VIII

The myth of unobservability

1. *A metaphysical unobservability*

Perhaps the most conspicuous feature of the Central Account is the claim that the referent of the concept *latent variate to* ***X*** is "unobservable". As was seen in Chapter III, special terminology, "unobservability talk", has been invented to suggest what is meant by this notion. Thus, the alleged referent is said to be *unobservable*, *unmeasurable*, *not directly measurable*, *underlying*, *hypothetical*, or *theoretical*. The idea of unobservability squares with the tacitly held belief that the referent of *latent variate to* ***X*** is, in some way, entity-like, since the paradigmatic cases of perceptual unobservability pertain to material entities. Now, certainly there are scientific concepts whose referents, for various reasons, cannot be observed by the members of a community of observers. That there exist such entities presents particular kinds of problems for the scientist, and often necessitates attempts to develop instrumentation to render these referents observable. It is commonplace within science to detect and measure the properties and effects of unobservable entities, forces, and phenomena. The referents of the concept *meson* are material entities that cannot be observed by the naked eye, but can be observed with the aid of instruments of observation developed by physicists. That is, the rules that fix the correct employment of the concept *meson* warrant its application to material constituents of natural reality that, without the aid of observational tools, happen to be unobservable to humans.

In contrast, the rules that fix the correct employment of concept *latent variate to* ***X*** warrant its application to random variates possessing certain model specified properties. Variates, however, are merely human created functions, hence, are not constituents of natural reality, and, hence, can neither coherently be said to be unobservable, nor observable. The latent variable modeller is not in possession of a concept (i.e., does not lay down rules that fix the correct employment of a concept) that denotes the members of a class of constituents of natural reality (of a behavioural, material (e.g., biological), or some other nature) that are to be detected. He cannot, then, legitimately claim that his latent variable model is a detector of members of any such class of *unobservable* constituents of natural reality. The latent variable model could not have been, and was not, designed to be a tool of detection of any sort.

The unobservability component of the Central Account does not arise from the latent variable modeller's having to deal with perceptually unobservable constituents of natural reality. It is, rather, a metaphysical doctrine, and this is why unobservability talk is largely incoherent. It will be shown that: i) The unobservability talk of latent variable modeling is granted the appearance of intelligibility through an illegitimate equating of it and true senses of perceptual unobservability; ii) In the absence of a true case of perceptual unobservability, the unobservability story of latent variable modeling degenerates into a frightening array of conceptual confusions; iii) The unobservability that the latent variable modeler believes attends the use of latent variable models is, in fact, a mislabeling of other serious problems, many of them conceptual (definitional) in nature, that arise in social and behavioural scientific work.

2. *The false identification of "unobservability" with true perceptual unobservability*

As was seen in Chapter III, Paul Meehl (1992, p.133) likens the unobservability claimed to attend the use of latent variable models to the unobservability brought about by spatial or temporal remoteness: "...the most persuasive evidence for theories concerning theoretical entities, or events and processes observable in principle but not observed because of spatial or temporal remoteness from the scientist." Dwyer (1983), on the other hand, likens Niels Bohr's inability to observe electrons to the situation faced by the latent variable modeller in his dealings with latent variates. Apparently, as with Bohr and the electron, the latent variable modeller is unable, at least in light of current technologies, to observe existing constituents of natural reality detected in his employments of latent variable models. But such analogies are illegitimate. Electrons *do* exist and are unobservable as a result of their very small size. Latent variable analyses, on the other hand, yield no detected constituents of natural reality whose perceptual unobservability could pose problematic.

Consider several scenarios that involve true perceptual unobservability. These are situations in which, for any of a number of reasons, the referents, γ, of a concept, "γ", cannot, at the moment at which observation is attempted, be observed. Now, as will be clear, these examples involve different brands of unobservability. Several, in particular those involving currently undiscovered referents, might best be given a different description, with the perceptual unobservability label reserved for those cases involving referents known to exist at the time at which observation is attempted.

Scenario i: In his research, Mendel observed certain characteristics of pea seeds, including their textures. Mendel crossbred plants with round seeds and those with wrinkled seeds, and discovered that all of the resulting offspring had round seeds. He hypothesized the existence of a single pair of entities that controlled seed texture. These entities turned out to exist, and came to be known as genes. The gene that controlls seed texture occurs in two alleles: one corresponding to round (smooth) seeds, the other to wrinkled seeds. Pea seeds are round and smooth when they contain the right amount of sugar. If peas are missing the gene that produces a protein called starch branching enzyme 1 (SBE1), the peas make too much sugar, causing the pea seeds to first swell, and then wrinkle and shrivel as they dry. At the time of their discovery, genes were unobservable in relation human visual capabilities, even given the employment of observational aids of the time. Genes were rendered observable with the development of the electron microscope.

Scenario ii: The following is from a correspondence between astronomers Leverrier and Galle.

> "It is impossible to satisfy the observations of Uranus without introducing the action of a new Planet, *thus far unknown* [italics added]... Here are the elements of the orbit which I assign to the body..." (Leverrier to Galle, September 18, 1846, see Grosser, 1962)
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> "The Planet whose position you have pointed out *actually* exists..." (Galle to Leverrier, September 25, 1846, see Grosser, 1962)

Scenario iii: In constructing his version of the periodic table in 1871, Mendeleyev left spaces for several elements (gallium, scandium, germanium) that, at the time, had not been discovered in nature. Mendeleyev hypothesized the existence in nature of these elements on the basis of

theory. Their existences were subsequently verified (i.e., these elements were eventually discovered).

Scenario iv: There was a time when the individual atoms of the element germanium were unobservable in relation human visual capabilities, even given the employment of available instruments of observation. These atoms can now be observed with the aid of computer generated imaging paired with the use of a scanning tunneling microscope. The microscope maps an atomic-scale surface by detecting an electric current flowing from the surface to the point of a fine metal probe.

Scenario v: The air that makes up the troposphere is, itself, unobservable in relation to human visual capabilities.

