AN INVESTIGATION INTO THE RELATIONS BETWEEN ASSOCIATION AND INTELLIGENCE

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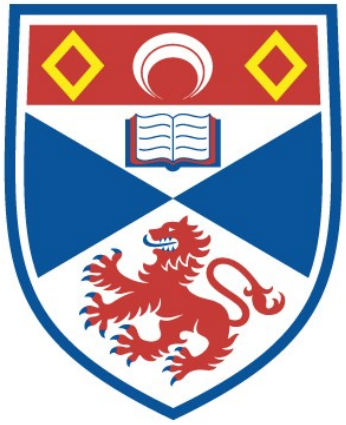
A Thesis Submitted for the Degree of PhD
at the
University of St Andrews



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AN INVESTIGATION INTO THE RELATIONS BETWEEN ASSOCIATION AND INTELLIGENCE.

being a thesis presented by

Ella Pratt Yule, M.A.

to the University of St.Andrews

in application for the degree of Ph.D.

I hereby certify that Ella Pratt Yale has spent nine terms at Research Work in Psychology, that she has fulfilled the conditions of Ordinance No.16 (St.Andrews), and that she is qualified to submit the accompanying thesis for the Degree of Ph.D.

I hereby declare that the following thesis is based upon psychological research and the results of experiments carried out by me, that the thesis is of my own composition and that it has not previously been presented for a Higher Degree.

The research was carried out in the Psychological Laboratory of St.Andrews University, the experimental data being gathered from investigations in Fifeshire schools. Reading and reference work were done in the University Library, in the British Museum and the Library of the British Psychological Society, Bedford Square, W.C.1.

CAREER.

I matriculated in the University of St.Andrews in October, 1924, and followed a course leading to graduation in Arts, M.A. June 1927. In September 1928, I added Post Graduate Honours of the First Class in Philosophy, Mental and Moral.

In March 1928, I was elected to a Carnegie Research Scholarship for the year 1929-30, which was renewed for the year 1930-31. In the course of these years I completed the experiments which are recorded in the present thesis.

In March 1931, I was elected to a Henry Fund Fellowship tenable at Yale University, U.S.A. for the year 1931-32. During this year, I pursued a course of study on William James. Returning from the United States in the summer of 1932, I completed this thesis in the course of the current academical year.

My sincere thanks are due to Mr. C. A. Mace, M.A. for his very kind interest and advice during the time this investigation has been in progress.

I have also to express my great indebtedness to Dr. Victoria Hazlitt's work on "Ability" which in the first place suggested the topic for this investigation, and has proved a constant source of fresh ideas.

C O N T E N T S.

Part I (Theoretical Analysis)

Part II (Experimental)

CHAPTER I.

Thought Processes in General in relation to the Consciousness of a Problem.

Synopsis.
All mental processes motivated by the consciousness of a problem. - A problem is implicit in every situation failing to satisfy with completeness in relation to a given end or purpose. - Consciousness of a problem in relation to (a) Cognitive (b) Conative thought processes. - Reflective thought as motivated by the consciousness of a problem. - Clearest case of thought process motivated and directed throughout by consciousness of problem found in intelligent activity of mind.

Mental experience is a unity, and mental process is a series of continuous inter-related events. Most attempts to analyse and classify mental processes have necessarily resulted in either (a) the analysis and classification of the contents of mental processes, or, (b) the abstraction and classification of aspects of mental processes.

If, however, concern is neither with the classification of the contents of mental processes, nor with the classification of aspects of mental process, but with the question of how mental processes are motivated and by what factors they are directed, - from such a consideration might result a different classification of mental processes, and a different emphasis on the facts of mental experience.

If mental processes are examined without regard to the bases on which existing classifications are made, it is apparent that all mental processes other than some routine activities such as habit, are motivated by the consciousness of problems. Under this may be included such biological processes as may be presumed to be directed by, or accompanied by, conscious processes.

The major part of the normal thought processes of normal individuals is occupied with problems of business or profession and with the problems of personal material existence; and the sphere of the problems which are dealt with widens to include, to a greater or less degree, preoccupation with the problems economic, social or/

or political, of the country and time. It will be admitted that preoccupation with problems of this nature must imply the conscious direction and motivation of thought processes by the consciousness of problems but it may be argued that large areas of mental experience, perceptual, affective and conative experience, the facts of memory, of reverie, and of imagination, have yet to be accounted for. Such mental processes as come under these heads seem far removed in nature from the mental processes occupied with the solution of problems of the kind which has been indicated. At first sight it seems that such processes could not be described as motivated by the consciousness of a problem.

This fact is to be attributed to the absence of a clear definition of the concept of a problem. What is implied by the consciousness of a problem has not yet been adequately analysed from a psychological point of view. If the accidental characteristics of specific problems are abstracted, there remains a certain essential fact which characterises every consciousness of a problem situation. It may be expressed by saying that a problem is implicit in every (apprehended) situation which fails to satisfy with completeness in relation to a given purpose. Further, since incompleteness can only exist in relation to a given purpose, we may leave aside at the moment the factor of purpose, and provisionally define a problem situation as, a situation characterised by incompleteness.

With such a concept of what is implied by the consciousness of a problem in view, it will be possible to show briefly in what sense it may be said that mental processes other than those which are generally recognised to be motivated and directed by the consciousness of a problem yet originate in a consciousness which is similar in its essentials to the consciousness of a problem.

(a) Consciousness of Problems in relation to Cognitive Processes.

It may be taken as the necessary pre-condition of cognition that an object is related to a subject, or, in other words, that the thinking or perceiving of anything, means that an object is present to consciousness. It is clear, further, that the object present to consciousness at any given moment may have different degrees of definition, or specification, and that the general/

general tendency of objects appearing in the field is to grow in the direction of definition and specification. On its first appearance in the field of consciousness, it may be said that an object tends to lack the definition and completeness which, subject to certain conditions, it later attains.

This fact can be substantiated by reference to three typical views as to the nature of a primitive experience and its growth.

In the first place, Stout distinguishes between the mere presence of an object to consciousness, (simple apprehension) and the mature consciousness of that object which implies judgment and can be expressed in a proposition. The cognate presence of an object and a judgment upon it constitute cognition. It is thus clear that Stout implies the incompleteness of the object as a mere sentient experience.

"When we ask a man what he is thinking of, he may reply 'the moon' or 'the college' or 'the soul'. But such answers are essentially incomplete. They leave room for further questions such as 'What are you thinking about the moon?' ..... In general, it would seem that a complete object can only be described, not by isolated words, but by propositions capable of being asserted, denied, doubted or assumed. The full object requires to be expressed in the form that something is, or is not, so and so" - and again, "Transient experiences as they come and go are never complete objects of thought."

(Manual. Bk.I, Chap.I)

It may be presumed hence that Stout would agree that an object present to sentience is incomplete and points beyond itself. When it is judged about, it becomes a whole entity, and has, as Stout says, the character of a fact as opposed to an event, "an identity independent of time and change"; nothing more is added or implied. The incomplete nature of the sentient experience is completed by the act of judging, which is the essential factor in cognition as opposed to sentience.

In the second place, reference may be made to Ward, who says that, "It is the characteristic of every completed concept to be a fixed and independent whole, crystallised out, as it were, from a still fluid matrix."

(Principles. Chap.III)

The/

The implications of this statement are ultimately similar to the position adopted by Stout. On its first appearance in the presentational continuum, an item is indefinite and non-specific. It grows to a completion and specification which contrasts it to the non-articulated and non-specified background (fluid matrix) of potential experience.

In the third place, reference may be made to the theory of the Gestalt school, that "the simplest possible experience cannot be that of a quality (for example) in vacuo, but must be that of a quality on a background." (Koffka. Growth of Mind. Chap.V.)

Consciousness is never the experiencing of a confused mass of objects present to consciousness, but always includes a background upon which qualities stand out in an orderly manner. Such outstanding groups of qualities (for example) are configurations or 'gestalten', and the essential property of such gestalten is their incompleteness on first appearance, and the fact that they point beyond themselves. Further, gestalten tend to grow, by the inherent laws of their own nature, to completeness or "closure". This growth implies also a growth in the individuality of the parts (articulation) and the growing independence or distinction of the whole from the background (unification). On their first appearance, gestalten imply potential or fragmentary judgments. On their organised completion, they imply complete judgments expressible in propositions.

The implication of all three theories is, in one respect, the same; that the characteristic of experiences as they first enter consciousness, is incompleteness, and that in virtue of a specific mental activity or process with regard to them, they attain completeness; that such completion results in the possibility of a judgment about them which is expressible in a proposition or series of propositions.

In so far as an experience first entering the field of consciousness is by nature essentially incomplete, in so far as it only grows to completion if it is attended to, in so far as it is only attended to if the intention to know more of it is present, it may be said that it possesses the characteristics of the consciousness of a problem. The cognitive process in so far as it completes the incompleteness in answering/

answering the potential implicit question "What is it?" may be said to be a problem-solving activity of mind. It has its origin and impetus in a problem situation and hence it may be said that cognition is motivated by the presence of a problem to consciousness.

(b) Consciousness of Problems in relation to Conative Processes.

In so far as behaviour takes place in response to the perception of a stimulus, the discussion of conative processes in relation to the consciousness of a problem depends on the discussion of cognitive processes. What stands out on first appearance as an incomplete configuration upon a background, is a problem, and hence what is not problem is background. The question to be decided is what calls forth the first reaction or response, i.e., in relation to what conative processes are initiated. There is only one alternative; conative process must begin either as a response to the background, or as a response to the configuration. It is clear that a uniform background could call for no response, and that hence, it is in response to the existence of the configuration that conative process begins.

