST approaches were:

	PEN	FFM
FFM	.924	
SST	.959	.982

Clearly the PEN, FFM and SST approaches converged upon an identical estimate.

When I calculated correlations between all five of the FFM measures from items, and the five SST second order factors, there was further evidence that the different procedures produced highly similar results:

Open-mindedness	.931
Conscientiousness	.975
Extraversion	.982
Agreeableness	.977
Neuroticism	.958

This evidence of overlap between measures created through the PEN, FFM and SST approaches to Personality Psychology suggests that progress toward developing a consensual model is being made.

Steps toward a consensus may also be seen with SST and Reinforcement Sensitivity Theory (RST).

When Jeffrey Gray (1970) famously altered Eysenck's PEN model by theoretically rotating the Extraversion axis 45 degrees toward the Neuroticism dimension, he began to emphasize the construct of Impulsivity. It happens that within SST, the source trait of Factor Q4 has been interpreted as indicating a strong tendency toward impulsivity, and Factor Q4 has for years been described as a measure of the amount of "ergic tension" a person is experiencing.

In order to understand how the SST concept of ergic tension fits with RST it is necessary to consider briefly two important matters: the idea of *ergs* (Cattell, 1980) and Philip Corr's notions about the process of *sub-goal scaffolding* (Corr, 2008) within RST.

An erg is a word originating in SST to refer to the biologically based forces that energize the behaviour of all organisms. Erg is a term similar in meaning to instincts, needs, and drives. Among the ergs of SST are the pugnacity and the fear ergs that are posited to be centrally involved in the Fight, Flight and Freeze subsystem (FFFS) portion of RST. However, it is in the Behaviour Activation System (BAS) that the *sub-goal scaffolding* process involving ergs, and hence ergic tension, may be seen most clearly to operate. After reinforcement interest (RI) is aroused, and Goal Drive Persistence (GDP) helps keep behaviour moving onward - as indicated by Reinforcement Reactivity (RR) - the intensity of the final step is reflected in differences in Impulsivity (IMP).

Corr and Cooper (2016) have recently created a RST personality test, which has a subscale to measure IMP. This means that an empirical test for a possible link between RST and SST could be undertaken. Impersonators of famous people, be they university students, amazon turks, official biographers, or whomever (as long as they possess expert-level knowledge) would complete the RST personality questionnaire "as if" they were people previously estimated to have exceptionally

high or low of levels of SST ergic tension (Q4), The high and low ergic tension groups would be predicted to score very differently on the IMP dimension.

As a concrete example of both the quark-like nature of source traits, and how a potential connection might be between SST and RST, let's take a look at some the actual scores obtained by "famous people" who were being channelled by university students majoring or honouring in Psychology (for more details about this research see Gillis, 2019). Each line in the following Tables 2 & 3 contains either blanks or letters representing scores produced by one of the participants in the study. A lower case letter indicates a below-average score; an upper case letter signifies an above-average score, while a blank represents an average score.

Table 2. The 10 highest scoring individuals on Factor Q4.

	c	E	F	g		L	M	N	o		q3	Q4		
		E	F	g	H	I		M	N	o		Q4		
	c	E	F	g		L	M	N	o		q3	Q4		
a		E	F	g		L	M	N	o		Q2	Q4		
a	c	E	f	g		L		N		Q1	Q2	Q4		
	c	E		g	H	I	L	M		o	Q1	Q2	Q4	
		E		g		I	L	M	N		Q2	Q4		
a	c	E		g		I	L	M	N		Q2	Q4		
a	c	E	f		h		L	M	N		Q1	Q2	Q3	Q4
a	c			g	h	I	L	M	N		Q2	Q4		

Table 3. The 10 lowest scoring individuals on Factor Q4.

A	C	e	f	G		I	l	m				Q3	q4	
A		e	f			I			n				q4	
	C			G	H		l	m		o		q2	q4	
	C	E	f			i		m		o	Q1		q4	
	C		f	G	H				n	o	Q1	Q2	Q3	q4
A	C		f						n				q4	
A	C					I				o	Q1	q2		q4
A	C		F	g	H	I	l		n	o	Q1	q2	q3	q4
A	C				H	I	l		n			q2		q4
A	C		f		H				n	o	Q1	q2		q4

These Tables illustrate a fundamental feature of source traits – it is rare to find people who score in an extreme manner on only one source trait, in other words you seldom see “naked” source traits. Source traits strongly tend to be embedded within surface traits, just as quarks exist within particles called hadrons, such as protons and neutrons.

