Psychology in Spain, 2000, Vol. 4. No 1, 167-182

THE STUDY OF HUMAN INTELIGENCE: A REVIEW AT THE TURN OF THE MILLENNIUM

Roberto Colom Marañon* and Antonio Andrés-Pueyo**
Universidad Autónoma de Madrid and **Universitat de Barcelona*

The study of intelligence has been one of the cornerstones of psychology throughout the twentieth century. From the work of pioneers Spearman, Binet and Thurstone up to the present day, advances in this area have been constant, but also controversial. Given the relevance of this area for everyday life, the question of intelligence models and their implications has gone beyond the academic framework to become a hot topic of socio-political debate. Motivated by recent controversies, our aim in this article is to describe, with the necessary brevity, what psychology currently knows about human intelligence, what remains to be discovered, and the consequences and possibilities of the application of this knowledge. We intend to present a photograph, a snapshot of the advances and discoveries made in this century in the field of the study of intelligence. Our aim is not to get "back to basics", but rather to take stock, to look back at the past and forward to the future of psychology's quest for understanding the nature of human intelligence.

El estudio de la inteligencia ha sido uno de los apartados más característicos de la Psicología a lo largo del siglo XX. Desde los trabajos de los pioneros Ch.Spearman, A.Binet, y L.L.Thurstone hasta la actualidad los avances en este terreno han sido constantes y también polémicos. Como en cualquier otra disciplina científica el debate en torno a los modelos, el contraste de las predicciones y de aplicaciones ha sido intenso y a veces ha superado el estricto marco de la Psicología para convertirse en un debate socio-político debido a la importancia de este fenómeno en la vida cotidiana. En este artículo queremos realizar una descripción, necesariamente breve, de lo que hoy la Psicología sabe de la inteligencia humana, lo que falta por descubrir, así como las consecuencias y posibilidades que se derivan de aplicar estos conocimientos. Esta descripción está motivada por las recientes polémicas y declaraciones que se han realizado en torno a este tópico. Pretendemos realizar una instantánea, una foto fija, realizada ante el conjunto de avances y descubrimientos realizados durante este siglo en el ámbito del estudio de la inteligencia. No es un «back to basics», sino un punto y seguido en la investigación psicológica de la inteligencia humana.

Almost 30 years ago, David Wechsler wrote: "Intelligence is one of the psychological phenomena about which we know most, and about which we have most information" (Wechsler, 1971). This opinion of one of the most reputable experts in intelligence is not shared by other psychologists, who consider intelligence to be a largely unknown phenomenon. This divergence may be due to the fact that intelligence is a complex and many-faceted phenomenon that admits a wide variety of approaches. Thus, many specialists have studied intelligence since the turn of the century with the intention of discovering its secrets. The psychologists involved in such work have come from a range of specialities (child psychology, educational psychology, clinical psychology, comparative psychology, neuropsychology, psychometrics, differentia psychology, etc.), and these have been joined by geneticists, sociologists, primatologists, palaeontologists, engineers, and so on.

Interest in human intelligence has been renewed in the last decade after a decline in the 1960s and 70s. Current interest goes beyond the limits of psychology, and represents the culmination of two decades in which psychological research on human intelligence regained much of the strength it had acquired in the 1930s and 1950s. Research on intelligence had stagnated in the 1960s for a variety of reasons, among them the crisis of analytical methods based on correlation and factor analysis, the harsh criticisms of intelligence tests (and by extension, IQ) from radical environmentalist positions, widely disparate –not to say antagonistic– models of the structure of intelligence, and ignorance of the functional mechanisms of this highly relevant attribute of cognitive activity. These, then, are some of the factors that explain the substantial crisis suffered by the study of intelligence. This hiatus did not affect research in the development of intelligence, which has had its own dynamic, though recently this aspect has recently also suffered a crisis,

The original Spanish version of this paper has been previously published in *Psicothema, 1999, Vol. 11 No 3, 453-476*

.....

Correspondence concerning this article should be addressed to Roberto Colom Marañon, Facultad de Psicología, Universidad Autónoma de Madrid, 28049 Madrid, Spain.
E-mail: roberto.colom@uam.es

given its strong dependence on the Piagetian tradition, which has shown its insufficiencies. The arrival of the cognitive paradigm in psychology, together with other important influences, such as interest in the role of intelligence in the lifespan and the growth and spread of multivariate data analysis techniques, have been instrumental in a renewal of interest in the study of intelligence. The result has been a high degree of enthusiasm and the development of new research programmes on intelligence that have aimed at resolving –and with a high degree of success –some problems and enigmas related to its structure and functioning. Thus, for example, the problem of the existence of different models of intelligence has been solved, with the achievement of the formulation of a single and comprehensive model accepted by the majority (Carroll, 1993; Colom, 1995, 1998; Andrés-Pueyo, 1996, 1997; Juan-Espinosa, 1997). Also in this latest period, enormous efforts have been devoted to studying the mechanisms that underpin intelligent behaviour, and the progress made, though insufficient, has brought us closer to a scientific explanation of the processes that constitute intelligence (Colom, 1997 a; Hunt, 1995 a; Jensen, 1998).

However, these advances in our understanding of the basic structure and mechanisms of intelligence have not been made alone. Within this context fascinating discoveries have been made in relation to the genetics of intelligence and its functioning in the most recent stages of human development, to the role of environmental variables in the development of this capacity, and to the use and effectiveness of its measurement. These advances have permitted psychologists to gain access to reliable information which, when used as the basis for the work of professionals, lends it a rigour essential to scientific practice (Colom, 1999). Our aim in this article is to describe, with the necessary brevity, what psychology currently knows about human intelligence, what remains to be discovered, and the consequences and possibilities of the application of this knowledge. The presentation of such a description has been motivated by the recent controversy surrounding this issue and the statements made in relation to it. We intend to present the reader with a photograph, a snapshot of the advances and discoveries made in this century in the field of the study of intelligence. Our aim is not to get "back to basics", but rather to take stock, to look back at the past and forward to the future of psychological research in human intelligence.

Knowledge and beliefs about intelligence

The concept of intelligence, or cognitive ability, is widely found in the Western philosophical and cultural tradition, perhaps to a greater extent than in other cultural traditions in which, while we find referents for this ability, they do not play the same role as in our own (Juan-Espinosa, 1997). Our immediate referents with regard to intelligence are peculiar to our Western culture.

In a general way, we can observe that between the popular or lay conception of intelligence and the scientific one there are many points of coincidence. Sternberg, in a seminal work, demonstrated that experts and non-experts agree that intelligent people are characterised by their capacity for solving problems, either new or familiar, their adeptness with language and their open and tolerant attitude to innovation (Sternberg, 1981). Lay and scientific conceptions also coincide, though perhaps to a lesser extent, in identifying the existence of a general capacity that permits the acquisition of knowledge and certain more specific abilities based on knowledge ability. This area of agreement extends to ideas about aspects of the nature and functions of intelligence that in Western society constitute a body of knowledge rooted in tradition, and whose basic tenets are that: a) intelligence is a dispositional aptitude or capacity (a faculty) that conditions the obtaining of an adequate level of performance in any task approached by an individual, b) this ability has an eminently adaptive function, c) it is not a property exclusive to human beings, though it is in humans that it attains it greatest complexity, and in whom its effects are most relevant, and d) it is closely related to the structure and function of the brain (Andrés-Pueyo, 1994; Colom, 1997; Juan-Espinosa, 1997). In this context the development of psychological research in intelligence throughout the twentieth century has been enormously fruitful.

