16

Diagnosis

- Diagnosis rarely uses deductive logic, but instead uses inductive logic to make diagnoses from imprecise, uncertain, probabilistic data.
- BAYES' THEOREM can be used by computer programs to calculate the probability of particular diseases given that particular symptoms are present.
- Computers can be more accurate at diagnosis than skilled physicians, not because doctors do not use Bayes' theorem appropriately but because doctors have an inaccurate data base of symptom and disease probabilities.
- When making diagnoses doctors start out with a very rapid EARLY HYPOTHESIS GENERATION, which is followed by CUE INTERPRETATION, and finally HYPOTHESIS EVALUATION.
- Experienced diagnosticians do not manipulate information differently from beginners, and neither do they consider a broader range of disease alternatives; instead they are like chess grandmasters in having a broader range of experiences against which to match the particular symptoms that they find in a patient.
- Inexperienced clinicians are often misled by FORCEFUL FEATURES; precise, easily analysed symptoms which are not strictly relevant to the actual, rather vague, symptoms with which patients have presented.

Hippocrates (ca. 460 BC–ca. 377 BC) recognized that diagnosis is the core of the entire medical enterprise. If an accurate diagnosis is made then, and only then, can an accurate prognosis be given, and appropriate treatment instituted. Surprisingly, diagnosis as a skill has hardly been studied until the past two decades. As one researcher put it:

> 'There is no more important field in medicine than diagnosis. Without it, we are charlatans or witch doctors treating in the dark with potions and prayers. Yet there is no field more difficult to teach. Strange that this art and science has not attracted innumerable theorists to make it more teachable! Thousands are studying membrane transfer, yet few strive to make a science of diagnosis.' (Cutler (1979) *Problem solving in clinical medicine. From data to diagnosis*, Baltimore, Williams and Wilkins)

The recent renaissance of interest in diagnosis has two origins: a growing interest by cognitive psychologists in the high level skilled activities involved in decisions and judgements by experts (and which are more 'natural', 'realistic' and 'ecological' than the sometimes artificial laboratory studies); and a demand fuelled by cheap, powerful microcomputers for programs to help with complex (and hence error prone) skills such as diagnosis. This demand for EXPERT SYSTEMS, imbued with ARTIFICIAL INTELLIGENCE, has focused attention upon the mechanisms used by real experts with 'natural intelligence'. The problems of understanding diagnosis as a skill can be seen by considering one popular form of expert system, which has been used for diagnosis, and comparing it with the same process as carried out by real doctors.

The earlier quotation by Cutler mentioned 'this art and science'. These terms are used in many ways, but one is that the *science* uses logical deduction, in which certain premises imply particular consequences (see Chapter 5). 'If, and only if, this patient has fresh blood in the cerebrospinal fluid, then subarachnoid haemorrhage can be diagnosed'. Such situations are fairly rare in clinical practice, and diagnosis in general uses not deductive logic but a form of inductive logic, in which a specific diagnosis is inferred from data which are only probabilistic. This manipulation of probabilities, likelihoods, relative risks, and the making of judgements under uncertainty, is the *art* of medicine. Consider the case of a patient with appendicitis. The appendix may simply be inflamed or it may have become gangrenous, a more serious condition needing immediate surgery, and having a greater morbidity and mortality. In one series of patients with appendicitis, the appendix was gangrenous in 29%. Patients with a gangrenous appendix are less likely to have audible bowel sounds, and hence it is routine examination in cases of acute abdomen to use a stethoscope to listen for bowel sounds. If a patient had appendicitis then, knowing nothing else about them, they have a probability of 0.29 of having a gangrenous appendix. Auscultation reveals no bowel sounds. Must the patient have a gangrenous appendix? No: many patients without bowel sounds have a normal appendix. However, the new information does make it *more likely* that our patient has a gangrenous appendix. If we have some background information then how much more likely can be calculated from BAYES' THEOREM (first formulated by the Rev. Thomas Bayes (1702–1762). Amongst all patients with appendicitis, 10% do not have bowel sounds, and in those with gangrene, 21% do not have bowel sounds. Bayes' theorem can be stated formally as:

$$p(disease \mid symptom) = \frac{p(disease) . p(symptom \mid disease)}{p(symptom)}$$