It is also clear that conative activity is directed towards the solution of problems which themselves arise, or are constituted by, the fact of obstruction to given ends. The behaviour of any organism is its response to the problems with which it is confronted in the course of direction to ends. Where there are no ends in view, there cannot be obstruction to ends, and hence problems will not arise and behaviour will not result. For example, the facts of adaptation to environment can be expressed in terms of the success with which the organism solves the problems which arise when normal conative directions are obstructed. Thus it may be said that not only does conative activity originate as the response to the consciousness of a problem, but also that problems are constituted when conative directions to ends are obstructed.

(c) Abstract Thinking in relation to the Consciousness of a Problem.

Reflective thought may be broadly classified into Directed and Undirected thought-processes. Both Directed and Undirected thought can be described by reference/

reference to the consciousness of problems. Dr.Stebbing, for example, says "Reflective thinking originates in a problem to be solved, and is throughout controlled by the conditions of that problem and directed to its solution." (Logic. Introduction.)

Directed Thought may be described as thought process specifically directed to a specific end, thus implying and originating in, specific problems. It is thought which is directed and controlled by the immediate requirements of a problem situation.

Nor can Undirected Thought be described as wholly aimless. In all its forms, in normal reverie, wish-fulfilment fantasy, retrospective or prospective, and even in dreams, it can always be shown to be preoccupied with some ends rather than others, and hence with some problems rather than others. It originates in, and is directed by, the consciousness of problems in the same way as Directed Thought, but it deals with problems in a different way.

The ultimate difference between Directed and Undirected thought-processes is to be found in the difference in the specificity, intensity and most frequently, the immediacy, of the intention to solve the problem. Further, it tends to be the case that in Undirected Thought, the solutions arrived at are not measured against objective facts and conditions - or, in short, critical tests of practicability are not applied. The distinction may be clarified by reference to the fact that a specific intention to solve a given problem will necessarily imply the intention to find a solution which will be in conformity with the facts of objective reality. If, moreover, the intention is to solve the problem immediately the conditions of objective reality will be held more rigorously before the mind, and the scrutiny of the solution in relation to these conditions will be more careful, viz., the more rigorous will be the critical tests of conformity applied.

In the case of Undirected Thought, preoccupation with a given problem need imply no immediate intention to solve the problem, but merely the wish that the problem may be solved. The possible methods of solving the problem or the possible solutions which occur as the result of the conscious wish to solve the problem, will not tend to be criticised in relation to objective conditions. For example, a wish-fulfilment fantasy implies/

implies that a certain end is desired and not yet attained. The path to this end is obstructed and a problem situation is constituted. In reverie, possible solutions to the problem are idly followed out - facts are supposed which have no counterpart in objective reality, hypothetical solutions are presumed which might in actuality be impossible.

It may be said that the intention in Directed Thought can be classified under the category of Will, the intention in Undirected Thought under the category of Wish. The distinction between these two cannot be better indicated than by reference to Aristotle's dictum that "Wish is for the end, Will is for the means".

Were the same problem to be considered in relation to a specific immediate intention to solve it, the means by which it might be solved would be considered in reference to practicability, that is, with regard to their conformity with objective fact. The resulting thought process would be narrowed, controlled and directed. It would be altered in quality and intensity and come at once under the category of Directed Thought. The same problem would motivate both thought processes. Both would be thought processes having their origin and stimulus in the existence of a problem for consciousness.

It can be shown that the same facts which hold for wish-fulfilment fantasy and reverie, hold also for dreams. The fact is fully substantiated by psycho-analytic analysis. In dreams, the solution of the problem tends to be represented symbolically, and this is true, also, of one aspect of imagination, more particularly artistic imagination, where the solution of problems is given by or in symbological images.

From the consideration of these fundamental aspects and usual classifications of mental processes in relation to the consciousness of a problem, it is evident that there is substantial justification for the view that mental processes on all levels are motivated by the consciousness of a problem. It is clear, however, that certain processes above all others are specified and directed in relation to consciousness of problems.

Such thought processes are those which were dealt with under the heading of Directed Thought processes. The specific conscious direction of mental process to the solution/

solution of specific problems is the mental activity which is commonly designated 'intelligent'. Hence it can be said, not only that the clearest case of motivation of thought process by the consciousness of a problem, but also the clearest case of direction of thought process to the solution of the problem existing for consciousness, is to be found in the intelligent activity of mind.

In view of this fact, it will be possible to describe intelligence provisionally as a problem-solving capacity of mind, and to justify the description by a more detailed consideration of what is implied by such a concept of intelligence, and how it can be substantiated by reference to existing theories of intelligence.

CHAPTER II.

Intelligence as a Problem-Solving Activity of Mind.

Implications of common-sense views, and of current theories of intelligence (a) Biological (b) Purely Psychological (c) Miscellaneous (1) Behaviourism (2) Gestalt. - All theories of intelligence explicitly introduce or tacitly assume concept of intelligence as problem-solving ability.

During the past thirty years, there have been innumerable theories advanced as to the nature of intell: igence. This has been due to the development of psychology as an experimental science, and to the belief implied by that development that all mental processes must be in some way measurable.

Of all the functions of mind, intelligence is that which it is perhaps of the greatest practical value to be able to measure. Adequate analysis, however, must precede satisfactory measurement, and adequate analysis is still lacking. If it were not so, the question "What is intelligence? What is it that is supposedly measured by mental tests?" would not continue to be asked with unabated persistence.

In spite of the lack of agreement among psychologists as to the definition of intelligence, what: ever psychologists may mean by intelligence, and whatever it may be that is measured by intelligence tests, the existence of a general consensus of opinion as to when intelligence can be ascribed to individuals and when it cannot be so ascribed, is proof of the fact that intelligence can be recognised and that there must exist a general pragmatic criterion as to how it can be recognised. What is plainly suggested by ordinary discourse is that, in saying "so-and-so is intelligent", it is implied that he is capable of solving problems. Hence intelligence is ordinarily defined in terms of what it does, and it may be that what it is may well consist in what it does.

Thurstone says, for example "When we define intelligence, we mean the effects of intelligence,

we cannot perceive the thing itself. Nearly all definitions of intelligence show it as the ability to do something or other, and it is this something or other which is defined." (L.L.Thurstone. B.J.Psych.Vol.XIV.) Hence when it is said that "x is intelligent", what is meant is that "x can do so-and-so". Thus, intelligence is the property of beings who are intelligent, while being intelligent means that they are able to do so-and-so. We may therefore define intelligence logically in terms of the performance, mental or otherwise, of some individual. Strictly it is the individual who does things and not his intelligence.

In short, intelligence can be described in terms of problem-solving ability. The activity which we describe as "using our intelligence" begins when we are conscious of a problem, continues through the various processes of finding a solution, and ends when we are satisfied with the completeness of that solution, and its conformity with objective conditions. Judgment as to the presence of intelligence in others will depend (a) on the success of solutions to problems, and (b) on the number of successful solutions as compared with the number of unsuccessful solutions.

It may be left an open question as to whether intelligence is identical with problem-solving activity. It has been shown that all thought processes can be said to be motivated by the consciousness of problems, and thus ultimately a careful distinction would have to be drawn between intelligence as problem-solving activity of mind and other thought processes which also come under the category of problem-solving activities of mind.

For present purposes it is sufficient that to describe intelligence as a problem-solving capacity is to describe what it is universally accepted that intelligence does. This might perhaps be stated as - "that the ability to solve problems to a greater or less degree will enable us to characterise an individual as to a concomitant degree, intelligent".

The concept of intelligence as problem-solving ability is not only the implication of the common-sense view of intelligence but is also implied by current theories of intelligence. A brief examination of the main trends taken by theories of intelligence will substantiate this.

Current/

Current Theories of Intelligence in relation to the Concept of Problem-Solving Activity.

Definitions of intelligence fall into two well defined categories.

I. Biological Theories, which involve distinctive biological concepts and teleology in some form.

II. Purely Psychological or 'Mentalistic' Theories, which involve reference to states of consciousness, and also

III. Miscellaneous Theories, which do not fall strictly under either of the last two categories (a) Strict Behaviourism (b) Gestalt Theory.

The first two categories are crossed by theories of intelligence which combine elements from both categories. These may be described as Biological - 'Mentalistic' definitions.

I. Biological Theories of Intelligence.

Such theories are based on emphasis of the conative sides of mental life. Their ultimate presupposition is an "impulse to live" of varying degrees of articulation, from a blind biological force to a conscious "will to live" and possibly even to a will to live in relation to certain standards. The ultimate reference is thus to a conative force which corresponds in certain essential ways to Bergson's 'élan vital', or possibly to Freud's 'libido', but it will be qualified or specified in many different ways by different psychologists. It is always teleological in nature.

This type of theory invariably introduces into its analysis biological metaphors, such as "adaptation to environment", or "domination of environment".

As an example of the kind of definition of intelligence given, reference may be made to Thurstone's definition "Mental life is an irreversible process beginning with the life impulse and terminating in a successful overt act." (L.L.Thurstone. 'The Nature of Intelligence'). There is Stern's definition that intelligence"consists in general adaptability to the new problems or conditions of life". There is Petersen's definition "Intelligence is a biological mechanism by which/

which the effects of a complexity of stimuli are brought together and given a somewhat unified effect on behaviour. It is a mechanism for adjustment and control and is operated by internal as well as external stimuli". There is Thorndike's definition "Intelligence is the power of good response to a given situation".

All such definitions of intelligence are biological in tendency in so far as they are based on the concept of conative striving for ends, which must be, at the same time, adjusted to comply with the demands of objective environment, before such ends are attained.

That the concept of intelligence as problem-solving ability is implied in all such definitions, is clear. Environment is always changing, and in changing, it sets problems of adjustment to the organism. Activity or behaviour will result as the effort on the part of the organism to solve these problems and adjust itself to the new conditions.