A simple observation of intelligence demonstrates the many and varied facets of this phenomenon, given its implication in all individual and social behaviours. And it this very ubiquitousness that gives rise to one of the most important problems regarding the formulation of a theory of intelligence, in terms of whether it should be considered as a single or multiple ability. In fact, a proper understanding of the phenomenon requires the identification of a wide variety of expressions of intelligence. We can speak of a social intelligence, which some prefer to call practical, that comes into play in everyday life, and that may be used equally to deal with a domestic, a financial or a work-related problem. In contrast to this wide category, there exists an intelligence understood as the abstract capacity or basic potentiality that permits the acquisition of knowledge and cognitive abilities that are essential for the individual and which develop as a function of interaction with the environment throug-

hout the lifespan; this intelligence could be labelled natural or potential. Furthermore, we should include another type of intelligence, that which we identify by means of IQ tests, a combination of the potentiality described above and the knowledge acquired in the first years of life and early education, so that this intelligence is sometimes referred to as "academic". This typology is useful only for describing the complexity of intelligence and to explain why measures based on IQ do not reflect its everyday reality –and the three categories described are by no means independent of one another. Moreover, the labels assigned to them do not do them justice, and it is therefore preferred to substitute them by other more neutral ones, following the proposals of Hebb and Vernon, who identify them as intelligence B, A and C, respectively (Eysenck, 1983).

Recently, a new proposal for distinction has been considered (though originally suggested by Cattell in the 1940s), and one that we believe to be of great utility. This proposal involves distinguishing intelligence from knowledge (or learning), since both phenomena are intimately related to performance, which is their ultimate referent. According to this criterion, we can distinguish two types of intelligence: that which is related to performance in the face of novel tasks (in which knowledge is not the central shaft of execution), and that which we use to confront familiar tasks. These two types of ability are normally referred to as fluid intelligence and crystallised intelligence. Both constitute types of general intelligence, not specific to a particular cognitive domain; they are inter-related, and, although used for the same ends, they are involved in tasks in different ways according to the task's demands. On the basis of concepts such as fluid and crystallised intelligence, specific measurement procedures have been designed. For example, for the study of fluid intelligence, problems new to the person have been created, such as those involving series of figures related to one another in ways that are not made explicit in the problems themselves. In this case, the person must discover the rules governing the relationships, for example, by selecting a congruent alternative and discarding incongruent ones. The mental operations required by this type of problem are aimed at testing processes that are important for everyday life situations. Thus, problems designed for studying concepts such as crystallised intelligence and fluid intelligence try to measure the way intelligent behaviour is manifested in everyday activities.

People's performance in dealing with a variety of problems tends to show a positive relationship to intelligence. This positive correlation constitutes a natural phenomenon that has given rise to the concept of *g*, a general factor that can be extracted on the basis of a correlation matrix composed of a series of ability tests. The concept of *g*, proposed by Spearman more than 70 years ago, has continued ever since to be confirmed empirically, and Carroll (1993) and Jensen (1998) have recently demonstrated its validity, together with its integration in the framework of a hierarchical model of intelligence, which goes far beyond the bi-factorial theory postulated by Spearman himself in 1927. There are various methods for extracting *g*. Although there are several tests that provide consistently good measures of *g*, it is conceptually incorrect to consider that the characteristics of these tests (e.g., the establishment of relations or abstract reasoning) are the essence of *g*. The g loading of a test and its level of difficulty are conceptually different aspects. It is also inappropriate to consider *g* as a cognitive process, as an operative principle of the mind or as a characteristic of the design of the brain's neuronal circuits. On a psychometric level, *g* should be conceived as a common source of individual differences in all mental tests. In this sense, *g* could be considered as equivalent to the power, effectiveness or speed of a computer's CPU. The knowledge and abilities required by the tests constitute a means of measuring *g*, but they are not themselves *g* (Jensen, 1998).

It is important to emphasise that the *g* factor is compatible with the existence of an enormous number of intellectual abilities. Thus, the study of intelligence suggests that it is not one-dimensional. On the contrary, intelligence, as a scientific concept, would be made up of more than 60 abilities (Carroll, 1993). The *g* factor would represent the result of the elements common to this series of abilities. According to Carroll (1997), *g* would explain more than half of the variance in a correlation matrix, a fact usually considered as a symptom of its importance. Nevertheless, there still remains a great deal of variance to explain, and which we should not ignore as far as the importance of its effects is concerned.

The current broad consensus on the scientific study of intelligence

Controversial books, newspaper declarations by scientists, monographic issues of specialist and general interest magazines and journals, an avalanche of publications –some reaching best-seller status–in several countries and languages, articles by leading columnists and intellectuals, to say nothing of the numerous debates among experts and novices alike –all of this reflects the atmosphere created by and reflecting the renewal of interest in human intelligence that we have witnessed in the decade that is drawing to a close. The most recent

controversy –the echoes of which can still be heard– is that which was provoked by the publication of Herrnstein and Murray's *The Bell Curve* (1994). Its release gave rise to such heated debate in the US that, within a few months of its appearance, the *Wall Street Journal* published a formal "declaration" by 52 psychologists, all internationally-recognised experts in the field of intelligence, summarising in 25 points all that could be confirmed by science with regard to human intelligence. More recently, in 1998, the journal *Scientific American* devoted its annual monographic number to the subject of intelligence. This had been preceded by monographic issues of several specialised psychological journals on the same topic, among them the relatively new but prestigious *Intelligence*. Moreover, numerous books dealing with the subject have appeared, one of them, Goleman's *Emotional Intelligence*, reaching the top of the non-fiction best sellers lists. Though unorthodox in terms of content (it deals more with questions of personality than of intelligence), its success demonstrates the considerable interest aroused in the public at large by the subject of intelligence. Since 1996, in its Spanish version alone, more than 29 editions have appeared. Along with Goleman's book, many others dealing in a more rigorous fashion with recent advances in the psychology of intelligence have seen the light; without achieving such public success, they too reflect the renewal of interest in this classic area of psychology. Likewise, we could list numerous newspaper articles, radio discussions and academic debates motivated in recent years by the publication of Herrnstein and Murray's (1994) work. Taken together, these elements make clear the importance of intelligence for today's society. This importance in itself constitutes a challenge for current psychology.

What does psychology know about intelligence?

As referred to above, the *Wall Street Journal* of 13th December, 1994 published a declaration of 25 basic points on the scientific study of intelligence, signed by 52 scientists from various countries. Its objective was to correct the errors that had appeared in the media in connection with the controversy stirred up by the publication of Herrnstein and Murray's *The Bell Curve* (1994). Its critics suggested the book was based on an outdated and pseudo-scientific notion of intelligence. Nevertheless, the knowledge that was caricaturised in the media in fact constitutes a solid body of scientific information, representing the data accumulated by psychology on the subject since the beginning of the twentieth century. Below we present, in summarised form, some of the main points of this declaration, given its importance as a meeting point for specialists in the scientific study of intelligence at present:

- Intelligence is a quite general mental ability that allows reasoning, planning, problem-solving, abstract thinking, the understanding of complex ideas, rapid learning and learning from experience. It is not simply encyclopaedic knowledge, a particular academic ability or expertise for doing tests; rather, it reflects a wider and more profound capacity for understanding one's environment –awareness, making sense of things, or imagining what should be done.
- Intelligence, thus defined, can be measured, and intelligence tests measure it adequately. These tests constitute the most precise, reliable and appropriate form of evaluating intelligence, and have multiple applications and utilities.
- There are various types of intelligence test, but all of them measure the same intelligence. Some include words or numbers and require culturally-specific knowledge (e.g., vocabulary); others, in contrast, do not require such knowledge, and include forms or patterns, so that they only require knowledge of simple universal concepts (a lot/ a little, open/closed, above/below).
- The distribution of people according to their performance in these tests can be adequately represented by a normal distribution. The majority are situated around the mid point (IQ=100). Few are brilliant or very poor.
- Intelligence tests are not culturally biased against Afro-Americans or any other English-speaking natives of the United States (it should be remembered that this declaration is made in the US, and for the American population).
- Members of all American ethnic-racial groups are situated at all levels of the intellectual performance scale. The curves of the different groups overlap, but the groups tend to be differentiated by the place in the curve in which their members tend to be grouped.
- Intellectual level is directly and closely related to performance in social, economic, occupational and educational contexts. Whatever the tests measure, they are of great practical and social importance.
- A high level of intelligence represents an advantage in everyday life, since the majority of everyday activities require some type of reasoning and decision-making. In contrast, low intelligence represents a disadvantage, especially in disorganised environments. Nevertheless, high IQ does not guarantee suc-

cess in life, and nor does low IQ guarantee failure.