Cases of perceptual unobservability have to do with the inability of a human observer, relative to a particular observational setup and perceptual modality (paradigmatically visual), to perceive a particular constituent of natural reality. The reason for his inability might be the result of normal limitations inherent to human perceptual capabilities, deficiencies unique to him, or features of the spatial relationship between he and the constituent he is attempting to observe (e.g., a star temporarily occluded by the moon). In a true case of perceptual unobservability, it is possible to classify the unobservable empirical constituent, γ, as a particular kind of entity, force, substance, or phenomena, provide (at least roughly) its spatio/temporal coordinates, state the medium in which it resides, or, if it has, to date, avoided discovery, is likely to reside, and explain *why* it is unobservable, and by what means it might be rendered "observable" (e.g., through the development of instrumentation). This presupposes that it makes *sense* to apply the predicate *unobservable* to γ, i.e., in conjunction with concept "γ", the concept that denotes γ. For the claim that γ is unobservable is coherent only if γ could conceivably be observed. It makes no sense to claim that "hope is unobservable" because the concept *hope* does not denote an entity that could, conceivably, be observed (although people most certainly *manifest* their hopes and desires in their behaviour). Scenarios (i)-(iv) can be broken down as follows:

Scenario i-

What is unobservable: A pair of material entities hypothesized to exist, that, if they exist, determine the texture of pea seeds.
Where: in pea seed matter.
Reason for unobservability: At the time Mendel hypothesized their existence, not observed because they had not yet been discovered. Following discovery, unobservable in relation to human visual capabilities due to the microscopic size of these entities. Eventually rendered observable with the invention of the electron microscope.
The actual location of these entities was eventually discovered to be in pea cell nucleii and chloroplasts.

Scenario ii-

What is unobservable: A material entity, a planet, hypothesized to exist.
Where: in space.

Reason for unobservability: Prior to September 25, 1846, planet had not been observed because, to this point, it had remained undiscovered. Following discovery, unobservable in relation to human visual capabilities due to distance from human observers. Rendered observable with aid of a telescope of sufficient magnification trained on the planets spatial coordinates.

Scenario iii-

What is unobservable: Several elements, gallium, scandium, and germanium, hypothesized, on the basis of theory, to exist.
Where: These being natural elements, in nature.
Reason for unobservability: Upon their discovery, these elements were observable in relation human visual capabilities.

Upon the discovery of scandium in nature, how was it determined that scandium, and not some other element, had been discovered? Answer: The space left for scandium in the periodic table, i.e., between calcium and titanium, functioned as a criterion of application for the concept *scandium*, in that an elements place in the table specifies its atomic weight and other properties that it should possess. The criterion of application for the concept *scandium* provided by Mendeleyev was, roughly, as follows:

Definition: *scandium*. A natural (transition) element whose atomic number (i.e., number of protons in nucleus) is 21, and whose properties resemble those of boron.

Note that scandium need not have existed in nature. Mendeleyev provides a rule for the application of the concept *scandium*, to wit, that the concept is to be applied to an element whose atomic number (i.e., number of protons in nucleus) is 21, and whose properties resemble those of boron. Whether such an element does, in fact, exist in nature is an empirical question, and, hence, a matter for science to investigate.

Scenario iv-

What is unobservable: Atoms are microscopic material entities, the "building blocks of matter".
Where: molecules of germanium.
Reason for unobservability: Following the discovery of germanium, its atoms were unobservable in relation human visual capabilities due to their incredibly small size.
Not rendered observable by standard observational aids (instruments of magnification), available at the time of discovery. Advances in observational aids, and, in particular, the development of the scanning, tunneling microscope (1981), rendered these atoms observable (in the sense that a computer generated representation of these atoms can now be produced).

Scenario v-

What is unobservable: Air
Where: More or less continuously, a gaseous layer surrounding earth.
Reason for nonobservability: "Air" is comprised predominantly of nitrogen (78%) and oxygen molecules (21%), among other substances. Both types of molecule are colourless, odourless, and

tasteless. They are, therefore, unobservable with respect these perceptual modalities, and, as a result, so is air. Nitrogen was isolated by Rutherford in 1772, and oxygen discovered by Priestley in 1774. That is, nitrogen and oxygen molecules were rendered "observable", but in a very different sense of the term, and, notably, not with respect the visual perceptual modality. Of course, the effects of air when it has a non-zero velocity are observable as wind. The Beaufort Wind Scale (1805) is used to measure the velocity of air.

To intelligibly claim that something is unobservable for one reason or another, one must be actually speaking *of* something. If it is claimed that material entity γ is unobservable, the claim is vacuous unless one can provide the rules $r_{"\gamma"}$ of application of concept "γ" that denotes the entity. For these rules settle *what* in natural reality is rightly called a γ, and, hence, what feature of natural reality the unobservability claim is about.[1] In each of the scenarios considered above, one can provide a concept "γ" whose referents γ (planets, molecules, atoms, elements) are, under the conditions of the scenario, unobservable in some particular sense. The concept *unobservable* can, legitmately, be applied in conjunction with the concept "γ" (e.g., the concept *air* denotes a particular mixture of gases. Gas molecules are characterizable by their colour, and collections of colourless molecules can rightly have applied to them the concept *unobservable*). The entities γ, unobservable at present, are understood within the context of theoretical frameworks. Theory and knowledge suggest that the unobservable γ will be found in a certain spatio/temporal location, and in a particular medium (e.g., the pair of material entities that determine the texture of pea seeds will not, for example, be found inside a rock). It makes sense to launch a research program in the hope that instruments will be developed that are capable of rendering the unobservable entities observable.

Latent variable modeling does not involve the detection of constituents of natural reality, and, hence, does not involve the detection of constituents of natural reality whose unobservability could be problematic. Not surprisingly, then, there can be given no account as to what *kinds* of thing are the unobservables alluded to in the Central Account, *why* they are unobservable, *where* they might be located, or *how* one would go about rendering them observable. It was never the case that: i) There was a realization, at some point in the history of the social and behavioural sciences, that the elements of the particular class of referents of the concept *latent variate to* ***X*** (whose denotational role is fixed by some set of rules, say r_{lvx}) existed, but were perceptually unobservable; ii) A diagnosis was made as to why these elements were, in fact, perceptually unobservable; iii) The latent variable model was developed to overcome the diagnosed brand of unobservability. This is not how latent variable models came to be. Merely not knowing what one is talking about when one alludes to "property/attribute (causal source) of the phenomena represented by the manifest variates" in the context of discussing the employment of latent variable models is quite a different matter than having to deal with perceptually unobservable entities. And this is why no attempts have been made to develop special instrumentation to render observable any referent of the concept *latent variate to* ***X***, nor elements of the much referred to "latent realm", and why there appears not the least concern, within the discipline, over this state of affairs. The unobservability portrayed in the Central Account is a metaphysical commitment, an unobservability *in principle*.