Rignano has expressed these facts by saying that any organism has an individual equilibrium, "an individual stationary psychological state", and when this is upset, it commences an active process directed towards the re-attainment of this equilibrium. (The Psychology of Reasoning. Chap.I). In doing so, obstructions to its ends create problems to be overcome. The successful solution of these problems, when they are concrete, constitutes intelligent behaviour. In man, the activity of solving these problems is rendered shorter, and the trial-and-error method of concrete problem-solving is eliminated, by the fact of the human capacity for mental trial-and-error problem solving. "Reasoning can be said to consist in the substitution of experiments thought of for actual experiments". In short, the capacity for abstract reasoning is envisaged by Rignano as having its origin in the necessity to solve the problem of re-attaining the equilibrium upset by the changing environmental conditions. The superiority of man in dominating his environment so as to preserve this necessary equilibrium despite its changes, lies in the fact that he is enabled to solve his problems by mental in place of bodily processes, thus effecting economy of time and energy, allowing of infinite experiments in place of a few, hence making for a greater plasticity of behaviour. Rignano's discussion of reasoning implies, then, that when an organism is successful in solving its problems, and in so far as it is so successful, it is acting/

acting or thinking intelligently. Thus his definition of intelligence falls into line with the general trend of biological interpretations of intelligence.

In the Journal of Educational Psychology 1921, there is a symposium on the nature of intelligence. An extract of the biological definitions in this symposium, together with biological aspects taken from other definitions not so consistently biological, yields this result as a composite biological definition of intelligence.

"Intelligence is conscious biological response to stimulus, (Thorndike, Watt, Petersen) resulting in environmental adjustment (Binet, Stern, Terman, Pintner, Thurstone) by conscious solution of problems not hitherto solved by the same animal (Meumann, Stern, Ballard, Pintner). In life process there are frequent conflicts among ideas, instincts and environments (Thurstone), individual and social, by which some satisfying responses are inhibited and annoying responses incited".

This composite statement brings out not only the reasons for calling such theories of intelligence as have been discussed, biological theories, but also makes clear their relation to, and dependence upon, the description of intelligence as problem-solving capacity of mind.

Purely Psychological or 'Mentalistic' Theories of Intelligence.

Such theories involve reference to states of consciousness, and ultimate emphasis is placed by them upon the cognitive aspects of mental experience in relation to intelligence, although they must be forced ultimately to recognise conation as specified or expressed in intentions or incentives to think in reference to given conditions.

Such a definition is Terman's "Intelligence is the ability for abstract thought", or Binet's statement that "intelligence is the power of auto-criticism".

The implication of a theory such as Terman's is that intelligence depends upon individual ability in certain of those activities which can be subsumed under the heading of abstract mental processes, such as discrimin: ation, power of analysis, integration or judgment. If judgment/

judgment is examined, for example, it is apparent that external reference is involved. Judgment must be about something, that "something is so-and-so", that it is the case or is not the case. In each judgment, there must be at least one alternative implied. If we judge that something is the case, there must also be the possibility that it is not the case. This fact must hold of even the most elementary of judgments.

A judgment is only called for where a situation presents alternatives, and a situation will only present alternatives when something is called in question, when objective existence has to be decided about in some way relative to conscious purposes or ends.

Thus the kind of situation about which judgment is made, is, as apprehended, the kind of situation which is characterised by incompleteness. A situation is given which presents alternatives to consciousness. It is an incomplete or problem situation. The judgment which is passed upon it is at once the completion of the situation and resolution of the problem.

Hence judgment clearly presupposes the existence of a problem situation defined by reference to its incompleteness in relation to a given end. When intelligence is referred to capacity for judgment, the implication of problem-solving activity is present.

When other 'faculties' of mind, which may be subsumed under the heading of abstract mental processes, such as integration or discrimination, are examined, it is evident that they are taken as criteria of intelligence because they bear upon the organisation of experience. The importance of organisation of experience to intelligent thinking is evident. The degree of articulation and ordering of past experience will determine its revivability, and the amount of experience which can be revived in answer to the requirements of any task demanding intelligence, will tend to aid the successful performance of that task. This is true, for example, of creative writing or composition of any kind.

Further, unless the kind of experience which is appropriate or relevant to the requirements can be produced, the amount of experience is of secondary importance. In so far as, in any task involving intelligence, the relevant experience can be produced, the greater likelihood there is of successful performance

of/

of the task. But the possibility of the production of a relevant part of experience depends in part upon the degree to which experience is organised. It is clear, in view of these considerations, why it should be supposed that mental activities which are responsible for the organising of experience will be taken as activities upon which intelligent thinking depends. Furthermore, the recall of past experience, and in particular the recall of some parts of past experience in preference to other parts, can only be explained by the postulating of a problem holding for consciousness. Past experience is only revived in a selective and orderly manner, if present experience is occupied with a problem. In so far as intelligent thinking involves the adaptation of past to present experience, present experience will be experience of a problem situation.

Thus the implication of any 'Mentalistic' theory of intelligence which emphasises either the dependence of intelligence upon judgment or its dependence upon the activities of mind which account for the organisation of experience, is that intelligence either <u>is</u> problem-solving activity, or is dependent upon factors which will account, in part, at least, for the successful solution of problems.

Finally, to deal with the concept of abstract thought along more general lines, it is true to say that the essential purpose of abstract thought is to render the solution of problems a speedier and more economical process. Rignano's account of the origin of reasoning describes the initial uses of abstract thought. In its final reaches, it becomes far removed from direct dealing with the concrete problems of environment, but it can never be divorced from dealing with problems as such. Any branch of highly abstract thought such as metaphysics or ethics is motivated throughout by consciousness of the problems of Truth, Existence or Value.

It may be concluded that, in so far as any 'Mentalistic' definition of intelligence will ultimately imply some or other of the factors influencing success in abstract thinking, the concept of the consciousness of a problem is implied and must entail the introduction of the problem solving aspect of intelligence.

<u>Biological - "Mentalistic" Theories of Intelligence</u>.

These/

These theories of intelligence take account both of the facts about intelligent thinking emphasised by Biological definitions and the facts emphasised by purely Psychological definitions. Very few theories of the nature of intelligence have attained a consciously equal balance between the two types of factor. Dr. Hazlitt's theory of ability is an example of a theory which equally balances emphasis on, and recognition of, these two aspects of the facts of intelligent thinking. The intelligent act involves (a) Drive, conative factors, and (b) Fecundity of Ideas, which, on analysis, covers many of the facts emphasised by purely psychological definitions of intelligence. In the light of her analysis of both factors, she defines intelligence as "a problem solving organisation of mind", thus stating explicitly the fundamental importance of the consciousness of problems in motivating intelligent thought process.

Miscellaneous Theories of Intelligence.
(a) Behaviourism.

Consistently Behaviouristic systems of psychology are strictly mechanistic and deterministic, and in such systems, there is, by definition, no place for what is commonly understood by intelligence. They deal with habit responses, conditioned responses, goal reactions, all the modifications and complications of the reflex arc, to which all phenomena of behaviour are reducible. Any response to any given situation is explained by reference to the assumption of pre-existing bonds between stimulus and response, and in the course of the transit between stimulus and response neither consciousness nor any of the factors generally attributed to consciousness, can intervene.

Hence strict Behaviourism cannot, by definition, substantiate any theory of intelligence as problem-solving capacity, since, in the first place, it does not allow the existence of intelligence in any form.

It is significant, however, that where Behaviourism most easily tends to break down, and to depart from its self set premises of mechanism and materialism, is exactly on the point of what is implied by the consciousness of a problem. Faced with the question of why, in a situation which involves innumerable potential stimuli, response only takes place with regard to certain of these stimuli, the Behaviourist has no adequate answer. Any answer which might be given must be/

be based on the fact that response is not to the situation, but to the perception of the situation, and, further, that response is made exactly to the elements in the situation which are apprehended as unsatisfactory or incomplete with reference to a given subjective end or purpose. In short, response to a situation occurs in so far as consciousness of the situation implies consciousness of a problem, and when response takes place, it takes place only in reference to the given parts of the situation.

It is to be noted that when Behaviouristic systems of psychology fail to maintain consistency, they most often fall back upon biological metaphors, and hence upon teleological concepts. These are latently introduced by reference to "good responses", or "successful responses" (Good in reference to what?) "adaptation to environment" (Can an automaton adapt itself?), thus introducing a concept of purpose or ends alien to a mechanical system, and ultimately implying a consciousness of situations as unsatisfactory or incomplete.

(b) Gestalt Psychology.

Gestalt psychology provides the best example of a theory which not only implies that thought processes in general have their origin in the consciousness of problems, but also shows the specific and peculiar relevance of such a consciousness in relation to learning and intelligence in particular.

The theory of intelligence advanced by the Gestalt school is bound up with the concept of the configuration and its tendency towards "closure". They thus emphasise quite rightly that a central and essential feature of the situation in which the agent is conscious of a problem, is its peculiar incompleteness or "lack of closure".

In so far as every cognized situation is first cognized as an incomplete configuration standing out upon a neutral background, every situation has the essential qualities of a problem situation. The lack of completeness of the configuration, which is the distinctive feature of the consciousness of the problem, can be described by saying the situation is characterised by a "gap". "When a solution is found, the situation is altered in such a way that the gap in the situation is closed./

closed. Here we have 'closure', for when the problem is solved, everything in the perceptual situation depends upon the total configuration". (Koffka. Growth of Mind. Chap.IV). Hence it is clear that intelligent process is the process implied in the completing of the gap, or the attainment of 'closure'. The intelligent process begins with the consciousness of incompleteness and continues until the situation is so altered that a consciousness of completeness is achieved. The situation, as complete, is static, and no further activity takes place with regard to it.

It is evident that this is a direct statement of intelligence as a problem-solving process.