- The practical advantages of having high intelligence increase as situations become more complex (novel, ambiguous, changing, unpredictable or with many alternatives).
- Differences in intelligence do not represent the only factor influencing educational performance, the effectiveness of the education received or performance in complex occupations, but intelligence tends to be the most important factor.
- People differ in intelligence due to both environmental and genetic factors. Estimations of heritability range from 0.4 to 0.8 (on a scale of 0 to 1). If environments were the same for everyone, heritability would be equal to 1 (i.e., 100%), given that any observable differences would necessarily be genetic in origin.
- Members of the same family tend to differ substantially in intelligence (12 IQ points on average), for both genetic and environmental reasons.
- We do not yet know how to manipulate intelligence in order to increase it in a permanent way.
- Differences in intelligence of genetic origin are not necessarily irremediable (consider diabetes or phenylketonuria), nor are differences caused by environmental agents necessarily remediable (consider physical damage, poisons and some illnesses).
- There is no definitive response to the question of why intellectual performance distributions differ among ethno-racial groups in the United States. The reasons for these differences may be different from the reasons for differences between individuals within each group. It is erroneous to assume, as some people do, that the reason why some individuals in a given population have a high IQ while others have a low one must be the same as the reason why some populations include more high-IQ or low-IQ individuals than others.
- Ethno-racial differences are somewhat smaller, but still substantial, among people with the same socioeconomic level.
- Studies on intelligence are based on self-classification in different ethno-racial categories (i.e., it is the subjects themselves that report their membership of a given ethno-racial group), as is the case in other types of study within the social sciences.

In addition to this declaration, the American Psychological Association (APA) considered it opportune to draw up a report that would provide a more detailed account than the *Wall Street Journal* text of the current state of the psychology of intelligence, creating a committee for this purpose. The Official Report of the APA was published in 1996, and enlarges upon and justifies the points made in the declaration. According to the report's Editorial Committee, chaired by Ulric Neisser and composed of recognised experts in the field of intelligence, the public debate provoked by *The Bell Curve* was replete with declarations and opinions that went far beyond the evidence available. The report presents the data emerging from the scientific study and the questions that remain unanswered (Neisser, Boodoo, Bouchard, Boykin, Brody, Ceci, Halpern, Loehlin, Sternberg and Urbina, 1996).

The report lists the scientific conceptions of intelligence –the psychometric approach and psychological tests, the theories of Howard Gardner, of Robert Sternberg, of Jean Piaget and of Lev Vygotsky, as well as the problem of cultural variation and biological approaches –, concluding that while all of them are relevant to an understanding of the concept of intelligence, a large part of the report's arguments concern "the dominant psychometric approach, which not only has inspired most of the research and attracted most of the attention (up to now), but is also the approach most frequently found in practice" (Neisser et al., 1996).

The APA report describes the meaning of the scores in intelligence tests, what they predict and with what precision they do so. Furthermore, it describes the great stability of intelligence test scores throughout individual development, their utility for the prediction of school and occupational performance and their relationship to social data, such as social status or class, income or criminal activity. It stresses that there are many other variables not measured by intelligence tests that influence these contexts (such as motivational, temperamental or attitudinal variables). Also, it discusses the relationships between test scores and laboratory measures of processing speed recently claimed by experimental research in cognition.

Of especial interest is the question of the influence of environmental and genetic factors on differences in intelligence, as measured by standardised tests. Descriptions are offered of the methods of decomposition of the variance –of the test scores–, of how genetic estimations are made, and of the meaning of heritability (h^2). The methods of behavioural genetics have shown, according to the report, that the genes and variations in the particular context of an individual –the non-shared environment or one's personal experience of it– contribute substantially to performance differences in intelligence tests, but that although the variation between families (shared environment) contributes significantly to IQ differences

observed in childhood, its effect subsequently decreases.

The report lists a series of environmental variables that appear to influence differences in test performance: social variables such as occupation, schooling, educational intervention and family, and biological variables such as nutrition, environmental lead levels, alcohol intake and perinatal factors. One of the best-documented environmental factors, but also the least well-explained, is the so-called "Flynn Effect", which consists in a gradual increase in mean performance in intelligence tests over the last 50 years[1] The report remarks on the interest of determining what individual experiences may contribute to differences in performance.

Finally, the report deals with the problem of group differences in intelligence test performance. Naturally, it starts out by stating that the group means have no direct implications for particular individuals and that the group distributions overlap in such a way that the range of scores within each group is always much greater than the mean differences between the groups. Data is presented on gender and ethno-racial differences that have been found in standardised intelligence test results. Of especial interest is the discussion of possible bias in the tests. Although, according to the report, "considered as predictors of future performance, tests do not appear to be biased", certain social conditions may prevail that prejudice test performance.

The APA report concludes by listing a series of questions on intelligence that remain unanswered, and constitute a veritable agenda for research in the twenty-first century:

- Genetic differences contribute in a substantial way to intelligence differences, but we are still ignorant of the mechanisms through which genes affect intelligence.
- Genetic influence increases with age, but we do not know why.
- Environmental factors also make a substantial contribution to intelligence differences, but we are unaware of what these factors are or of how they act.
- School attendance is important, but it is not clear which are the critical aspects of education.
- The role of nutrition in intelligence is still unclear
- There are significant correlations between laboratory measures of information processing speed and standardised measures of intelligence, but it is not yet known how to interpret this correlation.
- Mean scores in intelligence tests have increased throughout the twentieth century, but the causes of this increase are unclear.
- Mean differences in performance between certain social groups (in the United States) are not due to possible bias in the tests; nor do they reflect differences in socio-economic status. At present the causes of these mean differences are unknown.
- Currently-available intelligence tests do not explore all possible forms of intelligence, and it is necessary to widen their ambit to other domains affected by the social action of intelligence.

A review of the study of intelligence such as that pretended in this work requires the presentation of somewhat more specific evidence than that offered up to now. Thus, in the following sections we shall provide details of some of the most important evidence available, placing special emphasis on its practical implications, though also discussing its consequences with regard to the concept of intelligence itself.

Intelligence in professional activity

To a similar extent as in the case of money, intelligence is not important as long as one has sufficient amounts of it. It is important insofar as it has to do with our daily activities. Its practical importance can be evaluated by calculating the relationship between what a person scores in intelligence tests and his/her social achievements: the closer this relationship, the greater will be the practical importance of the performance observed in the tests.

How precise are the measurements made by intelligence tests?

In order to answer this question it is pertinent to consider the following evidence (Jensen, 1980, 1981, 1998; Jones and Bayley, 1941; Moffitt, Caspi, Harkness and Silva, 1993; Neisser et al., 1996): a) the internal consistency of an IQ test tends to be situated between .90 and .95. The correlation between the length of the right arm and the left arm measured in a representative sample of the population tends to be .95. The reliability coefficients of measures such as blood pressure or cholesterol level are usually around .5; b) the correlation between a person's IQ assessed on two occasions with a week in between is .95.The correlation between an average person's weight measured twice on the same scales with a week's interval is 0.97; IQ measures at age 6 correlate at a value of .96 with IQ measures of the same subjects at age 12. IQ measures at age 6 correlate at a value of .86 with those of the same subjects at 18. The correlation between the height of a group of children at age 2 and at

[1]Note: Colom, Andrés-Pueyo and Juan-Espinosa (1998) have recently replicated the Flynn Effect with Spanish data.

age 4 is .83; between height at age 2 and height at age 18 it is .60. Thus, psychological measures of intelligence are as precise as any other type of measure.

Are intelligence tests biased?

Suppose we travel to a planet in the galaxy of Andromeda and use a measuring tape to measure the height of the inhabitants of two countries 10,000 kilometres apart. The data indicate that the inhabitants of Country A are on average 10 cm taller than those of Country B. Would we conclude that the measuring tape was biased against the inhabitants of Country B?