3. *Unobservability and the morass of conceptual confusions*

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1 Of course, given a grasp of the rules $r_{"\gamma"}$, the unobservability claim can still, in the end, be incorrect.

The unobservability story of latent variable modeling is not false (for it makes no claims about natural reality), but is, rather, mere nonsense. To give the unobservability story of latent variable modeling the appearance of intellegibility it is falsely identified with true cases of perceptual unobservability. And in the absence of the real stuff, explanation very quickly degenerates into incoherence, the "unobservability talk" documented in Chapter III a prime example. Consider a sampling of this talk.

i. As will be recalled from Chapter III, Lohmoller speaks loosely about how latent variables can be more or less latent. According to him, they can be "unknown", "hidden", "invisible", "undercover", or "unmanifested". Holland & Rosenbaum (1986, p.1524) state that "The manifest variables, which are real or integer valued, can be observed directly while the latent variable is unobservable." Cureton and D'Agostino (1983, p.3) explain that "Factors are random variables that cannot be observed or counted or measured directly, but which are presumed to exist in the population. Because they are not observed or counted or measured directly, they are sometimes termed *latent variables*."

To begin, what sense is there to the claim that a *variable* is unobservable? A variable is merely a function. Functions are rules which map elements from one domain to another, and are created by humans for many different purposes, including for use in various calculi. Constituents of natural reality, notably, material entities, *can* be unobservable. Do these authors intend to assert that variables are constituents of natural reality that happen, as a matter of fact, to be perceptually unobservable in regard a particular observational set-up? Are they asserting that variables are "out there" with the phenomena, entities, and forces that are studied by other sciences? Are the variables studied in the social and behavioural sciences perhaps comprised of quarks? Should they be studied by physicists? And if, rather, these authors intend to make a claim that the *referents* of certain concepts are unobservable, then why do they not actually name the concepts to which they are alluding, explicate rules of employment for these concepts, and descibe, in detail, the natures of their alleged unobservable referents, rather than couch their talk in terms of "latent variates"? The reason, of course, is that they are not dealing with a true case of perceptual unobservability. Their talk is about variates because variates, not perceptually unobservable entities, are the stuff of latent variable modeling.

But, moreover, how does Lohmoller come to toss out as rough equivalents the concepts *unknown*, *hidden*, *invisible*, *undercover*, or *unmanifested* without establishing the equivalence of their rules of employment? In fact, the employments of these concepts, while, in certain cases, running parallel, are by no means identical. The concept *unknown* has many different senses, these generally having to do with a dearth of knowledge. One may assert that "the number of individuals with an IQ greater than 120 is unknown" or "it is unknown whether life exists anywhere other than earth" or "until its discovery in 1882, the cause of TB was unknown". Lohmoller does not make clear the sense he intends for *unknown*. Does he mean to suggest that, in analogy to the cause of TB, the latent variates of a given **X** are *themselves* currently unknown, in which case, science might, at some later date, discover this mysterious brand of function? Or, rather, does he mean to suggest that the referents of concepts somehow associated with these variates are unknown causal sources? Since he deals extensively with random variates, perhaps what are unknown are the values of the parameters of the distributions of certain random variates. Or perhaps he envisions each individual in a population under study as possessing a score on a latent variate, and these *scores* are unknown. The reader is left to guess.

The concept *hidden* also has multiple senses, two of which are clear from the following examples: "The house was hidden from view"; "The keys were hidden by the naughty child". In the former employment, the view of a material object, O, is occluded by a second material object, S. If S were to be removed, the observer would then be able to observe O. Does Lohmoller intend to claim that the problem of latency is that there are material objects obstructing the latent variable modeller's view of the latent variates (entities?) he wishes to see?[2] Certainly, the fact that it is unknown whether *p*, does not imply that *p* is hidden. Conversely, the fact that object A is hidden from view, does not imply that A is unknown (one can know full well that it is one's child who lies hidden behind the playground apparatus). On the contrary, to correctly note that A is hidden from view presupposes that As existence and spatio/temporal coordinates are known. The concept *invisible* is applied in the event that a material entity cannot be seen by an observer attempting to see it, because the matter of which the entity is comprised, under normal conditions visible, has been rendered transparent.[3] The concept *undercover* also has a number of distinct senses. When one states, for example, that "the spider completed its web undercover of darkness", the idea is that certain activities, those leading to completion of the web, were concealed by darkness.[4] If agent Bill is working undercover, then he is working while concealing his identity as an agent. What are the similarities and differences in the correct employments of the concepts *undercover* and *hidden*?

Lohmoller appears to view such issues as unimportant. Yet, in the absence of clarity in regard such issues, it is not the least bit obvious *what* he is intending to claim, let alone whether he is entitled to predicate the concept of *latent variate* with the concepts *unknown*, *hidden*, *invisible*, *undercover*, and *unmanifested*. Hence, for example, it is wholly unclear what could be meant by ascribing the predicates *invisible*, *hidden*, and *undercover* to a variate, the latter being merely a function and, hence, not composed of matter. On the other hand, Lohmoller identifies no class of referents of any distinct concept *latent variate to* ***X***, material or otherwise, to which these predicates *could* possibly be ascribed.

ii. "...the abilities or traits that psychologists wish to study are usually not directly measurable; rather they must be studied indirectly, through measurements of other quantities. We cannot directly measure a person's mathematical ability; we can only measure his performance on a number of mathematical test items... " (Lord & Novick, 1968, P.13). "The measured variables may be considered unimportant in their own right. They are merely taken as indicators of other underlying variables" (Blalock, 1963, p.54)

It is difficult to make out what the "not directly measurable" refrain really means. The idea seems to be that, with respect some population of objects, there exists measurements of, say, *mathematical ability*, but these measurements cannot be known, and must instead be gotten at via measurements taken with respect other quantities. One might begin by inquiring why Lord and Novick feel justified in claiming that "we cannot directly measure a person's mathematical ability". For Lord and Novick to know this, they would have had to have accumulated evidence

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2 If so, why can't research be undertaken to develop a machine to remove these obstructions? Perhaps E.T.S. could develop a psychometric crane to carry out the required work.

