Appendix 1

KNOWLEDGE: TYPES AND METHODS OF ACQUIRING

A 1.1   Introduction

There is a distinction is made between the terms *information* and *knowledge*, despite them being frequently used to mean the same thing in common parlance[1]. Knowledge is considered to be *a theoretical or practical understanding of a subject* (AOED); a coherent understanding of a way accepted facts about the subject relate to each other[2], whilst *information* is used to mean items of communicable knowledge (ideas). *Knowledge* is considered to be *a theoretical or practical understanding of a subject* (ACOD); a coherent understanding of a way accepted facts about the subject relate to each other. Accepted facts contribute to *truth,* that can be understood, after Fromm (1947: 238), to mean a functional approximation to reality; itself understood to be relative to an accepted body of knowledge. Descriptively, the term *knowledge* implies that its content is meaningful, 'acknowledged', and veridical. Strictly, an individual *S* knows a proposition *P* only if *S* believes *P* and *P* is true. If P is false, *S* does not know *P*, even though *S* might know that they *believe* that they know *P*. However, Truth is currently acknowledged to have multiple, and developing, ontologies.

This appendix outlines the major methods of acquiring knowledge. It does not account for the *reasons* an individual, or community, or culture use one method, or mixture of methods, rather than another, in a particular circumstance. Also, whilst it is not an historical account of the *getting* of knowledge, the methods are presented in an order which reflects the occidental procession from a reliance on authority and revelation as the principle source, stimulated by occasional revelatory experiences, to individual discovery that is verifiable by others, whether through intuition or more formally, through inference.

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[1]   Especially in English, where the Anglo-Saxon distinction between *witan* ('wit') and *cnawan* ('to know') barely survives. The distinction remains, in German, for example, with *wissen, kennen, erkennen* and in French, with *connaître* and *savoir*. Seen Chapter 3 Footnote 17 which relates 'wit' to the Greek *eide*.

[2]   Accepted facts contribute to 'truth' that can be understood, after Fromm (1947: 238), to mean a functional approximation to reality; itself understood to be relative to an accepted body of knowledge.

In an age when many thinkers were still wrestling for intellectual[3] independence from the dominance of the church in matter of knowledge, understanding and wisdom, the eighteenth century philosopher Immanuel Kant considered understanding to arise rationally:

> Understanding may be regarded as a faculty which secures the unity of appearances by means of rules and reason as being the faculty that secures the unity of the rules of understanding under principles. Accordingly, reason never applies itself directly to experience or to any object, but to understanding, in order to give to the manifold of knowledge of the latter an *a priori* unity by means of concepts, a unity of which may be called the unity of reason, and which is quite different in kind from any unity that can be accomplished by the understanding (Kant 1787/1929: 303).

Contemporary methods in scientific research, and particularly if they involve interdisciplinary practices, are usually an evolving mixture, and Reliabilism is seen to be a reasonable account of the methodology many contemporary practices, including many that are described by their users as empirical.

A.1.1.1 The logic and psychology of knowledge

There is a frequently confused epistemological distinction between the *logic* of knowledge that is concerned with logical relations, and the *psychology* of knowledge that deals with empirical discoveries, about which Immanuel Kant was clear:

> It is of the utmost importance to isolate the various modes of knowledge according as they differ in kind and in origin, and to secure that they be not confounded owing to the fact that usually, in our employment of them, they are combined. … It must be admitted, however, that the two elements of our knowledge -- that which is in our power completely a priori, and that which is obtainable only *a posteriori* from experience -- have never been very clearly distinguished, not even by professional thinkers and that they have therefore failed to bring about the delimitation of a special kind of knowledge, and thereby the true idea of the science which has preoccupied human reason so long and so greatly (Kant 1787/1929: 660). [4]

Called psychologism, Karl Popper made the same point, more than a century-and-a-half later:

> The initial stage, the act of conceiving or inventing a theory, seems to me neither to call for logical analysis nor to be susceptible of it. The question how it happens that a new idea occurs to a man … may be of great interest to empirical

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[3]   The noun use of the term *intellectual* for persons arose at this time (ACOD).
[4]   By *professional thinkers* Kant is referring to Lock and Hume, neither of who make the distinction.

psychology; but it is irrelevant to the logical analysis of scientific knowledge (Popper 1959/1972: 31).

Different methods of acquiring knowledge provide access to different *types* of knowledge and need not be employed in mutual exclusion. For example, empirical science, as practiced, increasingly relies on authority in the form of peer review as well as observation, and intuition can play a large part in deciding which possible consequences to use inductively. From a deductive perspective, abduction is a logical fallacy, yet it has proved to be a successful method in artificially intelligent agents' interaction within their environments and is now considered by some to be at the root of human perception and cognition.