The numerous criticisms of intelligence tests have been based on their supposed bias, both internal and external. External bias refers to the predictive validity of the tests, whilst internal bias refers to their cultural content, as well as to the influence of motivation and of differences in socio-economic status (SES) on performance. These criticisms have been refuted in diverse scientific publications (see, for example, Anastasi, 1996; Andrés-Pueyo, 1997; Brody, 1992; Carroll, 1993; Colom, 1998; Cronbach, 1998; Jensen, 1980, 1998; Snyderman and Rothman, 1998; Sternberg and Grigorenko, 1997). Let us consider briefly the nature of these refutations.

Studies carried out in the US on the level of prediction of intelligence tests indicate that they are valuable instruments: "psychometric tests are the best predictors of success in school and in the world of work. And what's more, they are no mean predictors of failure in everyday life, such as falling into poverty or dependence on the state (…). To say that other things are important, apart from intelligence, is not really a challenge until you say precisely what those other things are" (Hunt, 1997, pp. 539-540). According to the APA, standardised measures of intelligence correlate at levels of .50 with school performance, .55 with years of schooling, .54 with work performance, and –.19 with juvenile delinquency. No other psychological variable is capable of producing these correlations (Neisser et al., 1996).

With regard to the influence of cultural content on the performance of individuals from certain social groups, the data indicate that tests are not biased by this content. Thus, for example, the differences between the two main ethno-racial groups in the US are less pronounced in tests with greater cultural content than in tests with lesser cultural content (Neisser et al., 1996).

As far as the influence of SES is concerned, the APA report makes several points (Neisser et al., 1996). It is more probable that the children of privileged families attain higher social status than those whose parents have low incomes or less education. Intelligence and family SES correlate at a level of .33 (White, 1982). What is observed on comparing the occupational status (or income) of adult siblings raised in the same family and who, therefore, have the same family SES? In such cases, it is more probable that the brother or sister with the best intellectual performance in adolescence has the highest social status and the highest income in adulthood (Jencks, 1979). It is also more probable that the brother or sister with best performance in IQ tests gets more out of education, so that s/he has better credentials for aspiring to a good job.

In sum, the data currently available on standardised intelligence tests indicate that these do not involve the biases commonly attributed to them. Their predictive validity is socially important, and this prediction does not incorporate biases against particular social groups. Moreover, neither their cultural content, nor motivational differences, nor SES can satisfactorily explain the differences in performance observed in tests. In spite of this, we believe that the evidence accumulated to date on bias in intelligence tests should not lead scientists to forget their responsibility to submit this question to scrupulous and repeated analysis. The fact that it can currently be concluded that intelligence tests are not biased does not mean that certain social changes may not induce the appearance of bias, or that there may not exist some biases that go undetected by normal processes of psychometric analysis (Colom, 1998). It is therefore necessary to look deeper into this issue in order to further improve aspects related to the measurement of intelligence, but in a positive and objective context, free from the influence of any type of prejudice, so harmful to the development of psychology.

Evidence on the predictive validity of intelligence tests

There is a great deal of empirical evidence demonstrating the predictive validity of intelligence tests. There is also, however, a widespread belief that the utility of such tests is limited to the fields of education and school performance, and that they are not applicable to other types of social phenomenon. This belief is erroneous, and in order to demonstrate the fact, we present below a series of important results accumulated over several years with respect to predictive validity, in relation to both education and the world of work.

Education

Psychological Abstracts includes more than 11,000 references to studies on the relationship between IQ and school performance–a fact that indicates the enormous interest aroused by the issue. Generally, correlations bet-

ween intelligence measures and school performance are between .50 and .70 in primary education, falling to between .30 and .40 in high school pupils (Jensen, 1981). The decrease in this correlation as education advances is due essentially to the restriction of range. This phenomenon is similar to that found in certain sports, such as basketball: in school teams, height correlates with players' effectiveness, but in professional teams the correlation with height disappears, since all players are very tall, so that differences in performance are due to other variables, such as agility or speed.

Table 1 shows some results related to the school context (Jensen, 1981).

With practically universal access to education in recent decades, IQ measures are, if anything, increasing their predictive validity. The reason why IQ predicts educational performance is that school activities and the problems set by tests demand *g*. Pupils must constantly establish relationships to be able to acquire new material, and must transfer the knowledge and skills acquired in order to be able to learn new things. These types of cognitive activity clearly require *g*.

In general, intelligence differences are relevant in learning contexts in the following conditions: (1) learning is intentional and conscious mental effort is required; (2) the material to be learned is hierarchical, that is, learning B requires having learnt A; (3) the material to be learned is meaningful; (4) the learning task permits the transfer of knowledge or skills; (5) learning requires "realising", or "grasping the idea"; (6) the material to be learned is of moderate difficulty or complexity; (7) time available for learning is the same for everyone; (8) the material to be learned is in accordance with age; and (9) the first steps of the learning are analysed. Naturally, an understanding of the relationships between intelligence and these conditions would permit us to draw conclusions about how to adjust them through educational intervention.

Table 1
Correlations between intelligence and a series of criterion variables linked to education (Jensen, 1981)

Criterion variable	Correlation
Performance in primary education	.56/.71
IQ in 4th grade and performance in 6th grade	.75
Reading test	.84
Reading aloud	.62
Reading comprehension	.68
Teacher's estimation of pupils' intelligence	.60/.80
Performance in secondary education	.62
Performance in high school	.44
Mean performance in various high school courses	30/70
Mean performance in 48 high schools	.40
Performance in Law Faculty	.30
Educational level at age 40	.50/.58

There are at least two important questions that must be addressed before concluding this section: What is the importance of family environment for the development of intelligence?, and: Are intelligence differences the result of school experiences?

With respect to the first of these questions, one of the most impact-making conclusions deriving from recent research is that the majority of human environments are, in practice, functionally equivalent for stimulating children's mental development. The idea that environmental differences due to social class vary along a continuum of deprivation, in such a way that the environment is more deprived as we move down the social classes, constitutes a false conception. The environments of the majority of SES levels provide much more stimulation than the child needs for development. It is clearly possible to find truly deprived environments that seriously prejudice child development (though not only in terms of intelligence), such as in situations of war or extreme poverty, but the data indicate that such cases are for the most part rare in modern Western societies (Neisser et al., 1996; Sternberg and Grigorenko, 1997).

As far as the second question is concerned, we must try to respond to it by considering to what extent intelligence differences are a *direct* result of differences in schooling. Do people differ as a result of differences in education? One of the best studies on this issue was the now classic work by Jencks (1972). The principal conclusions drawn were as follows: (1) attendance at preschool courses (before age 6) has a limited effect on cognitive development. That is, massive attendance at pre-school courses does not reduce intelligence differences at later ages –on the contrary, differences may increase; (2) attendance at primary school classes influences the results obtained in intelligence tests. Test scores of children who for some reason cannot attend school during a particular period will be affected; (3) attendance at secondary and high school classes has more limited effects than primary school attendance; (4) differences in the quality of schools has a modest effect on intelligence. Average difference in IQ between the high and low parts of the cognitive distribution is 12 points. If it were possible to eliminate all educational inequalities, this average difference would be 10.7 points, that is, a reduction of 1.3 points. Consequently, differences in intelligence would not appear to be the direct result of differences in schooling (Jensen, 1981).

The world of work

Intelligence can be conceived as a ability for the mental processing of information from the environment (in its widest sense), so that the person can reason, solve problems and make decisions. Research data available on work performance contradict affirmations that performance in intelligence tests is only relevant for predicting school performance (Gottfredson, 1997). Currently, there is a great deal of empirical evidence on the high predictive validity of performance in intelligence tests in the world of work.

Table 2 presents an interesting synthesis of these types of result (Hunter, 1986).

The information in Table 2 indicates that the relationships are considerably stronger on evaluating what the worker actually does in his or her work (hands-on), rather than considering the supervisor's evaluation of the work.

Hunter (1983, 1986; Hunter and Hunter, 1984) carried out a study for the US employment service, calculating the predictive level of a battery of tests (GATB) according to the complexity of the different jobs. The data in Table 3 come from a meta-analysis of 515 studies, 425 on performance/execution (with 32,124 subjects) and 90 on training (with 6,496 subjects).