The vertical line or 'solidus' means 'given that', and *p*(disease | symptom) is the conditional probability that a patient has a particular disease given that they have a particular symptom. Such abstract quantities are not easy to comprehend, and a more concrete form is:

$$p(gangrene \mid no\ bowel\ sounds) = \frac{p(gangrene) . p(no\ bowel\ sounds \mid gangrene)}{p(no\ bowel\ sounds)}$$

We can now substitute the specific numbers mentioned above and calculate the probability that our particular patient has gangrene:

$$p(gangrene \mid no\ bowel\ sounds) = \frac{.29 \times .21}{.10} = .61$$

Knowing that our patient lacks bowel sounds therefore substantially increases the probability of a gangrenous appendix, making it twice as likely, although still not a certainty. The addition of further symptoms and signs, such as generalized abdominal tenderness, fever, and leucocytosis could all be included in the equation in a similar way, until eventually a sufficiently high probability is reached that we would decide to operate on the patient.

Computers have been programmed to use Bayes' theorem to diagnose many conditions, using basic information collected by non-medically qualified staff. One study looked at all patients in accident and emergency with an 'acute abdomen' (abdominal pain of recent onset). Although many diagnoses were made by the computer, here we need only differentiate two classes, those requiring immediate surgery and those not. In 45% of cases a correct diagnosis was made by the casualty officer, in 55% of cases by the surgical house-officer, in 70% of cases by the surgical registrar, and in 81% of cases by the consultant surgeon (in each case using identical information to that available to the computer). These differences between doctors can be explained in terms of different experience. Most interestingly, the computer was correct in 91% of cases, more accurate even than a consultant surgeon.

It may be felt that the computer had an unfair advantage in being presented with all the available information, much of which would be redundant and not normally collected by an astute doctor. However, computers using Bayes' theorem can also examine information sequentially, at each step choosing the item which is most informative (and if their cost differs, selecting the item with the best cost-benefit ratio). Figure 16.1 shows such an analysis, in a patient with jaundice, eleven categories of liver disease being considered. At each step the computer chose a piece of information from a list of 45 symptoms, signs and laboratory tests which gave the maximal amount of information. In Figure 16.2, in a study of non-toxic goitre, only three classes of diagnosis need be considered, and hence the relative probabilities of the three conditions can be plotted within a triangle. The computer (dashed line) moves in a smooth path from its initial position to the final diagnosis. Clinician 5 behaves similarly, whereas clinicians 3 and 6 take no note of much information they have asked

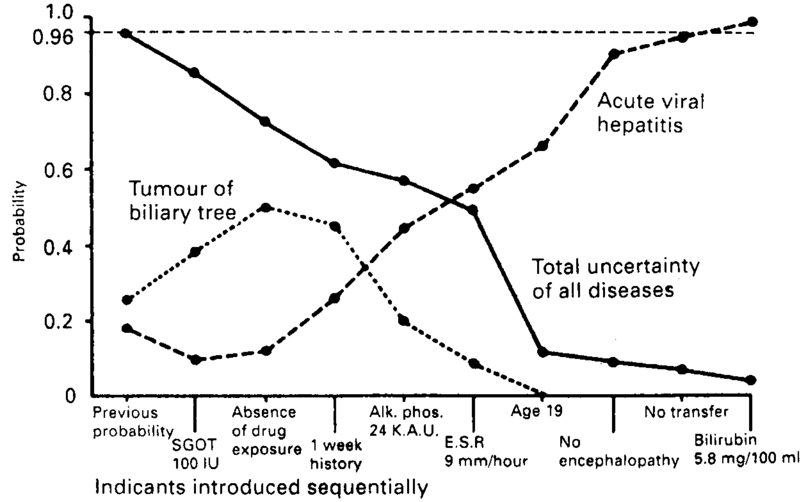

Fig. 16.1 An example of a computer sequentially selecting items of information in order to differentiate maximally between eleven different causes of jaundice using Bayes' theorem at each step, and calculating the conditional probability of each condition. Only two diseases are plotted here (for clarity). The 'total uncertainty' is an estimate of the amount of ignorance remaining at each step. 'No transfer' on the abscissa indicates that the patient had not been transferred from another hospital to this particular specialist unit. Reproduced with permission from Knill-Jones R P, Stern R B, Grimes D H, Maxwell J D, Thompson R P H and Williams R (1973), Use of sequential Bayesian model in diagnosis of jaundice by computer, *Br Med J*, **1**, 530–3.

for, and clinician 6 in particular asks for six tests from which no information at all is apparently derived. Given such results we cannot say that the difference between computer and clinicians in the acute abdomen study was due to clinicians making sequential use of information.