The salient feature of such a description of the nature of intelligent thinking is that no conative element is supposed. Emphasis is placed wholly upon the 'absence of closure' which characterises the consciousness of the problem situation. Such an omission is characteristic of the system as a whole. Having received its initial impetus from the experimental investigation of the phenomena of the perceptual field, it has consistently omitted consideration of conative elements. The consciousness of a problem is not merely characterised by 'absence of closure' or a gap, but there is an impulse towards closure, and an intention to fill the gap. The assumption most difficult to accept of all the assumptions in the theory of the Gestalt school, is that the incomplete configuration which is the problem-situation, grows to completion and closure by the inherent laws of its own nature. The acceptance of this theory on the purely perceptual level is difficult since it implies that a perceptual experience achieves distinctness and articulation without the intervention of attention or subjective activity with regard to it, but on the level of intelligent processes, it presents further and, I believe, insuperable difficulties.

The solving of a problem, as an intelligent process, cannot be conceived as the growing to completion of objective data of consciousness in abstraction. It must imply a conscious activity, and conscious intention and effort. In short, the consciousness of a problem situation does imply a gap, or an 'absence of closure', but it must also imply the impulse towards closure, and the existence of certain specific conative factors.

Conclusions.

All/

All theories of intelligence other than strictly consistent Behaviouristic theories, either explicitly introduce or tacitly presuppose the concept of a problem.

An intelligent thought process begins with the consciousness of a problem and the intention to solve it, is directed throughout to the solving of the problem, and ends when a solution is found.

Hence ability to solve problems is an essential factor in intelligence, and the measure of the success with which problems are solved will be the measure of the degree of intelligence.

CHAPTER III.

The Nature of a Problem.

Problem and Question. - Question and propositional function. - Question, propositional function and Proposition. - The necessary elements in the consciousness of a problem.

Problems as such are universally recognised to exist, and each individual recognises so clearly that any problem with which he is confronted, is a problem, that it must be presumed that in such unhesitating recognition of problems when they are presented, will be implicit certain criteria as to the nature of a problem. Actually, however, it is very difficult for an individual to state exactly what he means when he talks of a problem. The concept has neither been sufficiently analysed nor clearly defined, and this is more particularly the case when the problem is considered from the psychological point of view. A detailed epistemological analysis of a problem will be found in Nicolai Hartmann's "Grundzüge einer Metaphysik der Erkentniss" Part IV. Section V., "Das Wissen des Nichtwissens". What is required is an analysis of the necessary elements in the consciousness of a problem.

If any individual is asked what he considers a problem to be, he will most probably reply that an ordinary problem presents to consciousness a situation about which a question can be asked. If this is so, it may be said that "S is confronted with a problem" means "S asks, or is aware of, a question". Hence, as has been seen, a problem is something which, in its essential nature, is incomplete. It is not a finished whole, since something must be added or adjusted to satisfy given conditions or conditions thought of. A practical problem calls for something to be done; the objective situation must be altered in some way. A problem points beyond itself, and no matter what kind of problem it is, or of what degree of complexity, it is always characterised by incompleteness either in view of an end set by the individual who is going to solve the problem, or objectively, by the conditions of the problem as such. Some examples of ordinary problems will/

will suffice to make this clear.
For example (1) Complete the following:-
Apple is to fruit as sheep is to - ?
or (2) Given a triangle ABC in which AB - 4.5 inches, CBA - 72°, CAB - 45°. What is the length of CA?

Here the conditions are set objectively. The exact place and nature of the gap is explicitly indicated in the statement of the problem. But a type of problem exists where it may be said that the conditions are indicated subjectively. Suppose a man comes to a river which is not spanned by a bridge. To anyone who has no wish to cross the river, the situation does not present a problem. But if it is the case that this particular individual has a goal in view which entails his reaching the opposite bank, then the situation immediately presents a problem to him.

A similar example is that of balls on a billiard table. Such a situation only presents a problem to the person who wishes to change the situation in order to attain a specific end. In itself, as apart from such a wish or intention, the situation of three balls lying on a green baize table is not a problem situation. In the same way, a pile of wood has nothing problematical about it, but it will take on the character of a problem-situation if it is perceived by, for example, a carpenter who intends to make a table from the wood. To Köhler's ape, the fact that he is enclosed within a cage while a bunch of bananas hangs outside the cage, is not a problem situation unless he experiences a definite desire for the bananas.

In all these cases, the incompleteness and gap in the situation is apparent. The sentence requires something to be added in accordance with given conditions, the geometrical problem in effect asks for something to be done to comply with given conditions, the man requires to alter or add to the situation at the riverside to gain his goal, the billiard player wishes to alter the situation relative to certain requirements he has in mind, and so also do the ape and the carpenter. In so far as each of these situations is incomplete, it presents a problem to consciousness. The primary characteristic of a problem-situation is that it contains a gap and an incompleteness which is indicated by the conditions of the problem, and it may be concluded that it is to this gap that implicit reference is made when it is said that to/

to be confronted with a problem is to be conscious of a question.

A question must hence be concerned with the consciousness of a gap.

Problem and Question.

The relation of the problem to the question must be scrutinised.

In the case of the man who, arriving at the river bank, sees no means of crossing to the other side, it cannot be said that his question "How am I to cross this river?" is a problem. It cannot even be said to be the expression of a problem; it is the expression of the consciousness of a problem, or, more accurately, the expression of the consciousness of a gap. The peculiar state of consciousness which can be expressed in a question, is not the same thing as the expression of it. In other words, a question exists apart from the expression of a question.

When a question is expressed verbally, it takes the form of an interrogative sentence, which can clearly never be identified with the consciousness it expresses. As composed of words which express, an interrogative sentence is verbally complete, while what is expressed is, as the consciousness of a problem situation, essentially incomplete. Interrogative sentences are the clearest verbal expressions of the consciousness of a problem. Consequently, it is possible to learn much about the nature of the consciousness of a problem by an examination of the expression of a question in an interrogative sentence.

A primitive form of the expression of a question would be "What is so-and-so?" Clearly this is verbally complete as it stands, and looks like a proposition of the Subject-copula-predicate order. As we apprehend its meaning, however, its incompleteness is evident. The fact of its incompleteness for consciousness may be made clearer if it is expressed "So-and-so is -?" It is apparent that it requires to be added to in some way before it satisfies the mind with completeness and adequacy, that is, before it becomes a judgment. This consideration only emphasises the fact that the verbal completeness of an interrogative sentence is nevertheless the expression of a consciousness of incompleteness. 'What' is the symbol of this incompleteness. Its symbolic/

symbolic function is therefore fundamentally different from that of a word which "stands for" something. As a symbol it stands for the gap and incompleteness. It may be said of it that it symbolizes something in consciousness, but symbolizes something which is not there rather than something which is there. It symbolizes an absence of something. Words like "how" and "why" are also symbols of gaps. They are constituents of the expression of a problem in a sentence, but they partake also in one respect of the nature of what Russell calls "undetermined constituents".

The gap may hence be provisionally defined as an undetermined constituent in the consciousness of a problem expressed verbally in an interrogative sentence. Further logical examination of the concept of the undetermined constituent may enable us to say more about the gap. A logical form which has much in common with an interrogative sentence in that it also contains an undetermined constituent is the propositional function.

Question and Propositional Function.

If we examine the propositional function "x is wise", it is apparent that it differs little from the interrogative sentence "Who is wise?", in so far as both x and who represent, or are symbols of, incompleteness. They are both, in some sense, undetermined constituents. Here again, it is to be noted that the propositional function "x is wise" is verbally complete as it stands, and that it is only the consciousness of its meaning that is a consciousness of incompleteness. Thus, the expression of that consciousness, the propositional function as a verbal expression, is to be distinguished from a proposition, i.e., a determinate statement. It is impossible to judge a propositional function to be either true or false. Only when the undetermined constituent is determined, (- as, for example, when 'Socrates' is substituted for x in "x is wise") do we have a determinate statement, which is the expression of a completed judgment. Both interrogative sentences and propositional functions may be said to be verbal expressions of a consciousness of incompleteness, the incompleteness in both cases being symbolised by an undetermined constituent.

The undetermined constituent in a propositional function is to be considered with reference to the implications of a variable. In, for example, "x is wise", x is a symbol which allows for the substitution of any member/

member of a class or set of items. As Russell says, "A satisfactory definition of a variable presupposes the notion any" (Princip. Math. Chap.VIII). The notion of "any" always implies any one of a set of items which will fulfil a certain condition or conditions, a member of a set or class selected in view of their possession of certain properties. To understand the concept of the variable, which is the undetermined constituent, reference must be made to the concept of a class. The concept of classes is closely connected with the propositional function. Classes may be expressed by what Russell calls "propositional functions involving one variable".

From this point of view, it may be said that since what is meant, in speaking of men, is "everyone who is human", the class men may be expressed by "x is human". If then the name of any individual who is human is substituted for x, a true proposition results as, for example, "Plato is human". The class men is equivalent to the set of individuals whose names can be substituted for x in "x is human", and any member of this class satisfies the propositional function.

A variable then, is a class or set symbol.ϕ It represents any one of a class or set, but it is clear that it refers to the class in a way fundamentally different from that in which a name refers to an individual.

This description of the function of a variable within a propositional function is still insufficient. It is clear that for any variable occurring in any propositional function, a member of any class or set cannot be substituted. This is often not sufficiently provided against in definitions of a variable. Frege, for example, says "The variable keeps an empty place which must be filled in by a member of a class in order that the expression in which the variable occurs may be completed (Über Begriff und Gegenstand). It is clearly necessary to specify the class or set of which the variable is a symbol. What is required is the notion of any one of a class or set defined by the function.ϕϕ

A/

ϕ (A class is determined by a property or set of properties, - a set by enumeration, but the fact of enumeration pre: supposes some property in common. As Johnson says, the connection is intimate. Both are covered by the concept of the variable in this sense.)

ϕϕ (Such a definition does not guarantee that wherever the same letter occurs, the same value shall be substituted. It would be impossible, on this definition of a variable, to distinguish between $3x^2+x$ amd $3x^2+y$).