In order to obtain an idea of the meaning of these values, we can make use of the following rationale: let us consider a situation in which 60% of individuals are successful. To be more specific, around 60% of the working population are above the intelligence level (IQ=100) necessary for performing adequately in a bank (for example). If this bank were to take on its employees at random, the probability of success would be 1.5:1 (60:40). If the bank were to select its workers in accordance with a test whose predictive validity was .3 (and employ half of the candidates), the probability of success would increase to 2:1 (69:31). If the test validity were .45 (which is fairly normal), probability would rise to 3:1 (74:26), thus doubling the initial probability. Of course, the higher the number of candidates and the fewer the jobs available, the greater the benefits of using tests, even with validity indices of less than .3 (Cronbach, 1998; Gottfredson, 1997).

A large-scale study carried out by the US Army, *Project A*, demonstrates that intelligence is the best predictor of work performance (McHenry, Hough, Toquam, Hanson and Ashworth, 1990). Specific ability, interests, personality traits and temperament contribute little to the prediction of general work performance. In spite of this, general intelligence predicts more poorly than these other psychological variables other aspects of work, such as personal discipline or physical fitness. The results demonstrating this are shown in Table 4 (N=4.039; k=number of variables).

It is important to bear in mind that general intelligence is less related to jobs in which the person knows exactly what s/he must do, that is, when what the worker has to do consists in following a series of previously-specified steps (routine work). Experience is especially important in jobs that are learned through experience, rather than through training (Gottfredson, 1997; Hunt, 1995 a and b).

In this context, it has been suggested that with a sufficient level of training, low-ability subjects may attain the performance level of high-ability subjects. However, the available data indicate that this is not the case (Sticht et al., 1987). Training does not improve general ability, though it may have some effect on specific skills related to the work in question. Furthermore, nor does extensive experience in a job (5 years is generally considered as a minimum) eliminate differences in performance between the highest and lowest-ability workers (Schmidt et al., 1988). The studies by Ackerman (1987) have shown that performance differences are not reduced with practice, and that they actually increase when the activities involved in the work cannot easily be automated. In these cases, that is, when the work requires systematic changes, intelligence plays an especially relevant role. If we consider the forecasts that this is what work will be like in the Third Millennium (Hunt, 1995 a), it would appear that scientists, and especially psychologists, are faced with a research field with important social implications.

Table 2
Validity coefficients of general intelligence for civil and military work, according to whether the criterion measurement consists in a sample of the work carried out by the worker or in supervisor ratings (Hunter, 1986)

Criterion	Civil work	Military work
Sample of work (hands-on)	.75	.53
Supervisor ratings	.47	.24

Table 3
Validity for work categories varying in complexity, according to whether the prediction refers to the job itself or to training courses for the job (Hunter and Hunter, 1984)

	Validity for… Performance/execution	Training
WORK CATEGORIES		
High complexity	.58	.5
Medium complexity	.51	.57
Low complexity	.4	.54

Why do standardised measures of intelligence predict?
Essentially, because they measure *g*. There are two basic generalisations about *g* worthy of mention:

(1) *g* is not related to the specific content of test problems or their superficial characteristics. This constitutes the *principle of the indifference of the indicator*.

(2) *g* is related to the complexity of the cognitive activity demanded by the problems, that is, grasping the relationships between elements, abstract concepts, reasoning, analysing, finding common characteristics among superficially different elements, and making conclusive inferences based on the information.

One of the main reasons why it is sometimes considered that intelligence tests cannot make relevant predictions about daily life performance is that their items often appear to be unrelated to everyday activities. However, this is no more than an appearance. The content of the tests is of least importance; the key aspect is their complexity. An example is the digits subtest of the WAIS: with exactly the same type of content the subtest can be converted into a more or less complex task. The more complex version is more closely related to general intelligence (*g* factor) than the simpler version. Another example can be observed in level of vocabulary. Although it may appear that richness of vocabulary derives from simple passive exposure to words and their meanings, the key is actually in the process of inference of meanings (acquiring vocabulary involves a process of distinction and generalisation of concepts). Thus, contrast, abstraction, inference, and the search for similarities and differences constitute some of the key elements of intelligence, as manifested in reasoning, problem-solving and the acquisition of new concepts.

As long as the task, whatever its type, involves complexity, novelty, uncertainty, mental manipulation of the elements of the problem, or recall of relevant aspects of the information, *g* takes on importance. This *g* can be measured precisely through standardised IQ tests. The average correlation between the IQ tests most commonly used in professional practice is .77. The square root of this correlation (=.88) is an estimation of the average load of *g* in IQ tests in general. Thus, average *g* of IQ measures is between .80 and .90 (Jensen, 1988).

The problems with the highest load of *g* are those that require deductive or inductive reasoning, spatial visualisation, quantitative reasoning, and verbal knowledge and reasoning (meaning of words, distinctions between related words, synonyms-antonyms, verbal analogies, and reading comprehension). The best *g* problems make minimal demands of specialised knowledge. These characteristics of problems through which *g* is measured (so-called "vehicles of g") are shared with many everyday activities, and hence their strong predictive validity.

Socio-political debate on intelligence
Why are the results of scientific research on intelligence differences of such social importance? Why do they provoke heated debates of a socio-political nature? Essentially, because of the social phenomena with which standardised measures of intelligence are associated, i.e., because of their social correlates. Despite the fact that standardised tests for measuring intelligence have not been designed for this purpose, their scores are associated in a positive way with, among others, the following social phenomena: achievement motivation, altruism, creativity, emotional sensitivity, health, income, interests, leadership, moral development, occupational level, response to psychotherapy, socio-economic level, values, and attitudes. Likewise, scores in these tests are negatively associated with, among others, the social phenomena of: tendency to have accidents, alcoholism, authoritarianism, conservatism, criminal behaviour, dogmatism, lack of sincerity, impulsiveness, and poor health habits.

Table 4
Validity coefficients for predicting different facets of a series of jobs, calculated within Project A of the US Army (McHenry et al., 1990). It is observed that for predicting basic technical expertise, adding other predictors to general cognitive ability barely adds validity. However, for work aspects such as personal discipline, general ability contributes relatively little, whilst other variables, such as temperament, add validity.

WORK FACTOR	PREDICTORS					
	General cognitive ability (K=4)	General cognitive ability plus spatial ability (K=5)	General cognitive ability plus psychomotor and perceptual ability (K=10)	General cognitive ability plus personality and temperament (K=8)	General cognitive ability plus vocational interests (K=10)	General cognitive ability plus preference for a job (K=7)
Basic technical expertise	.63	.65	.64	.63	.64	.63
General performance as a soldier	.65	.68	.67	.66	.66	.66
Effort and leadership	.31	.32	.32	.42	.35	.33
Personal discipline	.16	.17	.17	.35	.19	.19
Physical fitness and military relations	.20	.22	.22	.41	.24	.22

The Bell Curve, by Herrnstein and Murray (1994), has given rise to the fiercest public debate of recent times about a book with psychological content. Possibly, the reason for this is that the book not only deals with the role of individual intelligence in the development of different aspects of US society, but that it also, on the basis of certain data, makes suggestions about social policy. Thus, the book has two distinct parts. The first is a description, based on the results of a series of empirical studies, of the role of intelligence and its effects at various levels of society; the second is a prospective exercise about the future of that society. This second part proposes certain social policies to avoid the dangers allegedly deriving from the present situation. In general, this book is aimed at the general public, not at experts in the psychology of intelligence, with the intention of presenting a rigorous treatment of the issue to a general readership. The objective of making an impact that goes beyond the scientific community has been achieved in no uncertain terms.

If we had to summarise the political vision represented in *The Bell Curve*, we might say it was Jeffersonian. In an interview for the journal *Skeptic*, Murray remarks: "If we were in the early 1960s, Dick Herrnstein and I would be describing a vision of America to which everyone would respond 'of course'. It's a vision according to which people put different things on the table. The important thing is that everyone is given the opportunity to get as far as their temperament, their energy, their characteristics and their intelligence let them. The crucial factor for a harmonious society is not equality of results, but an abundance of opportunities".