Since the computer and clinician receive identical information before making a diagnosis, two possibilities arise. Either clinicians do not have an adequate set of base-line probabilities (i.e. $p(D)$, $p(S)$ and $p(D|S)$ in Bayes' theorem), or else they have such information but fail to integrate it optimally with Bayes' theorem. That the former is the case is shown by two studies. Firstly, clinicians are frequently in error when asked to estimate probabilities. In one study, de Dombal asked six clinicians to estimate the proportion of patients with acute appendicitis in which pain is aggravated by movement; they estimated 26, 29, 30, 35, 43 and 54%, whereas in a series of 221 patients 62% had actually shown the symptom. A second study modified the earlier study of acute abdomen. Computer implementations of Bayes' theorem use a data base of probabilities calculated from all previous patients with that disease. Such a data base could also be estimated by a clinician drawing on their knowledge and experience. The study found

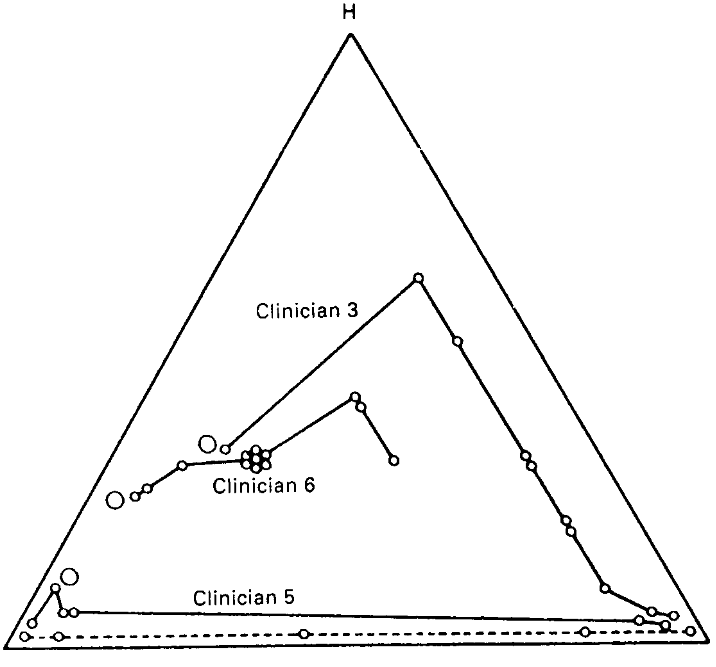

Fig. 16.2 Three clinicians and a computer (dashed line) diagnosing a patient with a non-toxic goitre, for which there are three main principal diagnoses possible: simple goitre (S), carcinoma of the thyroid (C), and Hashimoto's autoimmune thyroiditis (H). At each step, the clinician or computer asked for the results of a specific investigation and then stated what they thought were the relative probabilities of each diagnosis, and that judgement was entered as a single point in the triangle, the closer a point being to one corner then the more likely being that diagnosis. The patient in question actually had a carcinoma of the thyroid. Reproduced with permission from Taylor T R, Aitchison J and McGirr E M (1971), Doctors as decision makers: a computer-assisted study of diagnosis as a cognitive skill. *Br Med J*, **3**, 35–40.

that using its own data base the computer was correct in 91% of cases, the clinicians were correct in 80% of cases, and the computer using the clinicians' data base was correct in 82% of cases. We can conclude that clinicians are failing, relative to the computer, because they have an inaccurate data base, although Bayes' theorem was being applied adequately to those erroneous data.