3 If the problem of latency is that latent variables are invisible, perhaps E.T.S., under Lohmoller's direction, could work on the development of chemical staining agents capable of rendering elements of the latent domain visible (Perhaps latent entities from the domain of personality would require one type of stain, and those from the domain of intellectual functioning, another)

4 Are latent variates using darkness or some other screen to conceal their activities?

that past attempts to "directly measure" mathematical ability had failed. To have produced such evidence, they would have had to have been able to state the grounds for *judging* whether attempts to "directly measure mathematical ability" do, in fact, yield the desired "measurements of mathematical ability." But to have been able to provide such grounds would presuppose that they were able to cite rules that fixed the senses of the expressions "direct measure of mathematical ability" and "measurements of mathematical ability." For, once again, unless they possessed the capacity to judge whether or not an attempt to "directly measure" did, in fact, yield "measurements of mathematical ability", their claim would lack a sense. But, of course, Lord and Novick did not clarify the senses of any of these expressions, and, in fact, were in no position to do so. Their talk is merely vacuous, and betrays confusions in regard the nature of measurement. In particular, it implies that measurement can be non-normative, i.e., not governed by rules for the production of measurements created and followed by humans for just this purpose, and that measurements are somehow "discoverable" (that the "true thing", mathematical ability, lies behind or under behavioural phenomena). This is akin to claiming that there can be such a thing as naturally occurring conceptual signification, as if it were possible that a set of scores not created *as* measurements of length (i.e., by following rules for the measurement of length) might just happen to be signified by the concept *length*.[5]

English contains a large number of psychological concepts, including trait and ability terms such as *dominant*, *agreeable*, *intelligent*, and *athletic* (and their cognates). Concepts have normative (rule guided) employments. What constitutes the correct employment of a concept is fixed by linguistic rules. As with any rule, linguistic rules are created by humans and are recognized by language speakers *as* standards of correctness in regard the employment of concepts. Certain concepts are embedded in practices of measurements, others are not. Certain concepts refer to material (and other) referents, others do not. The notion that there could exist concepts (e.g., mathematical ability) that signify scores, these scores not produced *as* measurements by humans following rules for the production of such measurements, is, as will be argued later, incoherent. There can be no doubt whether a concept is, or is not, embedded in a practice of measurement. For, in teaching the meaning of a concept that is so embedded, the rules that govern how to measure with respect it are taught, as are the rules that govern the employment of units in which to express measurements taken with respect it. If it is possible to produce measurements of the γ of a class of "objects" that are signified by concept "γ", i.e., if it is possible to produce scores that are signified by a concept "γ" whose correct employment is fixed by rules $r_{"\gamma"}$, then at least some members of the linguistic community whose employment of "γ" is governed by $r_{"\gamma"}$ must *know* that γ is measurable, and must grasp the rules according to which such measurements are produced. For to justify the claim that one has produced measurements of γ, one must be able to justify the claim that the alleged measurements are signified by "γ", and this requires a grasp of the rules of correct employment, $r_{"\gamma"}$. If one can measure at all, then one can measure "directly".

As do so many psychometricians, Lord and Novick misdiagnose the problem that they face. It is not that the measurements of the mathematical abilities of a population of humans "exist", but are "not directly accessible." The problem here has nothing to do with difficulty in measuring, but, rather, that Lord and Novick are unclear about the rules of employment of the concept *mathematical ability*. They literally do not know what they mean by this concept, and this ambiguity is what produces in them the feeling that the meaning of the concept is ineffable, and, as a next step, that it is "not directly measurable" (as if it resides in a hidden domain).

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5 This is a topic we return to in the section on latent variate interpretation.

Capacity and ability terms are ascribed in the third person present-tense mode on the basis of behavioural criteria. A person's mathematical ability is *manifest* in his possessing certain skills and capacities (e.g., the capacity to solve mathematical problems). The manifesting of these skills and capacities is logico-grammatical support for ascribing mathematical ability to another. To clarify what is meant by *mathematical ability* is to clarify the skills and capacities possession of which warrants ascription of the concept to an individual.

On the other hand, what could be meant by characterizing a variate as underlying? The class of referents of a concept might, if they were material entities, be correctly characterized as underlying, e.g., if this term is used as shorthand for "unobservable and causal". A set of variates could, possibly, play the role of indicators of these unobservable agents in the same way that litmus can be used as an indicator of certain chemical reactions. But, once again, variates themselves cannot be causes, and latent variable models have nothing to do with the detection of unobservable causes.

iii. "Each postulates constructs that are not directly measurable and each observes phenomena that manifest these latent constructs but that also exhibit fluctuation due to other factors..." (Lord & Novick, p.14).

Latent constructs, not directly measurable, are also called "hypothetical" (Lord & Novick, p.14) or "theoretical" (Lord & Novick, p.15).

"We use the term "factors" to designate latent variables; the term "variable" (or "test") will *always* designate a manifest variable. The factors are actually hypothetical or explanatory *constructs*" (Cureton & D'Agostino,1983, p.3).