In essence, Herrnstein and Murray (1994) maintain that the society of the future will basically be stratified according to intelligence differences, so that social mobility will be markedly influenced by these differences. This kind of division is already giving rise to a cognitive elite and subclass, in which the key factor is intelligence, not one's social status or class of origin. These authors consider that this division will have important repercussions for the social dynamic, and they express some degree of fear, going as far as speculating on the notion of a kind of guardian state in which the cognitive elite will impose its norms from a centralised authority, and in which the cognitive subclass will be relegated to ghettos under strict and centralised police control. The author's response to this perspective is decentralisation, that is, a return to what they consider "the original and genuine American ideal".

Social correlates of intelligence

These correlates are usually shown in the form of graphs or tables representing the percentages of people within each segment of the IQ distribution according to the social phenomenon in question. Moreover, given that the majority of these social variables correlate with age and SES, statistical techniques are necessary for separating out their effects on the social variable of interest.

This type of analysis has been carried out by, among others, Herrnstein and Murray in *The Bell Curve*, on the basis of data from a representative sample (N=11,878) of adults from the *National Longitudinal Study of Youth* (NLSY), carried out in the US in the 1980s and 90s. Table 5 shows the probability (percentage) with which the people situated in one of the five segments of the IQ distribution present a series of social variables.

The data in Table 5 show a practically linear relationship between IQ and various social phenomena. Both age and SES were controlled statistically before the presentation of these data; this permits us to observe the effect of IQ in a more isolated way. If instead of observing the effect of IQ we wish to consider the isolated effect of SES, it can be seen that its relationship with these social phenomena is clearly weaker. Let us examine this in more detail.

Herrnstein and Murray employed a technique called logistic regression. First, they defined a binary social variable, such as having an income below the official poverty line, and then observed the probability of a person being at the disadvantaged end of this variable's continuum as a combined function of several predictors, such as IQ, SES and education. Due to a series of mat-

Table 5
Summary of some results found by Herrnstein and Murray (1994) on analysing data from the National Longitudinal Study on Youth (NLSY). The MEAN row is based on more data than that shown in the table, and shows the proportion of social problems linked to the different IQ ranges in this US sample

Social correlate	IQ level				
	<75	75-90	90-100	110-125	>125
High school qualification	0	1	8	38	75
Below official poverty line+	26	14	7	4	1
Dropped out of school+	64	26	6	1	0
Unemployed one month per year (males)+	14	11	8	6	4
Disability in employment (males)	62	45	37	21	13
Divorced within 5 years of marriage+	32	26	21	17	12
Mother with first child illegitimate+	34	22	14	8	4
Illegitimate children	32	17	8	4	2
Chronic dependence on social welfare+	28	20	14	10	7
Mother gives birth to underweight baby+	7.2	5	3.5	2.3	1.5
MEAN (excluding first variable)	33.8	20	12.7	7.5	4.3

+Effects of age and family SES statistically controlled

hematical problems, it was not possible to observe directly the probability of, for example, level of poverty. On the other hand, it was possible to calculate a regression equation. In this equation, *p* is the probability of being in a situation of poverty. A logarithmic expression based on *p* is related to IQ, SES, education (ED), and so on, with the regression coefficient for each one of these variables (the B terms).

$$\text{In } (p/(1-p)) = A + B\ IQ\ (IQ) + B\ SES\ (SES) + B\ ED\ (ED) + \ldots$$

If all the variables are expressed in *z* scores, the relative importance of each variable as a predictor can be determined by comparing the regression coefficients. Thus, for example, in the case of poverty, the regression coefficient for IQ is –0.84 and the regression coefficient for SES is –0.33. That is, the risk of poverty increases as family IQ and SES decrease. However, given that the absolute value of the regression coefficient of IQ is greater than the absolute value of the regression coefficient of SES, it is therefore concluded that the risk of poverty is more sensitive to changes in personal IQ than to changes in family SES.

These are the typical results that can be observed in the NLSY: IQ is the best predictor of being below the official poverty line, of dropping out of school and of being dependent on the state. IQ and SES predict, in equal measure, the risk of long-term unemployment or the risk of divorce. According to Hunt (1995 b), since the publication of *The Bell Curve*, several authors have re-analysed the NLSY data, finding similar results to those of Herrnstein and Murray (1994): intelligence is a sound predictor of the usual indicators of social problems considered in the sociodemographic studies commonly carried out on societies such as that of the US (or in Europe).

However, though the empirical evidence presented by the authors of *The Bell Curve* appears to be well founded (and moreover, is open to review and checking), it is their proposals for social action that have provoked most criticism. These criticisms have suggested that Herrnstein and Murray (1994) are in favour of policies of the withdrawal of support for the socially disadvantaged –in short, a reduction of the social benefits provided by a welfare state. This is not the place to enter into an analysis of whether these criticisms correspond exactly to what these authors are really suggesting, since this would go beyond our brief; what is clear is that the condemnations of their work constitute a clear example of the type of reaction often incited by socio-political proposals in which human intelligence appears to play some role.

The complexity of modern societies

Currently, it is difficult to find jobs for people with an IQ of between 75 and 80, with the result that this area of the cognitive distribution has become a high-risk zone. In modern society, employers tend to look for people with a high capacity for learning by themselves and working without intensive supervision, especially as the level of complexity of jobs increases. Low-IQ subjects appear to have problems satisfying these demands. Why? To answer this question it should be borne in mind that intelligence is not the quantity of information people possess, but rather their aptitude for recognising, acquiring, organising, updating, selecting and efficiently applying that information.

On analysing the demands of modern jobs, we find a similar situation to that which we found on analysing the items in intelligence tests. That is, the higher the level of cognitive complexity, the greater the relevance of intelligence. This is illustrated in Table 6 (Arvery, 1986):

It is important to stress that previous training and experience do not prepare workers for all types of eventuality. And this is especially important in the most complex jobs, which demand systematic updating of the knowledge necessary for carrying out the work. Complex tasks require the application of the knowledge learned, but they may also require the acquisition of new knowledge in a rapid and precise fashion. Thus, knowledge is an instrument that people use with different levels of competence in different situations. The ease with which these instruments are accumulated (trainability) and the competence with which they are applied (efficiency in the task) frequently depend to a large extent on general intelligence (*g*), especially when people's work is not closely supervised.

Nevertheless, it should not be forgotten that the effects of intelligence are probabilistic, not deterministic. It is true that high intelligence improves the possibilities of success in school and work, but it does not in itself guarantee such success. Other things are also important. However, a high level of intelligence works like the small percentage (2.7%) that favours the bank in roulette –that is, it produces enormous benefits in the long run. Everyone makes foolish decisions from time to time, but high intelligence prevents the accumulation of too many of these decisions.

There is no doubt that complexity enriches social and cultural life, but it also increases the probability that some people will get left behind. Democracies should perhaps be concerned about the social inequalities that may be produced by the increase in cognitive complexity of modern societies. Can anything be done to prevent this situation of inequality?

The new types of job, as well as many everyday activities, reward high-level thinking, learning and information-processing skills, i.e., they reward intelligence. The most brilliant people, families and communities will take advantage of the growing social complexity, but this will tend not to be the case of the not-so-brilliant. The situation is complicated, since, while social actions may produce an overall improvement, it is possible that this will not reduce the previous differences (the mean can be raised without changing the variance at all: Detterman and Thompson, 1997).

Ignoring these logical forecasts may be enormously prejudicial to the chances of improved development for the socially disadvantaged. However, heeding them will involve the active participation of psychologists, who up to now have remained on the sidelines as other professionals, such as sociologists, economists or anthropologists, went about their business.

Is it possible to increase intelligence?

