British Journal of Psychology (1993), **84**, 27–37 *Printed in Great Britain*

On what intelligence is

Robert W. Howard*
Department of Education, University of Newcastle, Callaghan, NSW 2308, Australia

Despite much controversy over the exact definition of intelligence, most researchers agree that it is a concept labelled by a word, or even several related concepts labelled by a word. The present study applies recent theorizing about the nature of concepts in general to clarify the notion (or notions) of intelligence. This theorizing defines a concept as a person's unique and individual information about a category and a category as a set of things in the world. An example of a concept/category pair is 'dog', with the category being the set of all dogs and an individual's concept of dog being his or her personal knowledge of dogs. This knowledge can be used to place things in or out of the category. Different individuals may have somewhat different knowledge about the same category and a single word may label several different concept/category pairs. A concept of intelligence thus consists of information about a general category labelled by the word 'intelligence'. This study analyses three major concept/category pairs of 'intelligence': (1) Spearman's *g*; (2) intelligence as a property of behaviour; and (3) intelligence as a set of abilities. Each concept contains different information, refers to a different category, and should be used in different ways. Several recurrent issues, such as whether the word 'intelligence' refers to a thing and what things are intelligent (e.g. animals, computers), can be resolved by considering each issue in relation to these concept/category pairs. For instance, the word 'intelligence' refers to a thing only if one uses the *g* concept. Similarly, only humans are intelligent according to the *g* concept but animals and computers may be considered intelligent if the other concepts are applied. Recent theorizing on the nature of concepts can be used to clarify other important psychological notions.

One of psychology's most debated questions is 'What is intelligence?'. There is much dispute over the definition of 'intelligence' (e.g. Sternberg & Detterman, 1986) and exactly what things could be termed 'intelligent' (e.g. Schull, 1990). Such definitional controversies go back a long way, examples being the 1921 Journal of Educational Psychology symposium, Ryle (1949) and Miles (1957). Recently, some researchers have said that the term is vague and means so many things that it has limited scientific value in the study of mental abilities (Howe, 1988, 1989; Mackintosh, 1987).

Although researchers disagree about specifics, most agree on one major point: intelligence is a concept (or may be several related concepts) labelled by the word 'intelligence' (Howard, 1991). For instance, Eysenck (1988) says that intelligence is a scientific concept like 'temperature' and 'gravity', and has developed in a similar way. The concept of 'gravity' has developed from Newton's notion of a force acting at a distance to a property of curved space and an exchange of gravitons. Eysenck

* Requests for reprints.

argues that three major, related concepts are held: IQ, biological intelligence (analogous to Spearman's *g*) and 'social intelligence'. Jensen (1987) considers that the word 'intelligence' labels three different major concepts: *g*, the sum of an individual's knowledge and skills, and the specific mental abilities important in a given culture. Ryle (1949) defines intelligence as a 'dispositional' concept, pertaining to how a particular person is disposed to behave. Sternberg, Conway, Ketron & Bernstein (1981) explored what different information is stored by experts and non-experts to make up the concepts of intelligence they use in assessing mental abilities. Derr (1989) looked at ways in which the word 'intelligence' is used in order to derive some idea of the information in the word's associated concepts, and found that common ideas were that intelligence is innate and is a general mental capacity.

This agreement that intelligence is a concept suggests a way of clarifying the notion (or notions) and providing a new framework for thinking about related issues. Recent research and theorizing about the nature and uses of concepts in general can be applied to 'intelligence'. For instance, new views about the nature of concepts of any kind (e.g. Howard, 1987; Lakoff, 1987) may help to clarify various concepts of intelligence, to which categories they refer, and how they can be used. This general approach was also used by Miles (1957) who applied philosophical theories on the nature of word meaning and definition to the word 'intelligence'. Some of his ideas are used here, but couched in different terminology (for instance the distinction between a word meaning and a word's referent). However, views of the nature of concepts have changed quite dramatically since Miles' work and some philosophical ideas that Miles used (e.g. the notion of value concepts) are incompatible with the present framework (see Irvine & Berry, 1988, for work in this tradition).