As a result, in order to isolate source traits researchers need to use statistical techniques with the power of electron microscopes, and then employ computers to rotate the results into clearer focus.

Neighbours in Chicago often asked Nobel Prize winner, Leon Lederman, what he did at the particle accelerator, Fermilab, where he was the director. He found that the most readily comprehended answer was “Oh, we operate the world’s largest microscope.” In their book, *Beyond the God Particle*, Lederman and theoretical physicist, Christopher Hill, explain how all of Particle Physics, from the work of Rutherford with protons, to the discovery of the Higgs Boson, can be understood as following the paradigm of a microscope, in which Stimuli like light rays are bounced off Objects to detect what Responses occur.

As discussed earlier, Personality Psychology follows a similar paradigm. Here we have Stimuli in the form of questions directed at people (Organisms) who are producing Responses in the form of estimates of expected behaviour by another person. In what I call *LQ* data research, the targets of the stimuli are manipulated from being, the person actually doing the questionnaire, to becoming a famous person. But the overall procedure remains the same.

Similarly, *SST* data might be utilized to investigate the GDP component of RST. Many of the famous people I have studied scored off the charts on Factor E. Many of these high E people seem to have become famous because of their exceptional tendency to persistently pursue goals.

Ironically, it was Factor E that provided a link between papers presented by the founders of RST and SST, Jeffrey Gray and Raymond Cattell at a small professional conference I attended in Banff, Alberta at the *Center for Advanced Study in Theoretical Psychology* (Royce, 1973). In his presentation about *Causal Theories of Personality and How to Test Them*, Gray cited Cattell’s previous finding of a sex difference on the Dominance factor E as clearly displaying the sort of “unrivalled clue to the biological and physiological bases of human personality and social behaviour” that he had sung praises about in previous work (Gray, 1971).

The sex difference in Factor E has been replicated in numerous studies, as have differences with other factors, such as, Factors A (warmth), I (sensitivity), and O (apprehensiveness). These differences have been declining steadily over the years, but the main point is that a SST interpretation is the same as given by Gray in RST. Sex differences, at least partially, seem to reflect underlying biological mechanisms like genetics.

Hence I was not surprised to find that *LQ* data indicated robust sex differences. SST factors were major contributors to a regression equation that predicted about 25% of the variance between sexes. What was fascinating about this result was that two SST source traits - which have been found reliably to be part of the surface trait of Extraversion (Cattell & Nichols, 1972), namely A and H, contributed in *opposite*

directions. Because the scores of Factor A and Factor H were added together when the overall Extraversion score was calculated, it meant that the FFM could only predict about half of the sex variance, 12%. The contributions of source traits A and H were in effect cancelling each other out, suggesting they are under separate genetic control.

SST research dating back to the 1950s, with the introduction of *Multiple Abstract Variance Analysis* (Cattell, Blewett & Beloff, 1955) has suggested, like Gray's RST, that biological mechanisms need to be considered in any causal theories of personality.

Besides having a common outlook on the importance of biology, SST and RST come together in agreeing about the need to distinguish between fear and anxiety. Cattell considered this issue extensively in theoretical writing (Cattell, 1972) as well as in empirical research (Cattell & Bartlett, 1971).

Another area of agreement between SST and RST is adoption of a multifactor approach to learning processes. Hobart Mowrer, whose work had an important influence on RST, came to the University of Illinois as a research professor at about the same time as Raymond Cattell. They were friends for many years and often discussed mutual interests. The impact of Mowrer upon SST is most clearly seen in Cattell's two-volume book focused upon *Personality and Learning Theory* (Cattell, 1979, 1980).

The possibilities for moving toward a consensual Standard Theory of Personality by research studies integrating RST and SST are immense. Reinforcement Sensitivity Theory has stimulated a vast, rich research literature and SST contains an enormous number of potential PhD theses (Gillis, 1982). But there are many other theories that have been developed (too many to cover in a single journal article) which could be integrated into a generally agreed upon consensual approach by continuing to use the S-O-R paradigm that has proven to be so successful in both Particle Physics and Personality Psychology.

In order to engender a collaborative attempt to develop the type of *consensual* paradigm called for by Eysenck (1983) in his Presidential Address to the inaugural meeting of ISSID, I am suggesting we simply continue to follow explicitly the S-O-R paradigm that we have shared with Particle Physics for many years.