A variable may thus be defined as a symbol "representing anyone, but not a determined one of a class or set of items, the class or set being defined by the specific functional relation which is expressed". (Dr.Stebbing. Logic).

From this definition it may be concluded that the variable does not keep "an open place" in the expression, in the strict meaning of the words, but a space which is defined to a certain extent, and thus can only be filled by a member of a certain class or set of items, not by any item. For example in "If A is any man, A is mortal", A is a variable, and an undetermined constituent, but it can only be replaced by anyone of the definite set of items composing the class men.

In so far, then, as the undetermined constituent can only be replaced by a certain kind of determinate constituent, the kind being defined by the specific functional relation expressed, the degree of initial indetermination of the constituent must be qualified. It is not a wholly indeterminate constituent. This implies, further, that the nature of the incompleteness or the shape of the gap of which the undetermined constituent is the symbol, is restricted and to some extent defined. It is not an "ambiguous" gap nor is the expression containing such a gap an ambiguous expression. Russell says, for example, that the propositional function, as containing a variable with an unassigned value, is to be distinguished from a determinate statement in respect of its relative ambiguity. Dr. Stebbing, criticizing Russell on this score, remarks that if he means by ambiguity "indeterminateness", the whole concept of function is invalidated. "The notion of functional relation, in its most general form, is the notion of <u>determinate</u> correspondence in abstraction from the specific mode of such correspondence". (Logic).

The mathematical function $\frac{1}{2}x - y$ cannot be said to be either ambiguous or indeterminate. Both x and y are undetermined constituents, but the places they hold in the expression are not places into which any values may be fitted. In so far as a determinate correspondence is specified by the functional relation holding between the variables, a given relation must always exist, and a specific set of values is indicated. A symbol representing/

representing a set or class of items is neither ambiguous nor indeterminate, and the gap which is indicated by the symbol is thus a specific kind of gap.

The undetermined constituent in an interrogative sentence is similarly a symbol of a gap, and it is clear that the same reservations can be made about the gap in an interrogative sentence as about the gap in a propositional function. For symbols of gaps such as who, what, why, which, how, any item cannot be substituted, but only any one of a class or set of items defined by the inter-relations of the conditions of the problem which is given expression in the interrogative sentence. That this is the case is evident from the fact that, in asking a question, there is always present an implicit awareness of the kind of reply which must be given.

There is, however, an important difference between what is symbolized by the undetermined constituents in an interrogative sentence and a propositional function. While it is true that both the "x" of the propositional function and the who of the interrogative sentence symbolize gaps which are limited, in the propositional function the x is limited purely by the limits of significance, while in the interrogative sentence, the range of items symbolized by "who", although also limited by the limits of significance within its objective relational context, is further limited by a number of other factors, such as the subjective context of past and present experience. For example, for x in "x is wise" may be substituted any member of the class of wise individuals from Anaxagoras to Einstein, but in "who is wise?", for "who" must be substituted a member of the same class, but the choice is not co-extensive with the class. It will be limited also by the additional factors of present context and significance, and the background of individual experience. Hence the undetermined constituent in an interrogative sentence resembles only partially the undetermined constituent in a propositional function, since the gap, of which each undetermined constituent is the symbol, is specified or limited in each case somewhat differently.

There is another and ultimate difference between a propositional function and an interrogative sentence. The existence of the question which is expressed in the interrogative sentence implies a gap in the same way as a gap is implied by a propositional function/

function, but the existence of the question, the consciousness of a problem, implies the further and distinctive factor of the wish and intention to complete the gap.

It may be said that every question involves a propositional function, but that the whole nature of the propositional function involved is altered by the addition of the conative element distinctive of the question. For example, the gap becomes specified in a different way. "X is wise" does not present a problem-situation to consciousness, but when the intention to substitute a definite value for x is supposed, the propositional function becomes the question "who is wise", which is the expression of the fact that a specific gap exists for consciousness along with the intention to complete the gap, and resolve the incompleteness.

Question, Propositional Function and Proposition.

It has been shown that a propositional function and an interrogative sentence are alike in that both contain a gap and are incomplete. Analysis of what is implied in each case by the symbol of the gap or incompleteness has led to the point where the completion of both propositional functions and interrogative sentences may be discussed.

A propositional function is defined by Russell as "an expression containing an undetermined constituent "or several undetermined constituents and becoming a "proposition as soon as the undetermined constituents are "determined". An interrogative sentence is the expression of a question or the consciousness of a gap. Here also, the filling of the gap and resolving of the incompleteness will result in a consciousness of something complete which can be expressed verbally in a proposition or determinate statement. In this case also, a distinction is to be observed between the consciousness of completeness; a state of consciousness which can be expressed in a judgment, and the expression of that judgment in a determinate proposition.

In both cases, then, the filling of the gap results in a completed judgment.

(1) Who is wise? (Interrog.Sentence. Verbal expression of a question. "Gap" situation).

(2) X is wise (Propositional Function. Undetermined constituent).

(3)/

(3) Socrates is wise (Determinate sentence. Verbal expression of judgment. Resolution of "Gap" situation. Completeness).

The propositional function as such does not occur within normal thought processes. It is a logical concept. ϕ Normal thought begins with (1) and ends with (3). It may be said that (1) and (2) differ from (3) in that neither are complete, but that (1) and (2) differ from each other in respect of the nature of their incompleteness. It has been shown that in (2) x stands for a gap alone (although not an indeterminate gap), while 'who' in (1) stands objectively for a gap (still further specified) and subjectively, for an intention to complete the gap, the nature of which is further altered by the existence of the intention.

Conclusions as to the Nature of a Problem.

A problem must always involve
A. Objectively. (1) The consciousness of a gap or incompleteness which may be symbolised by an undetermined constituent in the verbal expression of the consciousness of the problem.

(2) The gap itself is not mere gap. It represents something in consciousness, and is a consciousness of something required. It is so specified by its context that it implies a consciousness of the kind of thing required. In this sense, it potentially involves an incomplete judgment or judgments.
B. Subjectively. The wish or intention to complete the incompleteness, to fill the gap, or to determine, in assigning a specific value to, the undetermined constituent, so that the result is something complete in itself, expressible in a proposition or series of propositions which can be judged to be either true or/

ϕ For example, the propositional function is introduced by Russell to facilitate his analysis of general propositions. For present purposes, the analysis of the undetermined constituents or variables in any of mathematical, descriptive or propositional functions would have served. A descriptive function is an expression containing a variable such that when the variable is replaced by a constant, a description results. Priority or differences in types of functions is of no present importance, since all, when determined, will result in expressions of judgment.

or false.

It cannot be said that either of these essential elements in the consciousness of a specific problem is prior to the other. On the one hand, it is clear that a problem only arises, that is, that a gap can only exist for consciousness, when there is present a general intention to achieve a specific end. On the other hand, in a given problem the intention clearly exists in relation to the existence of the specific gap. The seeming paradox can be resolved by reference to primary and secondary intentions. A more general intention to attain a certain end will determine which situations encountered in the attaining of that end will be problem-situations. Any situation which is incomplete or unsatisfactory in view of that end, will be a problem-situation, but given that such a specific problem-situation has arisen within the context of the general problem-situation implied by the existence of an end not yet attained, a specific intention will be correlated with, and consequent upon, the existence of the specific gap holding for consciousness.

CHAPTER IV.

The Nature of the Processes Involved in the Solving of a Problem, and Factors making for Success.

Processes presumably present in the solving of a problem. - Productive aspect of the problem-solving process. - Regulative principles controlling productive-reproductive processes. - Factors determining adequate specification of the gap. - Meaning in relation to adequacy. - Conditions of the problem as specified in meaning are agents productive of the relevant. - Success of problem-solving process depends upon the adequate functioning of the conditions of the problem.

Since it has been seen from the analysis of the nature of a problem that the consciousness of a problem must involve both the consciousness of a gap specified in some way, and the intention to fill the gap, it can be deduced that the actual solving of a problem will require, in the first place, material with which the gap may be filled and in the second place, since the gap is specified and not formless, that the material which fills the gap shall be "shaped" to fit the gap.

Hence it may be presupposed that the thought processes concerned with the solution of a problem present to consciousness must include (a) a thought process productive of material to fill the gap (b) a process "shaping" the material to fit the gap.

This hypothesis may be examined and expanded in relation to the theory of Dr.Hazlitt, who deals explicitly with the same problem of the nature of the processes involved in filling the gap in the consciousness of a problem.

The definition of intelligence given by Dr. Hazlitt (to which reference was made in dealing with types of definitions) involved, as was shown, explicit reference to the nature of the consciousness of a problem in relation to intelligent thought process. Intelligence is "a problem-solving organisation of mind" and "there is always a problem holding for consciousness a gap which can be filled in by the working together of experience/

experience". (Ability. Chap.I). Thus the gap in a problem is filled by means of a thought process which organises experience in some way to fit the gap. The process initially depends upon two factors

(1) Drive, coming from affective and conative settings of the situation

(2) Fecundity of Ideas, the coming to mind of items of experience.

It is this second factor, fecundity of ideas, which must be examined in detail. The factor of drive cannot, as Dr.Hazlitt herself says, be regarded as an element in the organising process as such. "It is the precondition of intelligent as of any other act not purely reflex. Its degree differs in the same person from one organising act to another, and hence it is not the determinant of general ability". It may be taken that under drive, Dr.Hazlitt would include what we have described as "the intention" to solve the problem. It may be admitted that the intensity of the intention will differ in the same individual from one problem to another, and thus cannot be the only determinant of the general measure of success in problem-solving. Moreover, since the intention has been treated as partly constitutive of the consciousness of a problem, it is to be regarded for that reason as a pre-condition of the problem-solving process, which may hence be analysed in abstraction from its motivating factors.ϕ

Fecundity of ideas, the coming to mind of experience as material to fill the gap, clearly implies, as already suggested, that there must be a process which produces material.