Programmes for the improvement of intelligence have been few, but well financed and exhaustively analysed (Jensen, 1981), and after half a century of trying, we still do not know whether or not it is possible to increase cognitive performance in the long term. The majority of studies aimed at increasing long-term cognitive performance have focused on children in deprived environments. Some of the conclusions they have reached are as follows: (a) IQ of pre-school children is more malleable than that of older children. Programmes that begin earliest and are maintained for longest are those that produce the highest gains; (b) IQ gains are more pronounced in the early stages of life; (c) initial gains tend to disappear between one and three years after the end of the programme; (d) the effects of intervention on some of the main life phenomena correlated with IQ are weaker, and disappear even more quickly after completion of the programme.

The response that psychology can honestly offer at the present time is socially disconcerting. In the words of the APA: "pre-school programmes and similar interventions usually have positive effects, but in the majority of cases the gains disappear when the programme finishes" (Neisser et al., 1996).

Changes in performance in a given intelligence test are possible, but producing long-term changes in *g* is a substantially different matter. Test problems are, as mentioned earlier, "vehicles of g", but they are not *g*. All organisms with a nervous system can learn, but what they learn about specific vehicles used for measuring *g* is not *g*. When we speak of increasing cognitive performance we are thinking of increasing *g*, since our real aim is to improve performance in the life correlates of intelligence, something to which we could aspire if *g* actually were a question of training.

It is also important to distinguish between gains at an individual level and gains at a group level. Thus, for example, a gain of 5 IQ points in a particular person is not especially relevant for his or her life. However, a group gain of 2 or 3 points may have important consequences at the level of population, if we assume that the distribution has moved up. A group gain of 5 points would double the percentage of persons with IQ over 130, and would halve the percentage of those with IQ under 70. The educational, social and economic consequences of this populational change could be highly important. Thus, at the level of population, we should take careful notice of such changes in IQ, as long as it can be demonstrated that they represent a change in *g* (Colom et al., 1998; Flynn, 1987; Neisser et al., 1996).

In spite of the pessimism in science's response to the question of whether intelligence can be increased, we believe it is possible, and even desirable, to offer an alternative interpretation of the evidence available. Better education and training can increase the mean level. We believe that in the society of the Third Millennium it will be necessary to increase citizens' cognitive competence. The technological nature of society will increase the opportunities available for the most competent, but also the problems for those who cannot keep up to date. The cognitive skills necessary for being a functional member of modern society are increasing (Hunt, 1995 a and b). Therefore, the social investment that can improve training and education will not only be beneficial, but indeed essential.

An alternative to improving education, though not at odds with it, would consist in conceiving ways of sim-

Table 6
Factor loading of a series of aspects related to jobs. It is observed that the greater the complexity, the greater the factor loading (Arvey, 1986)

Aspects	Relevance (factorial load)
Dealing with unexpected situations.	.75
Ability for learning and recalling information relevant to the job.	.71
Ability for reasoning and making judgements.	.69
Ability for rapid identification of problem situations.	.69
Capacity for reaction to unexpected problems.	.67
Ability for applying common sense for solving problems.	.66
Ability for learning new methods quickly.	.66
Being alert for understanding situations.	.55
Ability for comparing information from two or more sources to reach a conclusion.	.49

plifying the cognitive demands modern society imposes on its citizens. If, in reality, there are substantial numbers of citizens with problems for adapting to the new and ever-changing technological demands, we might consider ways of simplifying the psychological implications of these demands. Nevertheless, this alternative may be counterproductive in some ways (Gottfredson, 1997).

In sum, psychologists will have much to say in the society of the Third Millennium. Matters that have up to now been the practically exclusive preserve of other social scientists will almost surely become, priority issues for psychology. In this sense we agree with Hunt (1995 b) that "there are fascinating questions for those interested in the intersections of sociology, economics, anthropology and psychology. As yet we have no answers. But we shall soon need them".

Intelligence in twenty-first century society

As we have maintained elsewhere (Andrés-Pueyo and Colom, 1998), our belief is that social scientists must try to reach an understanding. The social panorama on the horizon as we enter the twenty-first century will oblige such an understanding. Having overcome our discrepancies, we shall begin to ask ourselves truly important questions with a view to helping the disadvantaged. As Sandra Scarr (1988) argues, we desperately need serious research that tells us what we need to do in order to help those without representation to be successful in our society. Believing they are protecting disadvantaged groups, some scientists have contributed to delaying the design of programmes for social improvement. The monographic issue of *Intelligence*, co-ordinated by Linda Gottfredson (1997), and which includes contributions by social scientists from a variety of disciplines, is an example of the call for understanding within the scientific community.

Social scientists have made reference to two general views of the world in defining the concept of "socially disadvantaged person". One of these supposes that people find themselves in this position because of the conditions in which they have had to live: the world is a system, societies are systems and everything interacts to produce socially disadvantaged people. When conditions are adverse people find themselves doomed to coping with disadvantage. If we want to bring about social change, the key element will not be the person, but rather our capacity for influencing societies as systems.

The other view of the world, and that which is closer to psychology, supposes that the person is actively involved in the determination of his or her social position. Though society can indeed be conceived as a system, it means little without the specific people of whom it is made up. One of the immediate consequences deriving from this conception of society is that the social conditions present at a given moment are not "determinant". A person born in a poor family is not condemned to be poor. While it is undoubtedly true that socio-economic status constitutes a relevant social variable, it does not appear to be the only factor that defines whether or not a person will be disadvantaged. Gottfredson (1997) points to the relative failure of the majority of social policies aimed at reducing disparities of an educational, occupational or any other nature that assume that simply by facilitating the access of more adolescents to social environments typical of middle-class families their conditions will improve. Far from suggesting that this should lead us to stop trying to reduce socio-economic disparities, the proposal is to think of new strategies that may be more efficient. Social scientists should cease to assume that people are the passive product of their genes or environments, and adopt a view of human behaviour in which *the person is an active being*.

The anger unleashed against the ideas put forward in *The Bell Curve* has been possibly the most virulent that psychology has witnessed in its history. We believe that Herrnstein and Murray's work has been caricaturised, and their frequent calls for caution ignored. According to its authors, *The Bell Curve* does not suggest ceasing to improve social policy, but rather a re-think on how to make progress. In their view, a harmonious society would require real equality of opportunity. Is Herrnstein and Murray's approach open to question? Of course, but it should not be questioned through the manipulation of what they originally said, or the creation of men of straw. Social problems demand the utmost seriousness of social scientists, not dialectical juggling or emotional accusation and dismissal. In the words of Eysenck (1971): "let us leave aside rhetorical discussion and philosophical speculation and devote ourselves to the work necessary for achieving what all right-thinking people want –the progress and rehabilitation of the underprivileged".

The basic thesis of *The Bell Curve*, as already mentioned, is that intelligence level constitutes a better predictor of stratification in highly technological modern societies than family socio-economic status. In the language of the two views of the world to which we referred above, the person would appear to count for more than certain social variables. Does this thesis

make social variables irrelevant? No. Does it make them less important than they have been thought to be? Yes. Psychological variables such as intelligence constitute solid predictors of the usual indicators of social problems. Does this mean that family socioeconomic status is irrelevant? No. It means that mobility in modern society is more closely related to intelligence than to social origin: a young person that has grown up in a home where one or both parents are unemployed, work in unskilled jobs or have only basic education, but whose IQ is 100, has a 90% probability of escaping from his or her situation of poverty. And vice-versa –a young person raised in a middle-class family, but with a below-average IQ, will constantly be threatened by poverty, despite his or her social support. According to psychologists David Lubinski and Lloyd Humphreys (1997), the welfare of society and its members, especially the most disadvantaged, demands that we consider in a constructive way the intelligence variable and its effects. A collective attitude of avoidance and negation undermines the reflection necessary for reducing the social divisions that such an attitude is believed to be aimed at combating, but in fact only aggravates.

The resolution of the social problems besieging us, and which we will foreseeably deal with in the course of the twenty-first century, are too important to allow ourselves to become entangled in accusations and counter-accusations that may further delay their proper consideration. Failing to study from different perspectives the question of the socially disadvantaged may lead us to overlook variables that could be crucial to a better definition of the problem, and consequently to the search for specific paths towards a solution. Will we be wise enough to look for answers to the important questions with patience and scientific impartiality, or will we go on trying to solve human problems on the basis of all sorts of prejudice? The answer to this question may be more important than we think.