An accurate data base of conditional probabilities does not just happen, but instead must be acquired, a process taking time and requiring experience of many patients, which probably explains the improved accuracy of the more senior, more experienced doctors. Of course mere exposure to patients does not necessarily produce an *accurate* data base, and as we have seen in Chapter 5, estimates of probability often err due to using faulty heuristics such as availability nd representativeness. If lack of experience is the problem shown y students and junior doctors we may ask how experience can be mproved. Seeing more actual patients is one possible solution, lthough in practice it might be difficult to implement, work load lready being great. Reading stereotyped or exaggeratedly typical ase histories would not help, as the errors of availability and epresentativeness would then be exaggerated further, as most patients re not 'typical', and it is the *variability* that produces diagnostic roblems. Case conferences and grand rounds may also exaggerate roblems, since patients are often presented *because* they are atypical, aving particularly bizarre or unusual features, which make them ery available for recall but would distort the overall data base. One ffective solution is to simulate patients on a micro-computer, so that ney have characteristics randomly drawn from the true population. ifty or a hundred different 'patients' could be seen in a morning, ith a diagnosis required for each one, and feedback being provided n errors and misconceptions. In the same way as much flying xperience of pilots is now obtained in flight simulators, particularly or dealing with emergencies, so patient simulators will probably play similar role in the future. The final way of acquiring the crucial robabilities is to examine the data base of the computer itself, as it as been put:

> 'Next to the fusty volumes in the ... library, with their loving descriptions of common, not uncommon, not so rare and rare disorders, will be the crisp new books that list the prior and the conditional probabilities of different states of health or illness. We need those books.' (Emerson P A (1979) *J Roy Coll Phys*, **13**, 185)

This chapter started by considering the problem of diagnosis as carried out *by doctors*, but has rapidly become side-tracked into a consideration of one very special way in which computers *can* make diagnoses. However, this does not provide any guarantee that such methods are the way in which doctors *actually* make diagnoses; indeed the abstruse nature of the equations, coupled with the very non-mathematical nature of many doctors, would seem to make Bayes' theorem a most unsatisfactory method of describing the behaviour of experienced doctors. The latter argument is in fact invalid (in the same way that when I catch a ball I must at some logical level be solving the appropriate equations of physical motion, although I may be profoundly ignorant of mathematical physics); nonetheless the criticism serves to highlight questions about the ways in which actual experts approach complex problems, albeit that their own introspections may not actually be an accurate guide to their true methods of solving the problems.

A range of studies have observed doctors making diagnoses in situations of differing degrees of realism. Some have video-taped real consultations and subsequently asked doctors to give a running commentary on their thought processes. Other studies have used actors who simulate patients, the doctors being asked to 'think out loud' as they talk to the 'patients'. A further variant adapts the game of 'Twenty Questions' and allows physicians to ask questions of a pseudo-patient, one item at a time, until a diagnosis is reached. The latter technique shows that clinicians who are more experienced ask less questions and get more information from each question than do inexperienced clinicians. A characteristic of all methods of study is that clinicians, be they experienced consultants or junior clinical students, show EARLY HYPOTHESIS GENERATION, with a list of four or five possible diagnoses being formed within the first few minutes of the consultation. This list frequently includes the final (but perhaps erroneous) diagnosis made by the clinician. The *number* of such hypotheses is unrelated to experience, and seems primarily to be limited by the capacity of working memory. The *nature* of the hypotheses, however, depends heavily upon experience and knowledge, experienced clinicians generating more hypotheses which usefully explain the patient's symptoms. The early hypotheses follow an initial process of CUE ACQUISITION, key items being extracted from the opening words of the patient. I only have to say 'A 58 year old man with a history of indigestion and weight loss' for experienced clinicians to be thinking 'carcinoma of the stomach/oesophagus; peptic ulceration; carcinoma of the pancreas' and they then ask specific questions to expand upon these and other related possibilities. Very many possible diagnoses will already have been implicitly excluded (e.g. prostatic hypertrophy, Alzheimer's disease, cystic fibrosis, Fallot's tetralogy, and diabetes inspidus), although those diagnoses might conceivably be returned to if necessary. The third stage, after cue acquisition and early hypothesis generation, is CUE INTERPRETATION; further information is collected by questioning and examination, to expand upon the early hypotheses and support or refute them, before the final stage of HYPOTHESIS EVALUATION. The hypotheses are systematically assessed and a final diagnosis reached, perhaps after creating further intermediate hypotheses. Experienced clinicians differ at each stage, although not in the way that they think or manipulate information, in the logic that they use, or in the range or depth of alternatives that they consider, but in the memory resources founded in experience that they apply to the task.