The application of recent research on concepts to clarify various ideas has proved useful in the past. A well-known example is that of psychiatric concepts such as schizophrenia and obsessive–compulsive disorder which were periodically attacked on several grounds; it was claimed that cases had few or no features in common, that it was difficult to place some individuals in or out of such categories, and even that schizophrenia, for example, did not exist. Some critics suggested scrapping the whole diagnostic category system. However, Cantor, Smith, French & Mezzich (1980) pointed out that some of these criticisms could be countered by referring to new theorizing about concepts, and by applying the useful distinction between a category (a set of things in the world) and a concept (an individual's information about that category). Cantor *et al.* argued that most critics held the old Aristotelian idea that concepts always consist of knowledge of common features, that cases are always clearly in or out of a given category, and that all cases are equally good exemplars. (Malt, 1990, found that most people hold such beliefs.) Cantor *et al.* also said that psychiatric concepts are more appropriately considered as 'prototype' concepts. The latter consist of knowledge of features that specific exemplars only *tend* to share, and their instances may vary in the extent to which they are good instances and may not be clearly in or out of the category. From this perspective, the whole psychiatric taxonomy seems more sensible. Indeed, the American Psychiatric Association's latest version of the system is based on prototypes.

Neisser (1976) applied the same principle to the concept of 'intelligent' person, arguing that instances share no clearcut common features. Rather, it is a prototype concept, in which exemplars only tend to share certain features. Miles similarly observed that intelligence is a polymorphous concept.

Understanding of the nature of concepts in general has advanced greatly since the work of Cantor *et al.*, Miles and Neisser and the aim of the present study is to analyse 'intelligence' in these terms. So the next section of this paper briefly outlines some major findings about concepts in general and the section after that applies these findings to intelligence. Following the argument that there are three major concepts of intelligence labelled by one word, each with several variants and different corresponding categories, the final section examines some implications.

New understanding of the nature of concepts

This section presents only a few of the major aspects of this very complex topic; see Howard (1987) and Lakoff (1987) for more detail.

Some important distinctions, mentioned earlier, are between words, concepts and categories. A word is a label, a symbol for a concept or concepts, and a concept is a word's meaning. The term 'concept' has been defined in many ways (see Cohen & Murphy, 1984) but the most useful is that mentioned above; the unique information that an individual has about a category. A category is a set of things, which may have none or an infinite number of exemplars, and a concept is the information an individual has about it. (This category/concept distinction corresponds to the philosophical distinction between a word's extension and intension). Thus, the concept is the mental representation of the category. For example, the category of square includes all the squares in existence and an individual's concept of square may contain such information as 'has four sides of equal length', 'is a plane, closed figure', and so on. The category of third-world nation includes the instances Chad, Burma, Panama, and so on. An individual's concept may include knowledge of such exemplars and of features such as 'has a low standard of living', 'is primarily agricultural', and so on. No two persons will ever have exactly the same data about a category, though with simple ones like square the overlap may be almost total. The information contained in a concept has several uses: (a) to categorize (e.g. the data that squares have four sides, etc. in order to place figures in or out of the category); (b) to relate instances to other concepts (e.g. of 'bird' to 'life-form' and 'object'); (c) to make sense of the world; (d) to solve problems and (e) to make inferences (Howard, 1987). Finally, one can have a concept with no real exemplars (e.g. 'unicorn' and perhaps 'tachyon').

A concept is never right or wrong, but is only more or less useful. A concept consists of information and even if there is no referent or no exemplar has been observed, the concept can still be very useful. An example is 'black hole'. Although no-one has ever seen a black hole, the concept (derived from relativity theory) has helped physicists understand the universe better. Similarly, the concepts of many subatomic particles were formed from theory long before instances were actually observed, and some postulated particles, such as tachyon, may not exist at all. But such concepts may have uses.