"One major concern in psychology is to define and describe psychological constructs such as a person's anxiety, extraversion, intelligence, or goal orientation. However, such psychological constructs cannot be observed directly. Measurements, tests, and item responses are used as indicators for the respective constructs. A psychological construct is empirically substantiated when it is confirmed by (valid) indicators like observations or tests" (Strauss, 1999, p.19)

Since Cronbach and Meehl (1955) popularized construct validation theory, there has existed in the psychological literature equivocation over the concept *construct*, and this equivocation becomes full-fledged confusion when paired with the conceptual/empirical conflations that are a hallmark of construct validation theory (the latter the result of initial misunderstandings of the empirical realist philosophy on which construct validation was based). Certainly, empirical realist discussions of the concept *theoretical term* (e.g., Tuomela, 1973), from whence construct validity arises, have usually been clear in drawing the distinction between a given term and the unobservable referents the term is alleged to have, these referents, presuming their existence, hypothesized to be causally responsible for a particular set of effects. Not so the psychometrician in his use of *construct*, for he at times speaks as if *construct* should be taken as a synonym for *theoretical term*, and, at other times, as if it is an unobservable constituent of natural reality, something having empirical characteristics. The former sense is implied when *construct* is employed in a manner that is roughly synonymous with the concept *concept*, and when ordinary language psychological concepts are called "constructs". The latter sense is implied in speaking of constructs as having indicators (concepts do not have indicators,

while entities, processes, and properties can (e.g., litmus is used as indicator of acidity, and tracks left in bubble chambers indicate the presence of various sub-atomic particles)) and as having causal roles, and in the use of the metaphor of "...tapping various constructs..."

In their popularization of construct validation theory, Cronbach and Meehl (1955, p.58) claimed that the problem facing the test analyzer was to decide "What constructs account for test performance" and that "... *the meaning of theoretical constructs is set forth by stating the laws in which they occur, our incomplete knowledge of the laws of nature produces a vagueness in our constructs*...We will be able to say "what anxiety is" when we know all of the laws involving it; meanwhile, since we are in the process of discovering these laws, we do not yet know precisely what anxiety is" (Cronbach & Meehl, 1955, p.69). Certainly, concepts are not the objects of laws, nor can they "account for test performance", because they are not constituents of natural reality. The referents of denotative concepts *can* be said to enter into laws and some might, indeed, play causal roles. It is the job of science to study the causal powers of such referents, and to formulate the laws that describe their behaviour. On the other hand, the referents of concepts cannot coherently be said to have *meanings*! It is the concepts that denote such referents that have meanings, and these meanings are manifest in their correct employments.

Constructs are often described as being unobservable or "latent". Various material entities (e.g., neutrinos with respect unaided human visual capacities) can rightly be said to be perceptually unobservable, but *concepts* are neither observable, nor unobservable, for they are not constituents of natural reality. It is noteworthy that sciences that have had to deal with true cases of perceptually unobservable entities have not felt the need to invoke the concept *construct*. The concept *neutrino* denotes entities that are perceptually unobservable to humans without the aid of instrumentation. These entities have properties and enter into laws. But neither facts about properties $\{p_1,...,p_t\}$ of neutrinos, nor laws $\{l_1,...,l_r\}$ describing their behaviour, bear on the meaning of the concept *neutrino*. In fact, the generation of $\{p_1,...,p_t\}$ and $\{l_1,...,l_r\}$ presupposes the capacity to identify entities *as* neutrinos, which, in turn, presupposes a grasp of the meaning of the concept *neutrino* (for the researcher must comprehend to which entities the concept is correctly applied).

If the psychometrician is speaking of constituents of natural reality when he speaks of constructs, "hypothetical construct" might simply mean hypothesized entity, although no special term would be needed to express this idea. If, on the other hand, he is employing *construct* as a synonym for *theoretical term*, then it is not clear why the modifier *hypothetical* would be required, when what is hypothesized to exist is not the term itself, but, rather, a material referent of the term. And, under this interpretation, "latent construct" makes absolutely no sense, since theoretical terms are not material entities, hence, cannot be unobservable, and, hence, cannot be "latent". Regradless, the equivocation over the concept *construct* invites some very confused attempts at explication, examples being the quotes given above.

Both Lord and Novick and Cureton and D'Agostino appear to equate constructs and factors (latent variates). But what do they take to be the terms of this equating? On the one hand, there is the concept *factor to* $\underline{\boldsymbol{X}}$ (*latent variate to* $\underline{\boldsymbol{X}}$), alleged referents of this concept, and the scores that comprise the distribution of the random variate $\boldsymbol{\theta}$ to $\underline{\mathbf{X}}$. On the other hand, there is the concept *construct*, possibly a synonym for *theoretical term*, and, if it be so, the alleged referents of particular of these theoretical terms. What exactly is being equated? Lord and Novick, additionally, equate abilities and traits with constructs, and, hence, with latent variates. They do not bother to sort out whether they are equating concepts or their referents, alleged or otherwise. Finally, note that Lord and Novick go on to claim that latent constructs are

hypothetical and *theoretical*. Hence, all told, they suggest an equating, in some poorly specified way, of the following: traits and abilities, latent constructs, the property of being "not directly measurable", latent variate, hypotheticality, and theoreticality. Consider the comments of Strauss (1999). He speaks of defining constructs, implying that he takes the term *construct* to be a synonym for the concept *theoretical term*. But then, on the other hand, he speaks of *describing* constructs, implying that constructs are constituents of natural reality. Such incoherence arises from tacit commitment to the metaphysical position that is the unobservability component of the CA.

The idea that the psychologist cannot observe his "constructs" directly, expressed in the quote from Strauss (1999), is pseudo-science. If Strauss is attempting to express interest in unobservable causes of behaviour, then he can say so without reference to the notion of *construct*. The idea that psychological *concepts* are unobservable is incoherent. Concepts are neither observable, nor unobservable. If he means that the referents of psychological concepts are unobservable, then he is suffering from conceptual confusion. Psychological concepts, at least the ordinary language concepts that are the foundation of psychology, do not denote entities that could be unobservable. A consideration of their grammars makes it clear that they are instantiated by behaviour, and behaviour is observable. That is why one can coherently speak of observing anger, sadness, intelligence, hope, etc.

iv. "any variable that might be considered to underlie or produce certain behavior or responses" (Edwards, 1957, p.101-106).

"We have already spoken of these measures as indices or hypothetical variables. The usual terminology is *latent variables* or *factors*. We prefer to speak of latent variables since this accurately conveys the idea of something underlying what is observed" (Bartholomew & Knott, 1999, p.2)

"It is the object of factor analysis to represent a variable z_j in terms of several underlying *factors*, or hypothetical constructs" (Harman,1960, p.14).

"The smaller set of variables [factors] can be used as operational representatives of the constructs underlying the complete set of variables" (Gorsuch, 1983, p.4)

"...The responses are said to covary because they are all mediated by the same hypothetical variable" (Green, 1954, p.335).