A similar process is clearly seen in a favourite subject for analysis of expert thought: the game of chess, with its most infinite numbers of variations and tactical subtleties. Grand masters do not think ahead more moves than amateurs, and neither do they try more combinations of moves, but rather for any specific situation they bring to bear a broader and deeper range of experience of similar situations, so that experience and practice can literally make perfect. This memory of previous games must not only be formed but also organized in a coherent manner reflecting the true possibilities of the game. As an example, chess masters are far superior to amateurs at remembering the positions of pieces placed in the middle play of a game of chess, but are no better at memorizing the positions of the same pieces placed *at random* on a chess board. The masters' experience of previous strategic play helps them understand, recall and organize the positions of the pieces only if those pieces are arranged in a manner truly compatible with an actual game of chess. A similar process occurs with experienced clinicians: patterns of symptoms fit together and evoke the recall of similar patterns from a well organized memory, derived from a lifetime of experience.

Diagnosis can sometimes be subverted, particularly in junior clinicians, by a FORCEFUL FEATURE, a piece of information that seems to suggest a particular range of hypotheses which are too constrained and do not include the actual diagnosis. This particularly occurs when a patient presents with diffuse symptoms (such as weakness or tiredness, for which there is a vast range of possible diagnoses). During history taking, another more forceful symptom is elicited (perhaps the suggestion of lower abdominal pain, for which specific hypotheses are readily generated), and much of the remaining consultation concentrates upon this all too forceful symptom. It was not a symptom that the patient presented with, but it is one with which the clinician feels comfortable (particularly if it includes an area of special expertise).

The problem with diagnosis as a skill is that it is highly ILL-DEFINED; it is not like solving Rubik's cube or doing The Times crossword, where the problem is well-defined, the relevant information and materials are specifically set out, and the solution is visible from afar. The diagnostician has to select the information that seems most useful from a vast range of possible items, must decide where to put most of the diagnostic effort, and must accept that much of the information which can be used is only probabilistic rather than absolute. Computers are only really good at solving well defined problems, as in the case in the programs described earlier for analysing the acute abdomen, jaundice or non-toxic goitre. Within such delineated areas, Bayes' theorem works well, and the processes of cue interpretation and hypothesis evaluation can be reasonably regarded as taking place in a similar way. The earlier stages though, of cue acquisition and early hypothesis generation, are not carried out well by computers, and they are the major stumbling blocks for junior, inexperienced clinicians who are lacking a conceptual data base in memory with which to derive adequate hypotheses for a subsequent more detailed analysis.

17

Ageing

- Erikson has identified three separate PSYCHOSOCIAL STAGES during adulthood, each with its associated CRISIS.
- CROSS-SECTIONAL studies of change during adulthood confound age differences with cohort difference, and are better replaced by CROSS-SEQUENTIAL studies.
- Intelligence and brain size are constant during adult life until about the age of 60, when a decline begins.
- The elderly suffer from a range of physical and sensory deficits which can exacerbate intellectual problems, and result in specific problems.
- SENILE DEMENTIA is a common problem in those over 75, and shows a characteristic sequence of decline in interests and abilities.
- Psychological treatment for senile dementia aims to be ameliorative, utilizing those abilities which are best preserved, minimizing inadvertent sensory deprivation, and using the environment as a COGNITIVE PROSTHESIS for failing memory and thought process.

Many things change with age, and the changes occur from early adulthood onwards. Some are physical and some psychological; some are continuous and others occur in stages, akin to child development. Life is continual change and adaptation, reflected in LIFE-SPAN DEVELOPMENTAL PSYCHOLOGY.

The American psychologist Erik Erikson (1902–) has identified eight PSYCHOSOCIAL STAGES OF DEVELOPMENT from birth to old age (Table 17.1), the first four being Freud's psychosexual stages (see also Chapters 10 and 11). Each stage has a critical problem or CRISIS to be overcome, successfully or unsuccessfully. Thus adolescence shows the well-known IDENTITY CRISIS, when individuals experiment to attain a firm and distinctive adult personality, copying from role models (friends, pop or sports stars, or ideals from philosophy or literature). Successful resolution of a crisis results in a BASIC STRENGTH, of long-lasting benefit for future stages. Table 17.1 also shows other characteristics assigned by Erikson to each stage.