A very common question is 'What information do concepts contain?'. When one learns a concept such as 'bird', 'square' or 'life-form', what knowledge leads to categorization of their instances? The view that was dominant until a few decades ago dates back to Aristotle, who held that people retain common (or defining) features shared by all exemplars. Defining features of a square would be 'four sides of equal length', 'four internal right angles', etc. Any stimulus must have all these features in order to fit the category. But recent research suggests that many concepts consist of knowledge of *characteristic* features, ones that instances only tend to share, or consist of knowledge of one or more well-known instances. Analogies are then used to categorize cases. Concepts may also contain metaphorical information or be based on metaphors (Lakoff, 1987; Lakoff & Johnson, 1980). For example, 'time' is usually understood by projecting a spatial metaphor – it is visualized as a line, with future in front and past behind, as evidenced by use of the word 'long' for both length and duration (Lakoff, 1987).

Very complex concepts may be understood by two or more such metaphors. Lakoff & Johnson illustrate this point with 'mind'. Some metaphors used to understand the concept of 'mind' are container, brittle object and machine, as evidenced by sentences like:

> I cannot get that tune out of my mind (the container metaphor).
> His mind just snapped (the brittle object metaphor).
> My mind is just not working today (the machine metaphor).

Lakoff (1987) also gives the example of 'anger', partly defined by such metaphors as heat and volcano ('he exploded with rage'). These types of information (defining features, metaphors, etc.) may be contained in a single concept.

In addition, a concept's features may be more or less abstract depending on individual experience – they may also change over a period of time. For example, the notion of 'acid' may develop from the idea of a substance that turns litmus paper red to an idea based on the abstract feature of hydrogen ion replaceability. A child's concept of 'father' may be based on a feature such as a man who lives in the same house as his children and with time may develop into the notion of a marriage partner and finally the abstract biological feature. As mentioned above, the features of 'gravity' held by physicists have developed since Newton.

A concept represents a category. The represented category may have exemplars which vary in typicality (e.g. robins are more typical birds than penguins) and category boundaries may be vague and vary across individuals (McCloskey & Glucksberg, 1978). These phenomena derive from the diverse information stored in different individuals' minds. For example, the life/non-life category border is variable. Biologists have long disputed whether viruses are life-forms, and some writers even argue that computers and computer viruses are life-forms (Simons, 1983). The border depends on the corresponding concept, which may entail a precise definition (e.g. a drunk driver is one with a blood alcohol level of 0.08 per cent) or several features. Border disputes may arise when people use different precise definitions or have concepts with different features. For example, one person may believe that a defining feature of life is carbon-based, and exclude computers and possible extraterrestrial life-forms based on silicon. Someone else may not hold this belief. Whether computers can be considered intelligent is a typical border dispute. Searle (1989) excludes artificial intelligence from the category of intelligent beings because it lacks 'intentionality', which he argues is a crucial feature of intelligence. Others dispute this view and so include computers (Simons, 1983).

In addition, category borders may expand or contract (e.g. by being redefined or having features added or deleted). They may also be extended by using the representing concept metaphorically (Lakoff, 1987). For example, the border of the category of lion may be extended to include human beings ('George is a lion').

Application to intelligence

The word 'intelligence' labels several different concepts. No individual's concept will be quite the same as anyone else's, as each person's concept consists of different information. However, it is argued here that there are three major concepts, each with several variants, into which most researchers' concepts seem to fit. Each concept is presented in a somewhat idealized form, holds somewhat different information and refers to somewhat different categories but all concepts are related because they derive from the same starting point; individual differences in adaptive behaviour. We all observe that some people are inclined to behave adaptively, do not create unnecessary difficulties for themselves, and seem to learn many things quickly and easily. Others have a tendency to behave much less adaptively, and seem to learn more slowly and with difficulty. Such everyday observations prompt us to form a concept, just as other sorts of observations prompt us to form concepts like 'star', 'angry person', 'island' and 'tree' and prompt researchers to form concepts such as 'gravity', 'subatomic particle', 'gene', and 'bacterium'. Even people from radically different cultures form concepts of intelligence using similar sorts of observations, e.g. Kalahari Bushmen (see Reuning, 1988). Such concepts help us make sense of the world, make inferences (e.g. predictions about how people will behave) and so on. The concepts may change and develop over time in the same way as concepts like 'gravity' do (Eysenck, 1988).