"...views factors as variables that mediate between S (stimulus) inputs and R (response) outputs in psychological data" (Rummel, 1970, p.20). Although the mechanism through which these causes operate may be unknown, the factors will delineate the phenomena that are involved" (Royce, 1963, p.20).

This series of quotes is a stew of inexplicably equated concepts. Harman, for example, equates *factor*, as employed within the domain of latent variable modeling, with *hypothetical construct*. But how can this make sense? For, if, according to Harman, *factor* is akin to *hypothetical construct*, and *hypothetical construct* is akin to *theoretical term*, then this would imply that the equations of factor models involve theoretical terms (concepts akin to *phlogiston*,

neutrino, *alpha particle*), which is patently false. *Concepts* (*terms*) are certainly not contained in sets of equations, but, rather, in language. If, on the other hand, a factor is akin to a hypothetical construct, and a construct is a constituent of natural reality, then the symbol **θ** which appears in the equations of the factor model, would denote a particular constituent of natural reality, and the factor model would represent the relationship between this feature of natural reality and the phenomena represented by the manifest variates. But this too is false. No rules of correspondence are layed down to establish correspondence relationships between the symbol **θ** which appears in the equations of latent variable models and particular constituents of natural reality, underlying or otherwise.

Once again, the latent variable modeller has never clarified what he means by *underlies*, unless, as was ventured in Chapter III, he means to employ the term as a synonym for *unobservable cause*. But then, certain material entities, forces, and other natural phenomena, not variables, can rightly be said to be unobservable causes. A variable cannot sensically be said to be unobservable, nor can it be said to "produce certain behavior or responses". It is simply a function created by humans for any of a wide variety of purposes. Finally, in regard Royce's claims, one might simply ask on what basis Royce can assert that a set of hypothesized causes are "delineated" (marked) by a set of factors from a factor analysis. How is it that a set of *unknown* causes, on the one hand, can be said to be signified by the concept *common factor to* ***X***, on the other? By what magic is this denotational linkage established? Certainly, to date, no one working within the field of latent variable modeling has succeeded in publishing the incantation by which such linkages are established.

v. "The present approach is to consider factors as constructs that will, hopefully, aid in theory development. Constructs are always abstractions from data and never observed" Gorsuch (1983, p.259)

Now, how is "construct", interpreted as either a synonym for *theoretical term*, or as a consituent of natural reality, "an abstraction from data and never observed". How does this make any sense? The predicate *unobservable* is properly applied to an existing (or, possibly, hypothesized) entity that, for one reason or another, is perceptually unavailable. What does Gorsuch mean by "abstraction from data", and how does the application of *unobservable* follow from something being an abstraction from data? Certainly, existing material entities, which *can* be unobservable, are not "abstractions from data".

vi. "Since all latent variables correspond to concepts, they are hypothetical variables. Concepts and latent variables, however, vary in their degree of abstractness. Intelligence, social class, power, and expectations are highly abstract latent variables that are central to many social science theories. Also important, but less abstract, are variables such as income, education, population size, and age. The latter type of latent variables are directly measurable, whereas the former are capable of being only indirectly measured" (Bollen, 1989, p.11);

"If a concept is directly caused or influenced by any of the other concepts, it is classified as endogenous..." (Hayduck, 1987, p.88).

A concept is neither observable nor unobservable. It is not an entity that occupies space and is characterized by a gravity and inertia[6]. Concepts, not being elements of natural reality, do not cause one another. A concept is an element of a language. Its correct employment is fixed by linguistic rules. Certain concepts signify material entities, and these entities can, in a variety of senses, be characterized as observable or unobservable. When the members of the class of referents of a denotative concept happen to be unobservable, it is possible to describe where these referents are located, what kind of entities they are, why they are unobservable, etc. It is interesting to ponder on how Bollen would go about justifying his equating of *concept*, *construct*, *hypothetical variate*, and *latent variate*, not to mention his claim that "concepts and variates", the latter merely functions, vary in their degrees of abstractness. Certainly, however, his belief that important concepts such as *intelligence* are "abstract" is a mislabeling of the fact that such concepts have complicated grammars (a topic to be discussed in detail in Chapter XII).

vii. As seems to be the wont of certain statisticians, Basilevsky begins his book *Statistical factor analysis and related methods: Theory and applications* (1994) by chastising the discipline of statistics for its lack of attention to latent variable modeling, and suggesting that psychologists were to blame for creating the impression that "...imposing a particular set of values and terminology was part and parcel of the models." The implication is that statisticians such as he have finally arrived to clear up the mess and set the practice of latent variable modeling on a rigorous footing. However, as a result of Basilevsky's inability to stear clear of CA induced confusions and incoherences, this promised rigour fails to materialize. In the preface alone, the following quotes can be found:

"...the variables we identify with the factors are almost never observed directly. Indeed, in many situations they are, for all practical purposes, unobservable" (p.xi)

"This raises a question concerning exactly what factors do estimate, and whether the accompanying identification process is inherently subjective and unscientific" (p.xi)

"The second major objection encountered in the statistical literature concerns the interpretation of factors as actual variables, capable of being identified with real or concrete phenomenon. Since factors essentially represent linear functions of the observed variables (or their transformations), they are not generally observable directly, and are thus at times deemed to lack the same degree of concreteness or authenticity as variables measured in a direct fashion" (p.xii)

"...whether factors correspond to real phenomena is essentially an empirical rather than a mathematical question." (pp.xii-xiii)

With respect to the first quote, it is not at all clear what Basilevsky means by the expression "the variables we identify with the factors." A factor to $\underline{\mathbf{X}}$ *is* a random variate. It is an element of set *C*. When a given $\underline{\mathbf{X}}$ is described by the linear factor model, what, then, are these further variables that are brought forth to be identified with the factors to $\underline{\mathbf{X}}$? The second

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6 If the latent variable modeller would like to argue otherwise, then let him provide some *evidence* (perhaps photographs or radar images) to support his claim that there exists a class of constituents of natural reality that also happen to be the concepts of language!

quote betrays Basilevsky's commitment to the CA mythology that the linear factor model is a detector, and suggests that what he means to say in the first quote is "the phenomena we identify with the factors." For, once again, variates, functions as they are, are not constituents of natural reality, and, hence, are neither the objects of scientific inquiry, nor of tools of detection. Evidently, Basilevsky has strayed into full-blown incoherence when he expresses, in the first quote, the belief that a variate can be unobservable. It makes no sense to describe a function as being unobservable. Since the factors to **X** are, indeed, variates, factors to **X** cannot coherently be described as either observable or unobservable.