Adulthood consists of three stages: EARLY ADULTHOOD, in which the major crisis is intimacy with others, in the form of love; MIDDLE ADULTHOOD, where caring is the basic virtue, and the crisis is the need to be GENERATIVE, producing objects of worth or quality for posterity

Stages	A Psychosexual stages and modes	B Psychosocial crises	C Radius of significant relations	D Basic strengths	E Core-pathology basic antipathies	F Related principles of social order	G Binding ritualizations	H Ritualism
I Infancy	Oral-respiratory, sensory-kinaesthetic (incorporative modes)	Basic trust *vs.* basic mistrust	Maternal person	Hope	Withdrawal	Cosmic order	Numinous	Idolism
II Early childhood	Anal-urethral, muscular (retentive–eliminative)	Autonomy *vs.* shame, doubt	Parental persons	Will	Compulsion	'Law and order'	Judicious	Legalism
III Play age	Infantile-genital, locomotor (intrusive, inclusive)	Initiative *vs.* guilt	Basic family	Purpose	Inhibition	Ideal prototypes	Dramatic	Moralism
IV School age	'Latency'	Industry *vs.* inferiority	'Neighbourhood' school	Competence	Inertia	Technological order	Formal (technical)	Formalism
V Adolescence	Puberty	Identity *vs.* identity confusion	Peer groups and outgroups; models of leadership	Fidelity	Repudiation	Ideological worldview	Ideological	Totalism
VI Young adulthood	Genitality	Intimacy *vs.* isolation	Partners in friendship, sex, competition, cooperation	Love	Exclusivity	Patterns of cooperation and competition	Affiliative	Elitism
VII Adulthood	(Procreativity)	Generativity *vs.* stagnation	Divided labour and shared household	Care	Rejectivity	Currents of education and tradition	Generational	Authoritism
VIII Old age	(Generalization of sensual modes)	Integrity *vs.* despair	'Mankind' 'My kind'	Wisdom	Disdain	Wisdom	Philosophical	Dogmatism

able 17.1
he eight stages of development, from infancy to old age, in Erikson's account of sychosocial development, showing the psychosexual stages (A), the psychosocial risis characterizing each stage (B), the significant persons who will help with hat crisis (C), the basic strength (D) that will be achieved if the crisis is successfully urmounted, and the basic antipathies or pathologies (E) that can result from nadequate resolution of the crisis. In addition the table also shows Erikson's leas on the social principles that predominate at each stage (G), and the itualizations (H) associated with each stage. Reproduced with permission from rikson E (1982), *The life cycle completed: a review*, New York, W W Norton, by ermission of W W Norton & Co, Inc, Copyright 1982 by Rikan Enterprises Ltd.

(children, social structures, intellectual or aesthetic products); and LATE ADULTHOOD in which the crisis is developing an EGO IDENTITY, of a life well lived, with biological and social fulfilment. Failure at these crises results in SOCIAL ISOLATION in early adulthood, in STAGNATION, of failure to achieve in middle life, and of DESPAIR, of a life ill-spent, and inability to accept the inevitability of death during later life.

Erikson emphasizes the importance of *social* pressures in adolescence and adult life. However ageing is also a *biological* process, with inevitable changes. Strictly, ageing starts at about three to four months of age, when neurones cease dividing and after which only neuronal loss occurs. Nevertheless, the brain continues developing into adult life with an increased neuronal connectivity.

The decrease in neurones in the adult brain has led to a series of myths, unsupported by adequate evidence, of declining intellectual ability in adulthood. The myths result from two errors. The first reflects the venerable but erroneous assumption that intelligence relates to brain size, brain size and IQ being empirically uncorrelated. The second error is more subtle. Early studies measured overall brain size as well as histological measures, such as total neurone counts and neurone density. CROSS-SECTIONAL STUDIES, examining brains from individuals of different ages (e.g. 10, 20, 30...80, 90) found that brain size and neuronal number decreased with age. Other cross-sectional studies had also found a continuous decline in intelligence from age twenty onwards. Putting the studies together, intelligence was assumed to decline with age because of decreasing brain size. That conclusion is not justified though because cross-sectional studies confound age with date of birth. If in 1990 I compare the brains of a 30 year-old and a 70 year-old, I am also comparing brains born in 1960 and 1920. The social, educational and nutritional changes occurring between 1920 and 1960 might have affected the brains as much as has ageing. The methodological solution is to carry out a LONGITUDINAL STUDY, although there are practical problems; for intelligence we would have to wait half a century until we got any results, and studies of brain morphology are problematic in that post-mortems can only be carried out once. A compromise in studying intelligence is a CROSS-SEQUENTIAL study, which starts as a cross-sectional study, but then the *same* individuals are reassessed a few years later. Figure 17.1 shows a cross-sequential study in which intelligence was tested 7 and 14 years after initial testing in 1956. The cross-sectional data for 1956 suggest that intelligence declines steadily from age 32 to age 60, whereas the longitudinal data show that only after age 60 is there a genuine decline in IQ. In studying brain size the methodological problem is solved by comparing brain size with total cranial capacity (for a larger brain at an earlier age must still have fitted inside the skull, and the skull does not shrink); a genuine decline in brain size only seems to occur after age 60.