We can gain much insight into concepts of intelligence by asking a few simple questions suggested by the previous section: What information do they hold? What category do they represent? What are this category's instances and boundaries? and How are the concepts used? Much has been written about the first question, but not in the present framework, and relatively little has been written about the others. Here is a brief description of three major concepts and their represented categories.

Intelligence 1

The first concept is basically Spearman's g, as described by Spearman himself, Jensen (1987) and Ceci (1990). The notion is quite close to Cattell's fluid intelligence and Eysenck's (1988) intelligence A. The main idea is of a biological difference between people which correlates with performance on virtually all mental tasks. Thus, intelligence is g.

What information does this concept contain? I argue that it holds knowledge of defining features and some metaphors. The major defining feature relates to a property that human brains have in varying degrees. However, many researchers who hold this concept have somewhat different versions of this feature, just as children might have different features of 'father'. Some appear to see it as a predominantly physiological feature. Eysenck (1988) writes that *g* is a kind of 'neural efficiency' (some brains work better than others). Jensen (1987) mostly appears to conceive of *g* as mental speed, though citing other factors too. Sternberg's (1985) conception of *g* is that it includes a set of information-processing 'components'.

Intelligence 1 is also based on several metaphors. Just as we may understand 'mind' by such metaphors as container and machine, people use such metaphors as energy (Spearman talked of *g* as mental energy), efficiency and capacity. The latter metaphor is quite common in everyday speech ('He lacks the mental capacity to succeed'). Brains are power is seen as differing in *g* as jugs differ in how much they can hold. Another metaphor is of a single continuum. These metaphors can be useful as long as they are recognized for what they are and not taken further. Intelligence 1 covers more aspects than the above, but these are the essential data.

What is the referent category? What are the exemplars? Essentially, Intelligence 1 represents two related categories, which are best thought of as different concept/category pairs. The first category is of a property of the human brain in which brains differ, e.g. by weight. Some brains fall at the high *g* end and some at the low *g* end. The second category relates to results that emerge from a given table of intercorrelations of performance on various mental tasks. Some say that *g* is a 'mathematical abstraction', by which they mean that their concept refers to a number.

Much unnecessary dispute has arisen from failure to distinguish clearly between these two categories (e.g. Gould, 1981). If *g*'s referent category is taken solely to include the general factor from a factor analysis, then *g* is indeed a mathematical abstraction and not a physical thing in the head. It would be fair to criticize this as 'reification' of the general factor, see Gould (1981). However, if one takes the category to include human brains as having some unique property that results of a factor analysis is evidence for this cannot lead to accusations of reification. The answer to the question 'Does *g* exist?' also depends on which of these categories is applied. It is easy to question whether there is a biological difference but hard to dispute the existence of the mathematical abstraction. These two concept/category pairs need to be distinguished. One refers to numbers and the other to a property of the brain, with the implicit assumption that the property causes the numbers.

Intelligence 2

The word that labels this concept is typically used as an adjective rather than a noun. Intelligence is not a 'thing in the head', but a characteristic of behaviour, analogous to an object's colour. Behaviours can be intelligent or not intelligent, just as objects can be red or not red. For example, Anastasi (1986) says 'Intelligence is not an entity within the organism but a quality of behaviour' and Estes (1982) says '...I shall take *intelligence*...to refer to adaptive behaviour of the individual'. Ryle (1949) discusses this notion in detail and examines some arguments against it.

This concept consists of information which is used to judge whether a given behaviour is intelligent or not. Intelligent behaviour is usually equated with adaptive behaviour. Thus, this concept contains an abstract defining feature. Determining whether a given behaviour is adaptive requires a frighteningly complex amount of information, since adaptiveness varies with context, time frame, goals and many other variables. I would also argue that the concept contains a metaphor from physical traits, such as colour, projected onto behaviours. Another metaphor is a dimensional one. We conceive of behaviours as lying along a continuum of this quality, as objects vary in, say, length or weight.