A 1.1.2   Explicit and implicit knowledge

There is a further epistemological distinction between explicit and implicit knowledge; between *knowing-that* (2+2 = 4; Tuesday follows Monday etc) and *knowing-how* (to play the violin; ride a bicycle etc). The distinction can found in the Greek distinction between *episteme* (theoretical truth) and *tekhne* (practical methods for effecting results). By the time the Latin Scholastics of the Middle Ages had rediscovered the Greek language and the philosophy of Aristotle, the term 'science' had come to imply both, differentiated as the theoretical sciences[5] (philosophy) and the manual arts[6] (practice).

Explicit knowledge is also known as *declarative*, *descriptive* or *propositional* knowledge. Such knowledge is usually acquired reflectively by logical reasoning, mathematical proof and scientific methods, or by reference to historical or cultural practices. By the time Descartes formulated his theory of the separation of the mind or soul (*res cogitans*) and the 'extended' world outside it (*res extensa*), now known as Cartesian Dualism, the mind was clearly thought of as the seat of reason, God and the sacred, while the body was a fleshy machine and clearly inferior, or at least secondary. This attitude began to change slowly through a philosophical 'bottom up' exploration of

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[5]   In its oldest sense (c.1300), 'science' meant knowledge (of something) acquired by study, also a particular branch of knowledge, from O.Fr. science, from L. scientia knowledge, from sciens (gen. scientis), prp. of scire to know, probably originally to separate one thing from another... Main modern (restricted) sense of body of regular or methodical observations or propositions ... concerning any subject or speculation is attested from 1725; in 17c.-18c.; this concept commonly was called philosophy. (OLED).

[6]   *ars*, from the Greek *artios* 'a complete skill as a result of learning or practice'.

the relationship between sensation and knowledge of the world, culminating in Kant's *transcendental idealism* as a way of resolving the idealist's dilemma of how true knowledge of the world was possible with the obvious success of empirical methods.

In an historically common 'spectator view' of knowledge, human experience is primarily a matter of contemplation. The American humanist philosopher Corliss Lamont suggests that this position is largely derived from an overemphasis on the role of vision. Further, he emphasizes the location of truth with respect to such knowledge:

> [W]orkability is the *test* of a truth, not the *source* of it. The truth of an idea does not lie *in* verification; we are able to prove it true *through* verification. An idea is true *if* it works, not because it works; for it already *was* true and corresponding to objective reality. New truths lie all about us waiting to be discovered by persons wielding scientific techniques; but the process of discovering does not *make* ideas true (Lamont 1949/1997: 243).

The polymath Michael Polanyi thought that non-explicit *know-how* type knowledge is 'tacit' in that it is *embodied* and cannot be fully described in words. Attempts to perform such analyses are often laborious, difficult and 'destructive' (Polanyi 1966). The fact that we know more than we can clearly articulate contributes to the conclusion that much knowledge is passed on tacitly by practical means. In such an operational approach to knowledge, truth is functional; an idea or hypothesis is true if and while it works.

A 1.2 Methods of acquiring knowledge

Knowledge acquisition, the process of gaining knowledge from information, can be understood as the integration of new information into that which is already coherently embodied. Considered in this way, the trans*form*ation of in*form*ation into knowledge is an internal process–whether to an individual, a group or a community, and while there may be sonification techniques to enhance that process[7], they lie outside scope of the current thesis. What follows is a pragmatic summary of different modes of knowledge acquisition. With the exception of Reliablism, so apt an epistemological description of current scholarly practice, most of its contents are widely understood, especially from an individual point–of–view.

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[7]   Such as those used to enhance learning by entraining the brain's beta frequencies.

A 1.2.1   Authority

Leaders, considered knowledgeable and wise, decide what is true for everyone, sometimes during periods of special inspiration, insight or perhaps revelation. The surrender to authority is common in most arenas of human endeavour. It acts to stabilise and encapsulate a corpus of traditional knowledge against which new ideas can be tested.

A 1.2.2   Revelation

Revelation is a method is often when seers and prophets employ magic and divination techniques. What is usually assumed is that the practitioners have ability to access knowledge through inspired communion with supernatural being(s); such access usually requiring mindful techniques such as faith (belief) sometimes induced by body renunciation techniques.

A 1.2.3   Intuition

Intuition is the direct, immediate and certain apprehension of truths without the intervention of conscious reasoning or related sensory perceptions. The difference between intuition and a revelation is the person doing the intuiting does not assume that the source of the knowledge is external to workings of their own brain.