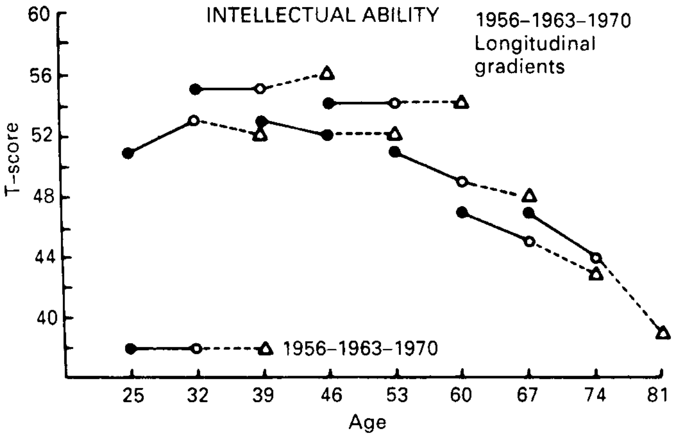

Fig. 17.1 Shows cross-sequential changes in intellectual ability of a group of adults assessed in 1956, 1963 and 1970. Solid circles represent measurements made in each cohort in 1956, open circles measurements made in 1963 and open triangles measurements made in 1970. The abscissa shows the age of each group of subjects at the time the measurement was made. Reproduced with permission from Schaie K W and Labouvie-Vief G (1974), Generational versus ontogenetic components of change in adult cognitive behaviour: a fourteen-year cross-sequential study, *Developmental Psychology*, **10**, 305–20.

Though the elderly undoubtedly show a declining IQ, the reasons for it are not obvious, not necessarily reflecting a simple decrease in information processing ability. In part the elderly perform less well on IQ tests because they fatigue more easily, are overly cautious in responding, and because of a NEGATIVE SELF-EVALUATION, believing themselves incapable of doing such tests; together these factors mean performance does not reflect competence. The decrease in IQ is also affected by many factors which are 'pathological' in some sense, but are so frequent in the elderly as to be seen as part of normal ageing. Those elderly with poor health have lower IQ scores, as do those with raised blood pressure or hearing defects. IQ also falls in the year or two before death, the TERMINAL DROP. Much of the intellectual deficit observed in the elderly therefore disappears if only the healthy, fit, normotensive, hearing elderly are assessed. The non-homogeneity of the elderly as a population is emphasized by greater range of IQ scores obtained in the elderly as compared with the young; many elderly persons are the intellectual equals of individuals 60 years younger. Indeed overall the effects of age are small compared with the large interindividual differences that occur at any age.

Intellectual deficits in the elderly particularly affect NON-VERBAL (or PERFORMANCE tasks) rather than VERBAL abilities. The distinction is also characterized in terms of FLUID rather than CRYSTALLIZED INTELLIGENCE, or

CONTROLLED rather than AUTOMATIC PROCESSING; well-consolidated, over-learnt and automatic skills such as language being less impaired than tasks requiring flexibility, novel thought or action, or the learning of new skills. Many non-verbal skills also stress response speed, and although the elderly are suggested to do less well because they cannot respond as quickly, that does not explain the results because the elderly still perform less well with unlimited time.