What is the represented category? There is a clear difference here from Intelligence 1. The latter category's exemplars are human brains. The exemplars of Intelligence 2's represented category are behaviours. Some fall into the represented category (e.g. stopping at a red traffic light in most circumstances) while others do not (e.g. going through a red light). There is nothing inherent in these behaviours that one could point to, as one might pinpoint the instances of Intelligence 1. Labelling them as intelligent is a judgement based on context, goals, and so on.

The category's boundaries vary considerably across researchers, creating a major source of controversy, First, where is the border between intelligent and unintelligent behaviour? Some researchers might consider intelligent behaviours to be essentially non-reflexive, thus excluding from the category adaptive but automatic responses such as eye-watering caused by a foreign particle, bird migration, etc. Some might also exclude learned but prepared behaviours such as avoiding food that had induced nausea when it had been eaten for the first time.

Second, what must do the behaving? Does only adaptive human behaviour qualify as intelligent? Are adaptive behaviours of an amoeba intelligent? While many researchers would baulk at calling a paramecium intelligent, Roitblat (1987) argues that all animals are equally intelligent with respect to their own environments, so such behaviour would qualify. Some researchers might extend the boundary further. Plant behaviour is often adaptive. Some plants turn leaves towards the sun, and the Venus Flytrap clamps down on insects, intelligently preventing their escape. Robots behave intelligently on the assembly line and chess-playing computers make intelligent moves on the chessboard. Some researchers extend the category border even further to collective entities that behave only in a particular sense. For example, Schull (1990) argues that species (e.g. all lions) are intelligent in the sense that each behaves adaptively, sensing and responding to changes in the environment (e.g. by increasing or decreasing numbers). A human or ant society considered as a whole also 'behaves' adaptively and intelligently, e.g. by dividing up labour and sharing resources amongst members.

Exactly where the category border should go is an arbitrary decision. It is entirely a question of convention, analogous to how a government should define 'drunk driver' or 'economic depression'. Some might argue that categorizing entities like species, societies and plants as intelligent is a metaphorical extension of the concept boundaries, but this is really just an arbitrary decision.

This concept is descriptive. It explains nothing. It does not go beyond the observations mentioned earlier of differences in adaptive behaviour. Problems may arise when researchers use the concept in ways that suggest their belief that it is more than descriptive, and that by using the concept they are actually explaining things (see Howe, 1988).

Intelligence 3

This concept defines intelligence as a set of abilities. Jensen (1987) labels it 'the sum total of all mental abilities' and 'the entire repertoire of a person's knowledge and skills'. The general cognitive science concept of intelligence is based on this definition (e.g. Anderson, 1990). For example, Simon & Kaplan (1989) say that cognitive science is 'the study of intelligence' and define intelligence as 'a diverse set of abilities', and distinguish between abilities based on knowledge and those that are 'almost knowledge-free'. The general notion is that individuals differ in the range and quality of their abilities, and that these differences result in differences in intelligent behaviour.

The information in this concept is very complex as it includes such defining features as ability, which can be broken down into specific abilities such as verbal and spatial ability, which in turn, are hard to define. Indeed, much recent research has tried to develop such defining features. For instance, Lohman (1988) divides spatial ability into such things as knowledge, processes and traits, and the power to visualize vividly and manipulate the resulting images. The concept also may contain knowledge of features which are used to decide if a given thing qualifies as an ability. For example, Gardner (1983) lists several 'signs' used to categorize a given ability as one of the 'intelligences' in his concept of intelligence. Some examples are localization in a brain region and a clear pattern of development. Many other abilities may also be contained in the concept simply by enumeration, like specific letters in 'letters of the English alphabet'.