Use of an S-O-R, instead of an S-R or R-R paradigm, is essentially what Cronbach (1957) advocated in his article cited by Eysenck about the need for unification of the experimental and correlational branches of psychology.

The parallel use of an S-O-R paradigm in Particle Physics and Personality Psychology may be seen in the following summary of research that has been carried out in each discipline:

Particle Physics

Ss	Os	Rs	Discovery
Alpha rays	Gold foil	Phosphorescent screen	Proton
Alpha rays	Beryllium	Oscilloscope	Neutron
Cosmic rays	Hydrogen	Cloud chamber	Muon
Electrons	Protons	Liquid hydrogen	Quarks
Protons	Antiprotons	LHC (AMOS CMS)	Higgs Boson

Personality Psychology

Ss	Os	Rs	Discovery
MPQ items	Soldiers	Item Patterns	Extraversion
EPI items	University Students	Item Patterns	Neuroticism
EPQ items	Clinical Patients	Item Patterns	Psychoticism
BFI items	Facebook Users	Item Patterns	5 Surface Traits
16PF	Famous People Proxies	Item Patterns	15 Source Traits

In both Particle Physics and Personality Psychology experimental manipulations can be made at each point in the paradigm: the Ss, the Os, or the Rs.

In physics, Stimuli that can be manipulated are alpha rays, cosmic rays, electrons, protons, atoms of lead, et cetera. In personality, Ss that are manipulated may be questionnaires differing in form and/or content. Over many years thousands of questionnaire items have been modified and refined by hundreds of personality psychologists. This enormous collaborative effort has resulted in a vast variety of highly sophisticated instruments being made available.

In physics, the Os targeted by stimuli have been gold foil, cloud chambers of hydrogen, bubble chambers of deuterium and so on. In personality the Os have been widely different samples of people, either drawn from the general population, or neurotics from clinics, psychopaths from prison, Amazon turks, or facebook users. In research described here, the Os were students pretending to be famous people.

Responses in physics can be detected in a variety of ways – from the simple phosphorescent screens of Rutherford to the incredibly complicated Large Hadron Collider (LHC) at CERN in Switzerland. In personality, responses may be collected in an infinite number of ways, from well-crafted rating scales to numerous laboratory tests such as EEGs and fMRIs. The list is endless. I have concentrated here upon questionnaires just for convenience (and hopefully clarity) of exposition.

Overall, at the end of the day (and this article) I believe Oerter (2006, page 275) has summarized the situation incisively,

"As science progresses, new ways of describing the world are invented. If the new paradigm provides a more accurate description, it takes the place of the old. A scientific revolution occurs. In many cases, though, the older theory is not discarded completely, but retained as a useful approximate theory. Newton's theory of gravity, more than 300 years old, is still used for planning rocket launches, satellite orbits, and the paths of interplanetary space probes. Only rarely is it necessary to employ the more accurate description provided by general relativity. Maxwell's electrodynamics equations have been superseded by the equations of QED, but Maxwell's continue to be used, except when dealing with very high energies or the world of the very small. Even if a more complete, more unified theory is discovered, the Standard Model will undoubtedly continue to be used as an accurate, if approximate, theory of particle interactions."

Similarly, in Personality Psychology, earlier conceptions such as Eysenck's PEN approach, and the FFM, need not be discarded. They are still useful approximate theories just like Rutherford's PEN model of the atom. But it is time to move in the direction of a more comprehensive Standard Theory of Personality Psychology (and eventually beyond) by working in an increasingly collaborative manner.

I say "beyond" because a Nobel Prize in Physics was recently awarded to Arthur B. McDonald for his work which indicates that, contrary to predictions based upon the Standard Model of Particle Physics, neutrinos have mass (McDonald, 2015). He did this using the familiar S-O-R paradigm that has served both Physics and Psychology so well. In this work, consisting of a 3-phase experiment, the Ss were neutrinos of different flavours coming from the sun. The Os were: (1) 1,000 tonnes of heavy water worth \$300 million dollars (donated by the Canadian Government for \$1.00), (2) the heavy water with 2 metric tons of salt added, and then (3) heavy water with Helium detectors inserted. The Rs were an array of photo sensors carefully placed in walls of the geodesic dome containing the heavy water.

This neutrino research is another superb demonstration of how the Os of the S-O-R paradigm can be advantageously utilized in order to achieve important results. At the same time it is an excellent example for Personality Psychologists of how to stand on the shoulders of giants, link arms with a huge team of collaborators, and not step on the toes of financial supporters (too often) while thinking big.

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