The nature of the material which comes to mind in answer to the consciousness of a problem requires careful analysis. The outstanding feature of such material is its relevance to the requirements of the problem, or, in other words, its relevance to the specific gap. Introspective reports from subjects on the solution of problems gives evidence of this fact. In/

ϕ The experimental investigation of 'Incentives', which are factors influencing the quality, intensity and duration of intentions to solve problems, show that ultimately the nature of the intention, and particularly its intensity, is a factor influencing the success of performance.

In the mental search for the right answer to a problem, the items which come to mind in answer to the consciousness of a problem are not any items, but items which tend to be, to a greater or less degree, relevant (See Appendix. Introspective reports). It will frequently happen that the items which come to mind on the presentation of a problem are characterised by complete relevance. Most often, however, the items coming to mind have only a partial relevance, so that a process of conscious selection between alternatives ensues. In difficult problems, this is almost invariably the case. The fact that there is most often the necessity for this process of judgment and even of trial-and-error activity, mental or actual, with regard to the items which first present themselves, does not invalidate the fact that the items initially coming to mind are characterised by a degree of relevance in every case. However remote the connection of such items with the requirements of the problem may be, a connection is present.

This primary fact of the relevance of what comes to mind leads Dr.Hazlitt to the conclusion that there must be "an unconscious factor at work in producing the relevant". Since the first items which come to mind are not primarily selected as relevant from any larger mass of irrelevant items by any conscious process of selection, hence, if any factors are present which guarantee the relevance of the items coming to mind, they are not factors discoverable by introspection, and must work without conscious direction. Dr.Hazlitt concludes from these facts that the factor accounting for the relevant must be unconscious. She recognises the point which has just been discussed, that there most frequently supervenes a process by which the more relevant is selected from the less relevant. "The organising act of mind is not complete without either implicit acceptance of what comes, or explicit judgment between alternatives". Clearly any process of conscious selection or explicit judging must take place with regard to the items which first come to mind, and which are straightway characterised by some degree of relevance.

What has to be considered, therefore, as of primary importance in the filling of the gap, is a process which is not only productive of material but productive of relevant material. The fact that the items first coming to mind are characterised by

some/

some degree of relevance is proof that the material is "shaped" in some way to fit the gap, i.e., to fulfil the conditions of the problem, and it may be concluded that some principle must be at work by which the productive process is directed along lines productive of the relevant to the gap. Whether there is any necessity to consider this principle 'unconscious' in an absolute sense, will be discussed later.

There is no need, therefore, to suppose two processes which fill the gap in the consciousness of a problem. A single process takes place which produces relevant material, i.e., it produces material already "shaped" to some degree to fit the gap. There is no ground for supposing a secondary regulative process which selects the relevant to be superimposed upon a process which produces material in response to the stimulus of the consciousness of a gap, without reference to its relevance to the specific shape of the gap or the requirements of the problem.

It may be supposed then that the thought process accounting for the initial coming to mind of relevant items is a single productive process, regulated in some way by one or more selective, directive or controlling factors. The process must imply principles of two kinds (a) Productive Principles (b) Regulative Principles. For purposes of analysis it will be well to consider first the process as productive in abstraction from its regulative aspect.

Productive Aspect of the Problem Solving Process.

The process in its productive aspect must account for the coming to mind of material. It cannot, in its purely productive aspect, account for the kind of material which comes to mind. There are two questions which may be asked about the productive process; in the first place, from where does the material come? In the second place, by what processes can it be presumed to come?

In answer to the first question, it is clear that whatever material presents itself on the presentation of a problem to consciousness must come from the past experience of the individual. In answer to the second question, it is evident that its presence will be accounted for by reference to the processes normally involved in the recall or revival of past experience.

Regarded from this purely productive aspect it can be said that the consciousness of the problem situation is equivalent to the presentation of a stimulus, and that the presence of the given stimulus to consciousness will revive other items with which the items within the stimulus situation have, in the past, been associated or co-presented. The consciousness of a problem situation, considered as an objective datum of consciousness, would clearly be productive of associated masses of past experience in the same way that a single associative item presented to consciousness will revive parts of its own contexts in past experience. It can be assumed then, that the principle of association itself would be sufficient to account for the revival - or, as we have called it, the production, of material in answer to the stimulus of the consciousness of a problem.

In explaining the presence of items from past experience in response to the requirements of a problem, Dr.Hazlitt refers to Spearman's Noetic and Noegenetic principles as accounting for the production of material. It is clear that a principle such as the eduction of relations, i.e., that the presentation of two ideas to consciousness will bring to mind any relations essentially holding between them, and a principle such as the eduction of correlates, i.e., that the presentation of an idea and a relation to consciousness will bring to mind the idea correlated, will be principles which will be implied in the production of material from past experience. These however are not the only principles accounting for the revival of past experience in answer to the conscious: ness of a problem. Spearman's principles are necessarily involved in a normal associative process, but they do not fully explain it. The principle of association cannot be subsumed under Spearman's principles. Spearman himself says "Association does not give an adequate account of the cognition of relations, but cognition of relations goes far in explaining association. Quasi-mechanical reproductive adherence has its source in noetic coherence". (Spearman. Intelligence. Part III.Chap.X).

It may be that the principle of association does not give an adequate account of the cognition of relations, but the principle of association is presupposed by the cognition of relations. Two items can only be cognised as related if it is presupposed that they are co-presented to the same state of consciousness. For example, it is impossible that A can be revived as being to the left of B unless at some time A has been judged/

judged to be to the left of B, and such a judgment is only possible if A and B are co-presented, or if A is revived along with B and thus enters the same state of consciousness. When A and B are co-presented, they are co-presented as related, but the fact of their co-presentation is both logically and actually prior to the fact of their relation.

Hence the cognition of relations cannot be substituted for the associative principle in explaining the recall of past experience. Spearman's principles may accompany and expand the principle of association and it is true that they become increasingly important as experience becomes organised, but they are not basic and cannot operate in isolation from the principle of association in explaining the recall of past experience. Both must be taken into account as being principles which explain the production of items in answer to the consciousness of a problem-situation.

Further, since it is clear that the productive aspect of the process in which these principles are embodied must be very largely a reproductive process, it may be referred to as the productive-reproductive process stimulated by the consciousness of a problem.

Regulative Principles Controlling the Productive-Reproductive Process.

Since it is clear that the principles making for the recall of past experience cannot be the only principles influencing the problem-solving thought-process, in virtue of the fact that the coming to mind of relevant items is the most important result of that process, there must be other principles involved. These other principles must be principles which direct the problem-solving process to the production of the relevant, or, in other words, principles which account for the elimination of the irrelevant. Productive principles account for the presence of material in response to the stimulus, but they cannot account for its relevance. Amount of material is, provisionally at least, to be distinguished from relevance of material.

The factor which Dr.Hazlitt postulates as accounting for relevance is the unconscious factor of confluence. It is to be defined as "the telling of one part of experience upon another, so that not only does the presented character tend to come into relation with innumerable/

innumerable characters with which it has been associated in the past, but the present task interpenetrates the whole situation".

The statement that relevance is to be accounted for by "the telling of one part of experience upon another" is of central importance, and its implications must be examined. It may be taken to mean, as it stands, that the associative context related to one presented character or condition, is interpenetrated by the associative context related to another condition, while the consciousness of the gap interpenetrates the whole situation and the compound associative relational context.

The principle of confluence is thus of great value in showing how the production of the relevant may be accounted for. It seems, however, to admit of further consideration. It may be asked, for example, in what sense it can be said that confluence is an unconscious factor, and again, in virtue of what principles the associative context of one presented character comes into relation with the associative context of another presented character, and by what means the present task interpenetrates the whole situation.

Taking these questions in the stated order, the question of the degree and kind of consciousness characterising the working of the principle of confluence may be dealt with first.

If the question "Who killed Cock Robin?" is examined, for example, it is clear that the gap symbolised by 'who' will be filled by some section of the associated relational context of the items (a) killed, and (b) Cock Robin. But the number of possible items which may fill the gap indicated by 'who' will be seen by the individual answering the question to be restricted (a) to a class of things which might kill, and within that class restricted again to a sub-class of (b) things which might kill Cock Robin. The fact that a conscious process of step-by-step reasoning along these lines is not gone through on the reading or hearing of the question by an individual who intends to reply, does not necessarily mean that the thought process producing a relevant answer to the question must be dependent upon unconscious factors. Although the steps in the reasoning are not actually present in consciousness, they would/

would seem to be implicit. In such a case as this the process of elimination of non-relevant classes is accomplished as soon as the meaning of the question is apprehended, and this means that the process is too quick to be normally introspectible. If a subject trained in introspection were asked to detail the steps by which the elimination of the irrelevant was accomplished, it might be possible for him to reproduce the steps in the reasoning. When the process is left as it would occur in the course of a normal answering of the question, however, the steps are not normally consciously present.

Hence it is necessary to say that the initial production of the relevant is habitually an unconscious process, but it is not a process which need be accounted for by the postulation of unconscious factors, if by unconscious factors is meant factors which cannot be detected in operation. In the first place, the fact that the steps in the elimination of the irrelevant are not in simple problems normally followed out consciously, does not mean that they cannot be followed out consciously. The more difficult the problem, the more conscious do the steps become. In the second place, the actual conditions of the problem in accordance with which the irrelevant items are eliminated are always present to consciousness and can never be described as unconscious factors. Thus the sense in which we talk of unconscious factors at work in the initial production of the relevant must be qualified. What is meant is rather that the factors which dictate the elimination of the irrelevant and production of the relevant, since they are the given conditions of the problem, must be present to consciousness, but the process in which these factors operate, since it is very often accomplished as soon as the conditions of the problem are apprehended, most frequently takes place too quickly to be detectable. It is clear that the steps in the process of elimination of the irrelevant become more conscious in proportion with the increasing difficulty of the problem. In most cases it may be said that the apprehension of the conditions of the problem will at once eliminate the greatest mass of irrelevant material, and narrow down consciousness to lines relevant to the problem. It may be stated that, for all practical purposes, the process of the initial coming to mind of relevant items is a process which is attended by a very low degree of consciousness and conscious direction, but that the factors influencing that process are not unconscious factors.