It is equally unclear what Basilevsky means when he expresses concern over whether factors are "actual variables, capable of being identified with real or concrete phenomenon." Clearly, from their role in the equations of the linear factor model *as* random variates, the factors of the linear factor model are "actual variates" (is there a such thing as a variate that is not actually a variate?). They can be nothing but. The next part of the quotation, however, is, once again, the Central Account speaking, the desire being expressed that, somehow, the linear factor model is a tool of detection, and that the "actual variates" contained in the equations of the model correspond to "real or concrete phenomena." But this is just mythology. The final part of this quote sees statistician Basilevsky slipping between technical statistics and metaphysics. One can take a realization of a linear function of a set of random variates (or their transformations), and one has then taken an observation. But, once again, such linear functions are not objects of natural reality, and, hence, are not coherently described as "not generally observable directly." Functions of sets of random variates can neither coherently be described as observable, nor unobservable. Finally, *variables* are not measured at all, let alone in a direct or indirect fashion. Various properties of objects and phenomena can be measured. Variables are created for many purposes, among these, to represent populations of measurements.

Finally, Basilevsky's claim that "...whether factors correspond to real phenomena is essentially an empirical rather than a mathematical question" is preposterous. The factors of a given set of variates **X** are variates. A variate can rightly be said to "correspond" to a given phenomenon if it has been *created* to represent, in some way, the phenomenon. Such representational relations are established through the antecedent laying down of rules of correspondence: e.g., the score of object j on variate X is the radioactivity of object j as measured by a Geiger counter. To know whether a variate "corresponds to a natural phenomenon" is to know whether it was created in accord with an antecedently stated rule of correspondence. There is nothing that further empirical research could possibly say about whether or not this was the case.

4. *The misdiagnosis at the heart of unobservability talk*

Spearman reacted to the difficulties he was having in coming to grips with the concept *intelligence* by developing linear factor analysis. He failed to recognize that his difficulties originated in his lack of a clear account of the normative employment of this key concept, and that the resolution of this conceptual problem was a precondition to the solution of the empirical issues that were of interest to him, notably, the role of intelligence as a determiner of a range of empirical phenomena. The latter question is, *potentially*, open to scientific investigation, but, until it is resolved what features of natural reality are signified by the concept *intelligence*, must remain beyond the grasp of science. While other sciences struggle to resolve the conceptual problems whose resolutions are a precondition to fruitful empirical work, the social and

behavioural sciences have either wholly side-stepped these issues, or recast them as bogus empirical problems. The unobservability story of latent variable modeling is an example of the recasting of a conceptual problem as a bogus empirical problem. It arises as follows: i) For the most part, empirical work in the social and behavioural sciences focusses on phenomena denoted by ordinary language psychological concepts; ii) The grammars (meanings) of ordinary language psychological concepts are notoriously difficult to come to grips with; iii) This conceptual difficulty produces in the researcher the belief that psychological concepts must, somehow, be ineffable, and, finally, that psychological concepts denote unobservables. For example, as was noted in Chapter III, Lazarsfeld comments on the seeming existence of psychological concepts that are "vague", "ill defined", and "fuzzy at the fringe", and explains this state of affairs as one in which an unobservable essence lies behind mere symptoms.

Empirical work in the social and behavioural sciences rests on the web of psychological concepts contained within the English language. The concepts of *hope*, *thought*, *dominance*, *intelligence* (*sharp*, *dull-witted*, *rapier-like witted*, *brilliant*, *etc.*) are ordinary language concepts, and the capacity to conceptualize psychological phenomena (i.e., to employ the array of psychological concepts contained in the English language) is precisely what motivated the development of the various social and behavioural sciences. Psychology, for example, did not begin, as did, say, mechanics, with the creation of a set of foundational technical concepts. It lept straight in to describe and explain such everyday psychological phenomena as feelings, perceptions, sensations, intelligence, mental imagery, depression, anguish, sadness, etc., this phenomena denoted by the ordinary language concepts employed by the man on the street.[7]

The problem faced by the behavioural and social scientist is that the psychological concepts that denote and organize his work are some of the most difficult to come to grips with: "Our grammar is above all lacking in surveyability...Moreover, some segments of our language, e.g., psychological terms, present greater barriers to the achievment of a proper surview than others, e.g., terms in mechanics...Grammar is not embodied in a static instantly surveyable medium, but is the structure of our dynamic linguistic practices" (Hacker, 1986, p.152). In contrast to the technical concepts of other sciences, the rules of employment of the ordinary language psychological concepts on which the social and behavioural sciences are founded are not of the necessary and sufficient variety. Psychological concepts have complicated, diffuse, and varied criteria of instantiation, and this is highly problematic for the social or behavioral scientist attempting to study phenomena denoted by these concepts. What is required is either the careful explication of the grammars of these concepts, this requiring a great deal of skill, or the formulation of novel technical concepts, this requiring the actual laying down of rules to fix the meanings of these new concepts.

But the social and behavioural scientist has taken neither of these paths, for he has not yet diagnosed correctly the (conceptual) *nature* of the problem he faces in attempting to investigate phenomena denoted by ordinary language psychological concepts. As a result, the "solutions" he has devised have, time and again, passed by the problem he truly faces. Thus, for example, it was popular to offer up operational definitions in an attempt to pin down what was meant by terms such as intelligence, attitude, desires, etc. But, as will be discussed later in some detail, this practice was equivalent to laying down technical definitions right over top of the normative employments of ordinary language psychological concepts, and then ignoring these technical definitions in favour of the ordinary language employments that are logically tied to the

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7 If the truth were otherwise, psychology would have had no need to invoke ordinary language concept labels in the first place.

phenomena actually of interest. Thus, Green (1954) apparently assigns the ordinary language concept *attitude* the technical sense "...a hypothetical or latent variable, rather than an immediately observable variable" (Green, 1954), and, yet, his entire discussion presupposes a grasp of the ordinary language employments of the concept. The product of operationism was, then, confusion in regard the concepts that actually were organizing and denoting the empirical work, and, as a result, confusion in regard the phenomena under study. Another "solution" was construct validation theory, which, as will later be discussed, is predicated on deep confusions over the relationship between the conceptual and empirical facets of scientific investigation.