What category does this general concept (or concepts) represent? The exemplars are things with abilities. Exactly what things are included again varies across researchers, and is another border dispute. Gardner (1983) would include only humans. Others include animals. A current perspective in comparative psychology sees intelligence as the set of abilities possessed by a given species (Mackintosh, 1987). These include sensory abilities, the superpower memory of Clark's Nutcracker, the language abilities of dolphins and chimpanzees, and the cognitive abilities of honeybees (Gould, 1990). Some researchers would extend the category boundary further to include plants, robots and computers. Simon & Kaplan (1989) and others argue that computers have abilities that allow them to behave intelligently, e.g. on the chessboard or in diagnosing bacterial diseases. Some extend the border even further to include objects such as buildings and materials. They may have abilities of a kind that allow them to 'behave' more intelligently. An 'intelligent' house may have the ability to detect intruders or prevailing temperature and humidity and behave adaptively in response, e.g. by signalling to the police or adjusting temperature. Some 'intelligent' materials have the ability to 'remember' a previous shape and revert to it under certain conditions. Though many would argue that buildings and materials should only be included in the category by a metaphorical extension of the concept, others would not. Where the border goes is an arbitrary decision.

Another problem is to decide exactly what counts as an ability. The list of human mental abilities alone is lengthy; sensory abilities, memory, the power to adapt, to play chess or a musical instrument, and so on. Which of these and other abilities are included in the category is a matter of dispute. Some researchers would include only those abilities which are important in a specific culture (Jensen, 1987), while Simon & Kaplan (1989) would include all abilities. Gardner (1983) defines seven abilities, but allows that more may be identified later and included in his general category. Some researchers would include *g* in the category, thus placing a general ability along with a list of specific ones.

Although this concept is merely descriptive, it is sometimes 'reified' (see Gould, 1981), a fault criticized by Howe (1988). Using the word 'intelligence' to refer to this concept can be seen as using a broad label to refer to intellect in general.

Discussion

The answer to the question 'What is intelligence?' is that it is a concept or concepts, consisting of information, labelled by a word, and concepts of intelligence are formed from observation of behaviour. As with any notion, individuals may have somewhat different knowledge stored in their concepts. The concepts described in this paper contain much more detailed information than it has been possible to include, and further research could usefully make a fuller analysis. Subsequent work could also attempt to develop further the defining features of these concepts.

The present analysis suggests that researchers discussing intelligence should always specify which concept and category they are using. Much unnecessary controversy has resulted from a failure to do so (see Sternberg, 1990). One mentioned already is the issue of whether *g* is a mathematical abstraction. Another is the controversy between Howe (1988) and Sternberg (1988) over whether intelligence is a 'descriptive' or 'explanatory' concept. Howe, essentially using Intelligence 3, argued for the former while Sternberg, using another concept, argued for the latter. Indeed the very question 'what is intelligence?' has generated unnecessary controversy because researchers approach it with different concepts. Some, believing in Intelligence 1, take the question to mean 'What is *g*?'. They try to answer it citing various lines of research: physiological research like that on evoked potential; analysis of performance on *g*-loaded tasks like Raven's Progressives Matrices items (Carpenter, Just & Shell, 1990); and factor analyses. Other researchers, believing in Intelligence 2 or 3, may take the question to mean 'What things cause adaptive behaviour?'. Clearly, the answer is many things. These include the knowledge base [exemplified by expert/novice differences and the *idiot savant* syndrome (Howe, 1989)], personality factors (Eysenck, 1979), and so on. These two questions are related but different, and should be distinguished. Another such controversy is whether 'intelligence' is reification of a metaphor. Using Intelligence 3 in some ways is an instance of this whereas using Intelligence 1 is not.