Proceeding/

Proceeding to the consideration of how the associative context of one presented character inter: penetrates that of another, it is necessary to consider first what is implied by "the present task interpenetrating the whole situation". This would seem to be the central fact by which the principle of confluence explains the directing of the productive-reproductive process to lines relevant to the problem. It may best be elucidated by reference to the analysis of the consciousness of a problem.

In terms of this analysis, it is clear that the "present task" can only mean the consciousness of the gap, and the intentional direction of a thought process towards the filling of the gap. "Interpenetration of the whole situation by the present task" may thus be restated as "interpenetration of the whole situation by the consciousness of the gap". It may then be considered how the consciousness of the gap acts as a regulative factor in eliminating the irrelevant.

To answer this question, reference must be made to what has been said of the nature of the gap, and to what is implied by the fact that the gap is a specified gap.

In an expression such as "x is wise", or in the question "Who is wise?" it was seen that x and who symbolize gaps existing for consciousness, and that x and who might be regarded as partaking of the nature of "undetermined constituents". In view of this fact, x and who could not stand for any substitutable item, but must be replaced by an item of a certain kind, by a member of a set or class of items defined by reference to the relation existing between x and who and the other constit: uents of the expression. Thus in answering the question "Who is wise?" there is already present implicit knowledge of the kind of item which must be substituted for who in the answer, and it may be concluded that the consciousness of a gap must imply knowledge of the kind of item which must fill the gap.

In short, consciousness of a gap implies knowledge of the kind of item which will be relevant to the gap, i.e., knowledge of the kind of thing required.

This may be substantiated by reference to introspection. A question, expressing the consciousness of a problem, is never asked without a knowledge of the kind/

kind of answer required being implicit in the query. On being asked a question, the comprehension of the meaning of the question in all cases gives knowledge of the kind of answer which is required. It is for this reason that a problem is epistemologically a unique entity. It implies knowledge of something not known, and every theory of knowledge has to give some account of how this is possible.ø

The fact that we know the kind of answer required is the widest regulative factor influencing the productive-reproductive process in the direction of the relevant. It specifies the initial intention to fill the gap to an intention to fill it with a certain kind of item, and explains how "the present task interpenetrates the whole situation" so that what is relevant to the gap comes to mind in preference to what is irrelevant.

We may diverge for a moment to explain this point. It may be argued that to explain the directing and controlling of the productive-reproductive process by reference to the fact that there is implicit knowledge of the kind of thing required is to explain a recondite process by reference to a more recondite fact. But the fact that there is a tendency for the kind of things which are required to be the kind of things which are revived is paralleled by the fact that on the perceptual level there is a tendency to perceive the kind of things which are being looked for.

If, for example, one is confronted with the problem of being miles from civilization and possessing no tin-opener, then anything which is sharp or pointed appearing on the perceptual field, assumes, since it is the kind of thing which is being looked for, a certain intensity value. Such facts relating to the objective side of perceptual experience cannot, of course, be abstracted from correlative facts of purpose, but in the same way, this is also true of the revival of the kind of thing which is required. This does not invalidate them as/

ø See, e.g., Hartmann. "Das Wissen des Nichtwissens" Metaphysik der Erkentniss.

as facts of experience in its objective aspect. Again, in looking for proof of a theoretical hypothesis, one looks about for facts which will substantiate the hypothesis. The specific nature of the facts which may be found is not known, but what is present is an implicit awareness of the kind of fact which will prove useful. Such facts come under the category "kind-of-thing-for-which-I-am-looking", and any fact which has a remote resemblance or connection with this category at once assumes an intensity value which sets it off from the background of irrelevant material. The same facts may be presumed to hold of items within the context of past experience.

To return however to the main line of argument and the consideration of the consciousness of the gap as the central factor accounting for relevance, - it had been agreed that it was not the amount of experience revived in answer to the consciousness of a gap but the relevance of that material which was important to the successful filling of the gap. It may therefore be concluded that the principles which make for relevance are those which determine the success of the problem-solving process. If the implicit knowledge of the kind of thing required is the main principle directing the productive-reproductive process towards the production of the relevant, it will at the same time be the factor which accounts for success in the solving of a problem.

It may be the case, however, that "knowledge of the kind of thing required" is itself a composite principle depending upon other factors.

"Knowledge of the kind of thing required" itself means knowledge of the gap existing for conscious: ness, and the knowledge of what is required to fill the gap will vary in degree with the adequacy of the apprehension of the gap as a specified gap. The factors which determine the consciousness of the gap as specified, and the adequacy of its specification must therefore be considered.

Factors determining Adequate Specification of the Gap.

Just as the nature of the gap symbolised by who in "Who is wise?" is defined by reference to its relation to the consciousness of the whole problem expressed in "Who is wise?", so, in any other problem, however/

however complex, the nature of the gap is defined by reference to the consciousness of the whole problem. Hence, in so far as the problem is constituted objectively by its conditions, the gap in the problem is to be regarded as constituted by the conditions of the problem.

Each of the conditions of the problem will help to "shape" or specify the gap, and it is the apprehension of the gap as specified which gives "knowledge of the kind of thing required" and consequently controls the productive-reproductive process. Thus it may be said that the specification of the gap depends upon what may be called the constitutive functioning of the conditions of the problem. In so far as each condition of a given problem co-operates with each other condition in constituting a gap of a specific shape, it may be said to have a constitutive function.

Ultimately then, it is the actual conditions of the problem which, working as one complex condition through the medium of the gap which they constitute and specify, decide the "knowledge of the kind of thing required" which is the regulative principle directing the productive-reproductive process towards the production of the relevant. In short, the efficacy of this regulative principle upon which the success of the problem-solving process depends will itself depend upon the adequacy of the specification of the gap by the conditions of the given problem.

It is the functioning of these conditions which is of ultimate importance.

The conditions will not function adequately in specifying the gap unless they are themselves apprehended in their full significance, i.e., not only as individually significant but as significant in relation to a given whole of conditions. This means that the meaning of each condition must be apprehended within its place in the whole and in relation to the whole. The exact meaning of any one condition must be fixed by the meaning of the whole problem. Failure to apprehend the significance of each condition in relation to the whole results in failure to solve the problem. Partial apprehension of the interrelational significance of conditions produces unsatisfactory solutions in that they are only partially relevant, or possibly contain much/

much that is irrelevant.

Technically, total or partial failure to solve problems (when it is not due to lack of appropriate past experience relevant to the conditions of the problem) is to be traced to the fact that inadequate apprehension of the conditions has meant that the gap has not been adequately specified in relation to those conditions, so that the regulative principle can only function imperfectly, failing to eliminate all irrelevant material.

Adequacy of Specification of the Gap in relation to Meaning.

When the question of the adequate specification of the gap is approached from the point of view of meaning, it is clear that a two-fold process must be involved in the apprehension of the meaning of a problem.

In the first place, each condition will be understood as having, in its own right, a certain meaning. Characterised by such meaning, it will co-operate with the other conditions in constituting the gap. But, in the second place, the nature of the gap, and the consciousness of the problem as a whole reflect back upon the individual conditions, fixing their significance and meaning in relation to the whole. Introspection on the process of apprehending the meaning of complex problems will substantiate these facts. The way in which this specification of meaning comes about may be illustrated by reference to the same process taking place on a different level.

If it is supposed for a moment that the words in a sentence, in relation to the whole which they constitute, are equivalent to the conditions of a problem in relation to the whole which they constitute, the way in which the meaning of the whole is constituted by the meaning of the parts and yet fixes the meaning of the parts, is evident.

It is clear, in view of this, that the conditions of a problem, although constitutive parts of a larger whole, do not cease to exist as individually significant entities in virtue of the fact; rather do they gain in specific individual definition in proportion as the whole itself becomes defined as a whole.

Regarded/

Regarded as a process taking place among the objective constituents of experience (i.e., in isolation from subjective factors of attention) the growth in the specification and articulation of the constitutive conditions of a problem in relation to the whole can be described as a process similar to that described by Gestalt theory as the growth in the organisation of the gestalt upon which the act of intelligence depends. The following extracts from C.K.Ogden's "The Nature of Intelligence" illustrate the fact clearly.

"The first appearance of any data of observation can be likened to the emergence of an articulate figure from an inarticulate ground .... The apprehended unit is from the start an organised whole, although it is at the same time one which may be capable of further organisation through a definition of its contour and inner articulation .... The next step in cognitive or intelligent response is the definition of the contour and articulation of the figure.... An act of intelligence is an act which reflects these higher degrees of definiteness whereby the figure becomes highly articulate and sharply drawn.... I regard cognition and intelligence as processes involving the constructive membership implied by a figural whole. The organised whole is there from the beginning, and its further definition is accomplished neither by the associative process of accretion nor by an alien mysterious act of eduction (criticism of Spearman) but solely by an intelligent principle of organic membership which is inherent in the data themselves.... The nature of intelligence is revealed by the contour and articulateness of experience. A mode of experience is an intelligent one according to the degree it is articulate within itself or sharply defined".

While refusing agreement to Ogden's contention as to the ultimate principle on which the organisation of the Gestalt depends, his description of the way in which the parts of the gestalt (i.e., in this case, the specific conditions of a given problem) become articulated and defined in relation to the whole of the problem, is relevant to this analysis and may be taken as substantiat: ing the fact that the separate conditions of a problem gain in specific significance as a result of their co-operative constitution and specification of the gap.