A 1.2.4   Heuristics, folklore and commonsense

The generalizations we apply in everyday life in predicting and explaining each other's behavior, often collectively referred to as *folk psychology*, is both remarkably successful and indispensable. A person's 'personal knowledge', what they believes doubt, desire, fear, etc. is a highly reliable indicator of what they will do, and we have no other way of making sense of each other's behavior than by ascribing such states and applying the relevant generalizations. This theory of knowledge is also known as *intentional realism*[8], which recognizes that we all, in some way, committed to the basic truth of commonsense psychology and, hence, to the existence of the states its generalizations refer to (Dretske 2000). Some, such as Fodor, also hold that commonsense psychology will be vindicated by cognitive science, given that

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[8]   For an extended description, See http://plato.stanford.edu/entries/ mental-representation/

propositional attitudes can be construed as computational relations to mental representations (Fodor 1987).

Churchland (1981) thinks that, as a theory of the mind, folk psychology has a long history of failure that can't be incorporated into the framework of modern scientific theories, including cognitive psychology. He argues that the states and representations folk psychology postulates simply don't exist; that it is comparable to alchemy and ought to suffer a comparable fate. On the other hand, Dennett (1987) seems prepared to admit that the generalizations of commonsense psychology are true and also indispensable, but denies that this is sufficient reason to believe in the entities to which they appear to refer. He supports this stance on that basis that there is nothing more to having a propositional attitude than to give an intentional explanation of a system's behavior by adopting an the *intentional stance* toward it. Assuming a system is is rational[9], if the strategy of assigning contentful states to it and predicting and explaining its behavior is successful, then the system is intentional and the generalised propositional attitudes we assign to it are true (Dennett 1987: 29.)

A 1.2.5 Inference

Inference is a term covering a number of forms of reasoning in which conclusions are drawn or judgments made on the basis of circumstantial evidence and prior conclusions rather than purely on the basis of direct observation or knowledge arrived at by direct observation. The conclusion may be correct, incorrect, partially correct, correct to within a certain degree of accuracy, or correct in certain situations. Five distinct inferential methods are recognised: deduction, induction, Bayesian inference (which is really a form of induction), abduction and reliability. Inferential methods are the principal methods of science, although not all types are undisputedly considered applicable to all fields of inquiry.

A 1.2.6 Deductive inference

A way of reasoning in which a collection of ideas is built into a coherent whole through the rigorous deductive application of certain axioms or

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[9]   Something is rational if behaves in accordance with the truths and falsehoods afforded by its environment.

postulates using propositional, predicate, modal, and/or fuzzy logics (Lemmon 1965, Hunter 1971, McNeil and Freiberger 1993). The appeal to deductive reason (syllogism) as a source of knowledge or justification is known as rationalism. Strictly, rationalism submits neither the original propositions, which may be selected through intuition, nor final conclusions, to experimental verification. Two important philosophers of the European Age of Reason (seventeenth century) were Descartes and Leibniz, who, after Plato and Spinoza, considered knowledge of eternal truths, including the epistemological and metaphysical foundations of the sciences and mathematics, could be attained deductively, i.e. syllogising without recourse to inference from any sensory experience.

<u>Summary</u>
If *a* then *b.*   [*b* is a consequence of the assumption of antecedent *a*].

A 1.2.6.1   Inductive inference

A form of reasoning that makes generalizations based on individual instances. It is used to ascribe properties or relations to types based on observed instances; to formulate laws based on the results of a limited number of experiments or the direct observations of recurring phenomenal patterns. In its rudimentary form, it is the process of learning through trial and error experience. In connection with the natural and social sciences, empiricism refers to the use of working hypotheses that are testable using observation or experiment. The doctrine of empiricism is discussed in more detail in §3.3.2.1.

<u>Summary</u>
• Simple: All observed *a* are *b*, therefore all *a* are *b*. (enumerative induction).
• Proportional: P(*g*), a percentage of known *g*'s in group *G*, have attribute *A* Individual *i* is another member of *G*, therefore there is a P(*i*), corresponding to P(*g*), that *i* has attribute *A*
• Analogic: *a* is similar to *b*. *a* has attribute *X*, therefore *b* has attribute *X*.

A 1.2.6.2   Bayesian inference

Bayesian inference is a type of inductive reasoning using the probability of dependence between events. If A and B, two random events, are *independent* of each other, then the probability (P) that they will appear jointly (i.e. together) is simply the product of the probabilities of each of them occurring: P (A and B) = P(A) . P(B). However, if C and D are *not independent* of each other, then the probability of the dependence can be expressed as a P(C given

D) and P(D given C), which need not be the same. In the eighteenth century, the British mathematician Thomas Bayes developed a theorem to compute the latter, given the former (see below).