Different questions about intelligence need to be considered in relation to a particular concept (Sternberg, 1990, makes the same point.) Consider the perennial question 'Are differences in intelligence partly inherited?'. The question makes sense in relation to Intelligence 1; the biological difference may well be partly inherited. But, how about Intelligence 2? How can adaptive behaviour in general be inherited? One can inherit genes that program the physiological substrates of adaptive reflexes, habituating responses and predispositions to learn certain things easily, but what inheritance is needed for stopping at red traffic lights? The issue needs careful analysis. Another such question is whether individuals can be ranked along a continuum according to intelligence. This may make sense with Intelligence 1, though of course factors such as the knowledge base are not being considered here, and so on. It is not possible to rank animals or computers by Intelligence 2 or 3 (Mackintosh, 1987). One can judge all animals as equally intelligent in relation to their environments, and differing evolutionary adaptations make it difficult to rank sensibly even closely related species. The question 'Can intelligence be increased?' must also be considered in relation to a given concept. Spitz (1986) argued that there is no evidence that this can be done, but he was evidently referring to something like Intelligence 1. One can certainly raise Intelligence 3 by increasing an individual's factual knowledge base and by teaching strategies – which is why governments spend so much money on education.

One might also ask which concept is most useful. As mentioned earlier, a concept is never right or wrong (another source of unnecessary controversy), only more or less useful. It is quite common for scientists to have two or more concepts to cover much the same phenomena. Physicists hold and use several concepts of gravity; Einstein's notion of curvature of space and the quantum view of an exchange of gravitons. Even Newton's concept of a force at a distance is still useful (and commonly used) for calculating spacecraft orbits. Each concept may have its uses, or existing knowledge may be insufficient to decide which one to reject. So it is with concepts of intelligence. Each still has its uses. For example, whether to keep using Intelligence 1 partly depends on the empirical question of whether human brains do actually differ in a biological property, which probably will be decided only from physiological studies. But this concept may continue to have its uses even if there turns out to be no referent. Intelligence 3 is useful for applying to computers and animals and for various other purposes. Intelligence 2 perhaps could only be used for non-explanatory purposes and in daily life, for reasons given by Eysenck (1988) and Howe (1988).

Finally, the present conceptual analysis could be applied to other important psychological concepts. Psychology has many poorly defined concepts that researchers conceptualize and use in different ways. Some examples are 'representation' (Palmer, 1978), 'concept' itself (Cohen & Murphy 1984), and 'prototype'. Many unnecessary disputes and some confusion result from failure to clarify and agree on meanings for terms. The present approach could be used to help clarify such concepts.

References

Anastasi, A. (1986). Intelligence as a quality of behaviour. In R. J. Sternberg & D. K. Detterman (Eds), *What is Intelligence?* Norwood, NJ: Ablex.

Anderson, J. R. (1990). *Cognitive Psychology and its Implications*, 2nd ed. New York: Freeman.

Cantor, N., Smith, E. E., French, R. & Mezzich, J. (1980). Psychiatric diagnosis as prototypes categorization. *Journal of Abnormal Psychology*, **89**, 181–193.

Carpenter, P. A., Just, M. A. & Shell, P. (1990). What one intelligence test measures: A theoretical account of the processing in the Raven Progressive Matrices Test. *Psychological Review*, **97**, 404–431.

Ceci, S. J. (1990). On the relation between microlevel processing efficiency and macrolevel measures of intelligence: Some arguments against current reductionism. *Intelligence*, **14**, 141–150.

Cohen, B. & Murphy, G. L. (1984). Models of concepts. *Cognitive Science*, **8**, 27–58.

Derr, R. L. (1989). Insights on the nature of intelligence from ordinary discourse. *Intelligence*, **13**, 113–118.