As scientists, we believe that an enlightened society is preferable to one that is not enlightened, and that, in consequence, all ideas should be discussed in an atmosphere of tolerance and respect. There is no absolute criterion with which to compare our society, so that, in principle, any idea merits calm and impartial discussion. Nevertheless, what we do firmly believe is that there is an idea which should admit no further discussion: whatever we do, scientists should never allow anyone to question the need to help the socially disadvantaged.

REFERENCES

Ackerman, P. L. (1987): Individual differences in skill learning: an integration of psychometrics and information processing perspectives. *Psychological Bulletin, 102*, 3-27.

Anastasi, A. (1996): *Psychological testing (7th Edition)*. New York: MacMillan.

Andrés Pueyo, A. (1994): *La inteligencia como fenómeno natural*. Valencia: Promolibro.

Andrés Pueyo, A. (1996): *Inteligencia y cognición*. Barcelona: Paidós.

Andrés Pueyo, A. (1997). *Manual de psicología diferencial*. Barcelona: McGraw-Hill.

Andrés Pueyo, A. and Colom, R. (1998): *Ciencia y política de la inteligencia en la sociedad moderna*. Madrid: Biblioteca Nueva.

Arvey, R. D. (1986): General ability in employment: a discussion. *Journal of vocational behavior, 29*, 415-420.

Brody, N. (1992): *Intelligence (2nd Edition)*. San Diego: Academic Press.

Carroll, J. B. (1993): *Human cognitive abilities. A survey of factor analytic studies*. Cambridge, Cambridge Univ. Press.

Carroll, J. B. (1997): Psychometrics, intelligence, and public perception. *Intelligence, 24, 1*, 25-52.

Colom, R. (1995): *Tests, inteligencia y personalidad*. Madrid: Pirámide.

Colom, R. (1997 a): *Capacidades humanas (2ª edición)*. Madrid: Pirámide.

Colom, R. (1997 b): *Orígenes de la diversidad humana (2ª edición)*. Madrid: Pirámide.

Colom, R. (1998): *Psicología de las diferencias individuales. Teoría y práctica*. Madrid: Pirámide.

Colom, R. (1999): Quien mucho abarca poco aprieta. *Papeles del Psicólogo, 72*, 57-60.

Colom, R., Andrés Pueyo, A. and Juan-Espinosa, M. (1998): Generational IQ gains: Spanish data. *Personality and Individual Differences, 25, 5*, 927-935.

Cronbach, L. (1990): *Essentials of Psychological Testing* (*5th Edition*). New York: Harper & Row. Translation: *Fundamentos de los tests psicológicos*. Madrid: Biblioteca Nueva, 1998.

Detterman, D. and Thompson, L. A. (1997): What is so special about special education? *American Psychologist, 52, 10*, 1,082-1,090.

Eysenck, H. (1971): *Race, intelligence and education*. London: Maurice Temple Smith.

Eysenck, H. J. (1983): *Estructura y medición de la inteligencia*. Barcelona: Herder.

Flynn, J. (1987): Massive IQ gains in 14 nations: what IQ tests really measure. *Psych. Bulletin, 101*, 171-191.

Goleman, D. (1996): *Inteligencia emocional*. Barcelona: Kairós.

Gottfredson, L. (1997 a): Why *g* matters: the complexity of everyday life. *Intelligence, 24, 1*, 79-132.

Gottfredson, L. (1997 b): Foreword to "Intelligence and Social Policy". *Intelligence, 24, 1*, 1-12.

Gottfredson, L. et al. (1994): Grandes acuerdos de los científicos sobre la inteligencia. In A. Andrés Pueyo and R. Colom (comps., 1998): *Ciencia y política de la inteligencia en la sociedad moderna*. Madrid: Biblioteca Nueva.

Herrnstein, R. and Murray, Ch. (1994): *The Bell Curve. Intelligence and class structure in American life*. New York: Free Press.

Hunt, E. (1995 a): *Will be we smart enough? A cognitive analysis of the coming workforce*. New York : Russel Sage Foundation.

Hunt, E. (1995 b): El papel de la inteligencia en la sociedad moderna. In A. Andrés Pueyo and R. Colom (comps., 1998): *Ciencia y política de la inteligencia en la sociedad moderna*. Madrid: Biblioteca Nueva.

Hunt, E. (1997): Nature vs. Nurture: the feeling of vujá dé. In R. Sternberg and E. Grigorenko (Eds.): *Intelligence, Heredity and Environment*. Cambridge, Cambridge Univ. Press.

Hunter, J. E. (1983): *Overview of validity generalization for the U.S. employment service*. (USES Test Research Report N1 43): Washington, DC: U.S. Department of Labor, Employment and Training Administration.

Hunter, J. E. (1986): Cognitive ability, cognitive aptitudes, job knowledge, and job performance. *Journal of vocational behavior, 29*, 340-362.

Hunter, J. E. and Hunter, R. F. (1984): Validity and utility of alternative predictors of job performance. *Psych. Bull., 96*, 72-98.

Jencks, C. (1972): Inequality: a reassessment of the effect of family and schooling in America. New York: Basic Books.

Jencks, C. (1979): *Who gets ahead? The determinants of economic success in America*. New York: Basic Books.

Jensen, A. (1980): *Bias in mental testing*. New York: Free Press.

Jensen, A. (1981): *Straight talk about mental tests*. London: Methuen.

Jensen, A. (1998): *The g factor.* London: Praeger.

Jones, J. E. and Bayley, N. (1941): The Berkeley Growth Study. *Child Development, 12*, 167-173.

Juan-Espinosa, M. (1997): *Geografía de la inteligencia humana*. Madrid: Pirámide.

Lubinsky, D. and Humphreys, L. (1997): Incorporating general intelligence into epidemiology and the social sciences. *Intelligence, 24, 1*, 159-201.

McHenry, J. J., Hough, L.,M., Toquam, J.,L., Hanson, M.A. and Ashworth, S. (1990): Project A validity results: the relationship between predictor and criterion domains. *Personnel Psychology, 43*, 335-354.

Moffitt, T. E., Caspi, A., Harkness, A. and Silva, P. (1993): The natural history of change in intellectual performance: who changes? How much? It is meaningful? *Journal of Child Psychology and Psychiatry, 34*, 455-506.

Neisser, U., Boodoo, G., Bouchard, T., Boykin, A., Brody, N., Ceci, S., Halpern, D., Loehlin, J., Perloff, R., Sternberg, R. and Urbina, S. (1996): Inteligencia: lo que sabemos y lo que desconocemos. In A. Andrés Pueyo and R. Colom (comps., 1998): *Ciencia y política de la inteligencia en la sociedad moderna*. Madrid: Biblioteca Nueva.

Scarr, S. (1988): Race and gender as psychological variables. *American Psychologist, 43, 1*, 56-59.

Schmidt, F. L., Hunter, J. E., Outerbridge, A. N. and Goff, S. (1988): Joint relation of experience and ability with job performance: test of three hypotheses. *Journal of Applied Psychology, 73*, 46-57.

Snyderman, M. and Rothman, S. (1988): *The IQ controversy, the media, and public policy*. New Jersey: Transaction.

Stich, T. G., Armstrong, W. B., Hickey, D. T. and Caylor, J. S. (1987): *Cast-off youth: policy and training methods from the military experience*. New York: Prager.

Sternberg, R. et al. (1981): People's conception of intelligence. *Journal of personality and social psychology, 41, 1*, 37-55.

Sternberg, R. and Grigorenko, E. (Eds.) (1997): *Intelligence, heredity, and environment*. New York: Cambridge Univ. Press.

Wechsler, D. (1971): Intelligence: definition, theory and the IQ. In Cancro, R. (Ed.) *Intelligence: genetic and environmental influences*. Grune Straton. New York.

White, K.R. (1982): The relation between socioeconomic status and academic achievement. *Psych. Bulletin, 91*, 461-481.