Summary

If P(b | a) = x	(if the probability of b given a is x)
then P(a | b) = x . P(b) / P(a)	(then the probability of a given b equals x multiplied by the probability of b divided by the probability of a)

A 1.2.6.3   Abductive inference

Abductive inference, or 'Inference to the Best Explanation', is a method of reasoning that infers the most likely explanations from data describing something. Abduction allows the precondition a of "a entails b" to be inferred from the consequence b. Deduction and abduction thus differ in the direction in which a rule like "a entails b" is used for inference. Abduction is formally equivalent to the logical fallacy affirming the consequent (*post hoc ergo propter hoc*), because there are multiple possible explanations for b. Unlike deduction and induction, abduction can produce results that are incorrect within its formal system. However, it can still be useful as a heuristic, especially when something is known about the likelihood of different causes for b.

The philosopher Charles Peirce introduced abduction into modern logic. In his works before 1900, he mostly uses the term to mean the use of a known rule to explain an observation, e.g., "If the bell rang, someone is at the door," or more accurately, "If the bell rang, then the most probable explanation is that it someone was at the door." Peirce changed his use of the term in later life to mean something similar to induction, though that need not concern us here.

From an abductive perspective, an explanation is valid if it is the best possible explanation of a set of known data. The 'best possible explanation' is often characterised, for scientific or technological purposes, for example, using Occam's razor, that is, in terms of simplicity and elegance. The philosopher Peter Lipton, in an attempt to avoid 'inference to the best explanation' being reduced to 'inference to the *likeliest* explanation' followed by probabilistic (Bayesian) analysis, suggests 'inference to the *loveliest* explanation'; the loveliest explanation to be the one that, if correct, provides the most understanding (Lipton 2004: 59). Perhaps originally, Lipton defends

the thesis that Bayesian induction and 'inference to the best explanation' are broadly compatible because of their common concern for and explanationist approach (Lipton 2004: 106-107) and so attempts to build a bridge between the two by exploiting an overlap between the *loveliest* and the *likeliest* explanations.

Summary
If D is a collection of data (facts, observations, *a priori* assumptions) and
       H is a collection of possible hypotheses (H_1, H_2, H_3, … H_n) for explaining
D, then
       the H_n that explains more D in the best, most elegantly is probably true.

A 1.2.7 Reliableness

Reliableness is a method for acquiring knowledge based on various belief-forming processes. It justifies the belief in the veridicity of perceptual sensations if the resulting perception is known to lead to a suitably high proportion of true beliefs. It is not a requirement of users of the method, or anyone else, know that the process is reliable or have any sort of knowledge of its reliability–all that is required is that it *is* in fact reliable. Thus, no appeal to sensory experience is required, thus effectively short-circuiting the issue that divides representationalism and phenomenalism. Reliabilism thus rejects the issue on which all three of the more traditional theories attempt to respond to: the issue of how sensory experience provides a reason for thinking that perceptual beliefs are true.[10] On the assumption that our perceptual processes are in fact reliable in the way that we take them to be, it offers a seemingly straightforward and account of how perceptual beliefs about physical objects and the physical world are justified.

Reliabilism emphasizes the properties of the processes used to arrive at truths. In reliabilist approaches to knowledge acquisition, noticing a static relationship between a conjecture and a body of evidence, knowing that an hypothesis does not contradict the evidence, or even is in-accord with it, for example, is insufficient to warrant support for it from the evidence; additional account must be taken of how reliable the method that produce the hypothesis is known to be in producing truthful hypotheses. Reliabilist thinking underpins the greater acceptance of the diagnostic judgements of

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[10]   For an extended description, See http://plato.stanford.edu/entries/reliabilism/

experts over laypersons, the preferential support for research programs with fecund histories and the scorn of *ad hoc* hypotheses.

The first, then unrecognised as such, formulation of a reliability account of knowledge was in the mathematician Frank Ramesy's writing on knowledge (Ramsey 1931). Several similarly subjunctive theories, such as tracking theory and contexturalism, were developed in the latter part of that century, as discussed by Goldman, who notes

> Reliability theories of knowledge of varying stripes continue to appeal to many epistemologists, and permutations abound. … [Some theories] focus on modal reliability, on getting truth or avoiding error in possible worlds with specified relations to the actual one. They also focus on local reliability, that is, truth-acquisition or error avoidance in scenarios linked to the actual scenario in question Goldman (2008).

Reliabilism is still in active development and, according to Goldman, seems to have considerable robustness and flexibility.

Summary
S knows *P* if and only if *S* truly believes *P*, and *S*'s belief that *P* was produced by a reliable belief-forming process.