Estes, W. K. (1982). Learning, memory and intelligence. In R. J. Sternberg (Ed.), *Handbook of Human Intelligence*. New York: Cambridge University Press.
Eysenck, H. J. (1979). *The Structure and Measurement of Intelligence*. Berlin: Springer-Verlag.
Eysenck, H. J. (1988). The concept of intelligence: Useful or useless? *Intelligence*, **12**, 1–17.
Gardner, H. (1983). *Frames of Mind*. New York: Basic Books.
Gould, J. L. (1990). Honeybee cognition. *Cognition*, **37**, 83–103.
Gould, S. J. (1981). *The Mismeasure of Man*. New York: Norton.
Howard, R. W. (1987). *Concepts and Schemata: An Introduction*. London: Cassell.
Howard, R. W. (1991). *All about Intelligence: Human, Animal and Artificial*. Sydney: New South Wales University Press/New York: Gardner Press.
Howe, M. J. A. (1988). Intelligence as an explanation. *British Journal of Psychology*, **79**, 349–360.
Howe, M. J. A. (1989). *Fragments of Genius*. London: Routledge.
Irvine, S. H. & Berry, J. W. (1988). The abilities of mankind: A re-evaluation. In S. H. Irvine & J. W. Berry (Eds), *Human Abilities in Cultural Context*. New York: Cambridge University Press.
Jensen, A. R. (1987). Psychometric g as a focus of concerted research effort. *Intelligence*, **11**, 193–198.
Lakoff, G. (1987). *Women, Fire and Dangerous Things*. Chicago: University of Chicago Press.
Lakoff, G. & Johnson, M. (1980). *Metaphors We Live By*. Chicago: University of Chicago Press.
Lohman, D. F. (1988). Spatial abilities as traits, processes and knowledge. In R. J. Sternberg (Ed.), *Advances in the Psychology of Human Intelligence*. Hillsdale, NJ: Erlbaum.
Mackintosh, N. J. (1987). A natural history of intelligence in man and other animals. In S. Nash (Ed.), *Science and Intelligence*. Northwood: Science Reviews.
Malt, B. C. (1990). Features and beliefs in the mental representation of categories. *Journal of Memory and Language*, **29**, 289–315.
McCloskey, M. E. & Glucksberg, S. (1978). Natural categories: Well-defined or fuzzy sets? *Memory & Cognition*, **6**, 642–672.
Miles, T. R. (1957). Contributions to intelligence testing and the theory of intelligence. I: On defining intelligence. *British Journal of Educational Psychology*, **27**, 153–165.
Neisser, U. (1976). General, academic and artificial intelligence. In L. B. Resnick (Ed.), *The Nature of Intelligence*. Hillsdale, NJ: Erlbaum.
Palmer, S. E. (1978). Fundamental aspects of cognitive representation. In E. Rosch & B. B. Lloyd (Eds), *Cognition and Categorization*. Hillsdale, NJ: Erlbaum.
Reuning, H. (1988). Testing bushmen in the central Kalahari. In S. H. Irvine & J. W. Berry (Eds), *Human Abilities in Cultural Context*. New York: Cambridge University Press.
Roitblat, H. L. (1987). *Introduction to Comparative Cognition*. New York: Freeman.
Ryle, G. (1949). *The Concept of Mind*. London: Hutchinson.
Schull, J. (1990). Are species intelligent? *Behavioural and Brain Sciences*, **13**, 63–108.
Searle, J. (1989). *Minds, Brains and Science*. Harmondsworth: Penguin.
Simon, H. A. & Kaplan, C. A. (1989). Foundations of cognitive science. In M. I. Posner (Ed.), *Foundations of Cognitive Science*. London: MIT Press.
Simons, G. L. (1983). *Are Computers Alive?* Brighton: Harvester.
Spitz, H. H. (1986). *The Raising of Intelligence*. Hillsdale, NJ: Erlbaum.
Sternberg, R. J. (1985). *Beyond IQ*. New York: Cambridge University Press.
Sternberg, R. J. (1988). Explaining away intelligence: A reply to Howe. *British Journal of Psychology*, **79**, 527–533.
Sternberg, R. J. (1990). *Metaphors of Mind*. New York: Cambridge University Press.
Sternberg, R. J. & Detterman, D. K. (Eds) (1986). *What is Intelligence?* Norwood, NJ: Ablex.
Sternberg, R. J., Conway, B. E., Ketron, J. L. & Bernstein, M. (1981). People's conceptions of intelligence. *Journal of Personality and Social Psychology*, **41**, 37–55.

Received 18 December 1990; revised version received 9 March 1992