The elderly also show other physical deficits relevant to psychological functioning, particularly in vision and hearing. Visual acuity worse than 6/18 (i.e. objects are only visible at 6 feet which should be visible at a distance of 18 feet) occurs in 10% of 60–69 year olds, 30% of 70–79 year olds, and 35% of those over 80, due principally to glaucoma, cataract, macular degeneration and diabetes. About 30% of those over 65 have hearing deficits. Sensory deficits do not only restrict physical activity but also produce social isolation, with restriction to the home, and reduction in the circle of friends, and decreased intellectual stimulation. Social isolation is stressful and can precipitate psychiatric illness, particularly if a predisposition is present. The syndrome of PARAPHRENIA, a form of paranoid schizophrenia marked mainly by delusions (see Chapter 30), and which occurs in the elderly, is especially common in those with visual or auditory deficits, presumably due to impaired communication with others. Such problems of sensory deficits are not confined to the elderly, but occur at any age; in one experiment, students wore ear-plugs to produce a 30–40 dB hearing loss and showed symptoms of irritability and feelings of alienation and inferiority.

Changes also occur with age in non-intellectual functioning. Retrieval from long-term memory is less good, although a signal detection analysis (see Chapter 2) shows this to be due to greater caution rather than worse memory, RECOGNITION being less impaired than RECALL. On learning tasks the elderly perform less well because they do not use deep information processing if superficial processing is possible, although when encouraged to use deep processing they do perform better. The adoption of different strategies by the elderly reflects a broader personality change of old age, DISENGAGEMENT, which is a greater degree of introversion, coupled with a withdrawal from other people and activities. Although imposed by society to some extent, with enforced retirement in many cases, restricted opportunities for developing new activities, and diminished income and resources, it is also an active choice by the elderly to meet their own needs, and allow a reflective acceptance of life and its meaning.

In medical and psychological terms, the major challenge of old age is SENILE DEMENTIA, a progressive loss of intellectual ability, usually accompanied by cerebral pathology in the form of ALZHEIMER'S DISEASE or MULTI-INFARCT DEMENTIA, although there are other causes. There is a decrease in brain size and widening of the sulci, narrowing of cortical convolutions, decreased white matter and enlarged ventricles. The psychological deficits of dementia are not merely an exaggeration of normal ageing, although performance tasks are more impaired than verbal tasks, but there are also deficits in iconic, primary, and secondary memory (which are relatively unimpaired in normal ageing), and problems in learning, conditioning, and the use of language, particularly for object naming, and there is POVERTY OF SPEECH (restricted vocabulary, expression and spontaneous speech). Together these suggest a separate defect from that of normal ageing. Deficits progress fairly rapidly and in a predictable order, so that a scale of disability may be created. The condition starts with loss of hobbies and participation in social events, and then an inability to wash and to dress, followed by a disorientation in space and an inability to recognize other persons and to communicate; finally there is loss of control of bladder and then of bowels, an inability to move and finally an inability to eat. Dementia is common, *severe* dementia occurring in 0.6% of 65–74 year olds, 5.5% of 75–84 years olds, and 17.8% of over 85 year olds, while *mild* dementia occurs in 7.3%, 27.8% and 42.9% of the same age groups.

Psychological *treatment* of dementia cannot be curative because lost cortex cannot be replaced. However, careful consideration of psychological factors can reduce the burden on carers, reduce institutional care, and make life more acceptable to the patient; the intention is to *ameliorate* problems where possible. The benefits of reducing incontinence from six times per day to once per day are vast, both for patient and carer. Since intellectual deficits are least for automatic processing, it is such remaining skills that should be exploited to the full. Therefore, if possible, the mildly demented patient is kept in their own home or an environment they know well, so they know their way around, can find things, carry out basic tasks, etc. Much support involves providing aids for a failing memory (so that, as one worker put it, the whole environment becomes a cognitive prosthesis for the missing intellectual skills). Such simple devices as ensuring that a purse is always kept in the same place, or using large print for lists, can make the difference between success and failure at simple tasks, which is the difference between dependence and independence. Within institutions, it is being realized that INSTITUTIONALIZATION can exacerbate dementia. Many patients suffer sensory deprivation, in part due to hearing or vision loss, but also due to a lack of social interaction and a reduced need for physical action, since all needs are met, and this can exacerbate problems. Staff can also reinforce inappropriate behaviour, feigning interest or understanding when a patient's speech is confused, and thereby increasing such behaviour. Treatment programmes have used two techniques: STIMULATION AND ACTIVITY PROGRAMMES, which aim, through occupational therapy and social and domestic activities, to stimulate the deprived patient, and thereby restore purposive behaviours, and REALITY ORIENTATION in which the intention is to make patients aware that their actions have results which are of consequence to them, thereby reinforcing such actions. Both forms of treatment have been shown to be of benefit in improving behaviour.