And yet another reaction was to misdiagnose the problem of a complicated conceptual foundation as being a case of the ineffability of the meanings of ordinary language psychological concepts, and to blame this ineffability on the unobservability of the psychological phenomena denoted by these concepts. One can detect this line of reasoning in many contributions to the latent variable modeling literature. Consider the following quote from Everett:

> Certain concepts in the social and behavioural sciences are not well defined and there are many discussions over the real meaning of terms such as *social class*, *public opinion* or *extrovert personality*. Such concepts are often referred to as *latent variables*, since they are not directly observable even in the population; they are essentially hypothetical constructs invented by a scientist for the purpose of understanding some research area of interest, and for which there exists no operational method for direct measurement. Although latent variables are not observable, certain of their effects on *measurable* (manifest) variables are observable, and hence subject to study (Everitt, 1984, p.2).

Thus, according to Everitt, the fact that, say, the concept *extrovert personality* is "not well defined" implies that it is a latent variable, and is "not directly observable". It is not clear why Everett believes that a scientific community's lack of clarity in regard the correct employment of one of its concepts implies that the concept (its referent?) is perceptually unobservable or hypothetical (does this mean hypothesized, but, heretofore, undiscovered?). How can Everitt sensibly imply the existence of a referent of a concept when he lacks an understanding of the grounds of application of the concept? And, finally, how can concepts that are "not well defined" play a useful role in a scientist's empirical investigations? Concepts denote phenomena of interest, the foci of such empirical investigations, and if, indeed, they are not well defined, then their grounds of application are unclear, and, hence, so too the foci of investigation. The scientist is then not lacking in his understanding of particular empirical phenomena, but, rather, he is lacking in empirical phenomena *to* understand. He simply does not know what phenomena he should study in studying, say, extrovert personalities. But there is yet another issue tied into these misunderstandings. It is the belief that to clarify the meaning of a concept is to provide necessary and sufficient conditions for the concept's application. By this standard, psychological concepts do not have meanings, and, hence, *must* be viewed as "not well defined". But this conclusion is the result of a false premise, to wit, that the meanings of all concepts are fixed by necessary and sufficient conditions. In fact, as was discussed earlier in this chapter, the rules of employment of ordinary language psychological concepts come in astonishingly diverse forms, and, notably, are never of the necessary and sufficient condition variety.

In other areas of science, scientists struggle long and hard to clarify the concepts that lie at the foundation of their disciplines, and to remedy the conceptual muddles that threaten to

undermine their empirical investigations. They do not recast conceptual confusions as cases of unobservability, nor string together fanciful metaphysics centered on this concept. In light of the circularity of Newton's definition of *mass*, Mach (1960) spends roughly forty pages analyzing *why* it is circular, explaining why such poorly created concepts cannot provide a reasonable basis for scientific investigation within physics, and offering an alternative definition that removes the circularity. One of Einstein's many contributions to physics was to point out the confusion that existed in regard the physicist's employment of the concept *simultaneity*. Essentially, he pointed out that the standard employment of the concept was unproblematic for events occurring at close proximity, but breaks down in the case of events occurring at a great distance from each other (Waismann, 1965).

Green (Green, 1954, p.727) states that "To obtain a more precise definition of attitude, we need a mathematical model that relates the responses, or observed variables, to the latent variable" and that "[concepts are] hypothetical variables [that have] been called *traits*, *intervening variables*.., *latent variables*...,*genotypes*..., and *factors*..." (p.725). Here, Green mistakes the need for a clarification of the employment of the concept *attitude* as the need for a mathematical model containing latent variates. There could not have been a more misguided attempt at solving a problem. For, while the problem calls for a clarification of the rules of employment of the ordinary language concept *attitude*, a difficult task indeed, what Green offers instead is the lazy subsitution of a symbol in a set of equations in place of the real thing, i.e., the concept *attitude* and the behavioural phenomena it denotes.

The unobservability the latent variable modeller believes attends his work with latent variable models has nothing to do with the perceptual unobservability that is sometimes a characteristic of observational setups involving, e.g., material entities and forces. It is a mislabeling of the real problem he faces, namely, that he does not know how to apply such concepts as *property of the phenomena represented by the manifest variates*, *attribute of the phenomena represented by the manifest variates*, and *causal source of the phenomena represented by the manifest variates*. He either fails to lay down rules of employment for technical concepts, or abdicates his responsibility to clarify the normative employments of the ordinary language psychological concepts that enter into his work. His conceptual confusions he misportrays as "unobservability". The corrolary of this misportrayal is his belief that observability is the holy grail that delivers conceptual unproblematicness, e.g., that there would exist no problems in regard the employment of the concept *anxiety*, if only the concept signified a class of, say, observable material entities. But this too is misguided, for if the concept *anxiety* did signify observable material entities, one would still need to be clear about its rules of correct employment, for these rules would then fix the material entities too which the concept could rightly be applied.

The source of these confusions is confusion over the boundary between conceptual and empirical issues. If the members of a class of referents signified by a concept are perceptually unobservable, then this can cause difficulties for empirical investigations aimed at describing and explaining these referents (as the unobservability of viruses did in the case of the search for the cause of the common cold), and can necessitate the development of various sorts of instrumentation to render these entities observable (as with the development of track detectors in physics). But whether or not the concept that denotes these entities is conceptually problematic for a scientific community rests solely upon the soundness of its grasp of the linguistic rules that govern the employment of the concept. The observability or unobservability of the elements, γ,

of the class of referents of a concept, "γ", has no bearing on the *meaning* of "γ", i.e., the rules that govern its employment, nor on one's likelihood of grasping this meaning.