<u>The Conditions of the Problem as Ultimate Productive-Reproductive Agents.</u>

In/

In discussing the principles implied by the productive-reproductive process in abstracts, the consciousness of the existing gap was said to be the stimulus initiating the process, and accounting for the revival of material from past experience. If, however, the consciousness of the gap is to be referred back to the individual conditions which specify the gap, it is clear that the productive-reproductive process stimulated by the consciousness of the gap must also be referred back to the individual conditions.

This will mean that each condition has a value as a productive-reproductive agent, but this only in a qualified sense. If each condition were to operate as a productive-reproductive agent in abstraction from its place within the whole, a chaotic mass of past experience would be brought to mind, out of which it would be necessary to select the relevant from the irrelevant by conscious judgment. It has been shown that, in virtue of the fact of the initial production of the relevant, no process of conscious judgment between alternatives is initially involved. It may be concluded hence that the conditions of the problem do not function as isolated productive-reproductive agents in abstraction from their significance within the whole. The meaning of each condition as specified in relation to the whole, controls the productive-reproductive function of each condition.

The way in which this happens may be illustrated by further reference to the example of a sentence. A word in a sentence has a meaning in its own right in every case. Even if the word has never before been perceived, it has the meaning of its present relational context. In the normal case of the perception of known words, the meaning is given by a mental act of relating in which the terms will be the word itself as an immediate datum of consciousness and some context other than itself which is aroused by it. Hence, in itself any word of a sentence is a potential productive-reproductive agent. It can bring to mind some portion of past experience.

Within the sentence, however, its meaning will be fixed in relation to the whole. Its specific meaning content, as fixed in such a way, will determine the nature of the portions of past experience with which it will be related. Hence, in so far as it functions as an agent productive of past experience, it will reproduce experience/

experience relevant to the whole of the sentence. The same facts hold true of the conditions of a problem. Their productive-reproductive activity will be restricted to lines of revival relevant to the gap holding for consciousness in proportion as their meaning is specified in relation to the whole.

It may be concluded then that the productive-reproductive process stimulated by the consciousness of a gap, can be referred back to the individual conditions of the problem as specified in meaning in relation to the exact nature of the specified gap.

Conclusions.

The conditions of the problem are the factors to which reference must ultimately be made in discussing the success of the problem-solving process.

Through the medium of the gap which they specify, the individual conditions are themselves specified in relation to the gap. As specified they act not only as agents stimulating a productive-reproductive process, but as agents directing that process to the production of items relevant to the gap.

Since the relevance of the material produced is the prime factor accounting for the success of the problem solving process, the success is ultimately to be attributed to the adequacy with which the conditions of a problem perform their function
(a) as specifying the gap.
(b) as, themselves specified in relation to the gap, stimulating a controlled productive-reproductive process.

Hence there are three aspects of the functioning of the conditions of a problem
(1) The Constitutive aspect, whereby they constitute, in co-operation with the other conditions of the problem, a gap of a specific size.
(2) The Productive aspect, whereby they act as agents stimulating a productive-reproductive process.
(3) The Regulative aspect, whereby, in virtue of their specific significance within the whole which they constitute, they control the productive-reproductive process so that material relevant to the gap comes to mind.

The success of the problem-solving process

will/

will depend upon the degree to which the process is controlled by the conditions of the problem in each of these three aspects. But, since the efficiency of the productive and regulative aspects depends ultimately upon the constitutive aspect, it may be said that the degree of success of the problem-solving process will depend upon the degree to which the individual conditions of the problem work together to constitute a gap which is adequately specified by these conditions.

CHAPTER V.

The "Reservoir" of Experience.

Qualitative aspects of experience. - Quantitative aspects of experience. - Amount of experience in relation to relevance. - Organisation and revivability. - Adaptability of organised experience.

The success of the problem-solving process has been traced to the adequate functioning of the conditions of the problem in each of their three aspects.

So far the functioning of the conditions of the problem has been considered in abstraction from the material upon which the conditions function, but it is evident that in a final consideration of the success of the problem-solving process, it will be impossible to omit consideration of factors connected with the material. If the success of the problem-solving process depends upon the adequate organisation of material to fill the gap in the consciousness of the problem, the principles accounting for the organisation of the material cannot, except for purposes of analysis, be considered in abstraction from the material itself. It cannot be supposed, for example, that either the quality or the quantity of past experience, which is the content of the problem-solving process, can be immaterial to the success of the process.

It must be presumed, in view of such facts, that the success of a problem-solving process as it occurs within the normal experience of a given individual will depend upon two different groups of factors

A. Factors relative to the adequate functioning of the conditions of the problem
B. Factors relative to the experience upon which the conditions of the problem function.

We shall now consider factors of experience in abstraction from factors relative to the functioning of the conditions.

The least which is demanded by the functioning of the conditions of a problem is the existence of a "reservoir" of past experience. Any analogy such as "reservoir"/

"reservoir", when used to describe past experience is, of course, ipso facto, a straining of facts. But the term is convenient if it is taken as representing the sum of dispositional traces of past experience and thus as the sum-total of potentially revivable experience. Two aspects of the nature of the "reservoir" affecting the success of the problem-solving process may provisionally be assumed, (1) the qualitative aspect, (2) the quantitative aspect.

Qualitative Aspects of Past Experience in relation to the Successful Solution of Problems.

The importance of the factor of relevance in accounting for the success of the problem-solving process has already been stressed, but clearly if appropriate experience has never been present, the principles making for the eduction of the relevant, however adequately they function, must function in vain. Where experience has been inadequate, no problem-solving process can be successful. It must be noted that in a problem where there has been inadequate experience a successful solution may yet be found, since random trial-and-error activity may possibly result in the filling of the gap by relevant material. But it cannot be said that in such a case, the problem has been intelligently solved. Chance will be a factor in the solution, and the problem-solving process will have none of the characteristics of an intelligent process.

Lack of appropriate experience accounts for most cases of failure to solve problems in the case of subjects who are recognised to be intelligent. If there is nothing within the "reservoir" of experience, which, by the organising work of the conditions of the problem, can be brought into connection with the specific gap, the most adequate functioning of the conditions of the problem must result in failure. It is with this fact in mind that intelligence tests which are designed to test the individual's ability to organise experience in relation to existing gaps, involve only such material as must be common property to all the subjects undergoing the test. Only by such means can experience factors be discounted and the efficacy of the principles organising experience be measured in abstraction from the experience which they organise.

Again, the material within the "reservoir" of a given individual will tend to be appropriate to certain

kinds/

kinds of problems rather than others, and hence the experience factors in the problem-solving process stimulated by the consciousness of such problems will favour relevance. This is one of the facts which explain special abilities.

It is clear, then, that the experience within the "reservoir" must be characterised by the quality of appropriateness to the existing problem-situation, if a successful solution is to be found. The detection of appropriate experience presupposes in every case the existence of a larger mass of experience bearing in a general way upon the situation. The exactly appropriate portions of experience are always surrounded by experiential contexts characterised by lesser degrees of appropriateness. These larger masses may or may not be present to consciousness. The existence of such larger masses may be verified by introspective examination of a process of conscious selection of appropriate material for any given purpose, for example, for the writing of an essay. Sometimes the consciousness of the larger mass of experience in which the exactly relevant is discovered is present, sometimes it is absent.

In the case of the process involved in the initial coming to mind of the relevant in answer to the consciousness of a problem, the consciousness of the larger masses of experience is almost invariably absent, since the initial process does not involve conscious selection of the relevant. If, however, the items which first present themselves in answer to the stimulus, are allowed to develop their implications by a conscious process, the larger masses in which they are "imbedded" come with such facility to mind that it is a likely hypothesis that such larger masses are already implicitly aroused in the course of the initial production of the relevant. Whether or not this is the case, the facts at least show that the coming to mind of relevant experience in every case presupposes the existence of a background of experiences characterised by lesser degrees of relevancy, and fading off into the completely irrelevant.

Quantitative Aspects of Experience.
Amount in relation to Relevance.

In so far as the exactly relevant is always to be found within a mass of experience characterised by degrees of relevance varying from the less relevant to the irrelevant, it might be presumed that amount of experience would/

would ultimately be a factor influencing the success of the problem-solving process. It seems probable that a larger "reservoir" of experience would have a greater likelihood of containing appropriate experience. Hence in considering the general measure of an individual's success in solving problems, one might be inclined to believe that an individual who had at his command a large "reservoir" of experience, would tend to find within it experience appropriate to a greater number of problems, and hence tend to be able to solve a greater number of problems. Such a consideration would lead to the conclusion that the amount of experience, in abstraction from its relevance, must be a factor determining success in solving problems.

But if this hypothesis is examined carefully, it is evident that what it implies with regard to "amount of experience" is not amount of experience in a purely quantitative sense. The implication is rather "amount of experience of a certain kind", which is exactly what is implied by the phrase "amount of experience" as used in ordinary discourse.

When an individual is said to have "a great deal of experience", either of two things is implied. What is meant is either (a) that he has much experience of one certain kind of material, or (b) that he has experience of many different kinds of material. It cannot be denied that these meanings of "amount of experience" must be taken into account in considering the success of a problem-solving process, and they have already been touched upon in discussing the qualitative aspects of experience. In the first case, amount of experience of a certain kind of material will tend to render the individual who possesses such experience able to solve problems dealing with such material, for he will have within the "reservoir" the experience appropriate to such problems. In the second case, the existence within the "reservoir" of experience of many diverse kinds of material will enable an individual to find experience appropriate to problems dealing with many different kinds of material, and he will hence tend to be able to solve problems of many diverse kinds. Thus, what is implied by "amount of experience" in ordinary discourse is amount of experience either (a) appropriate to problems all having the same kind of material as content or (b) appropriate to problems having diverse kinds of material as content. The meaning attached to amount of experience is therefore "amount of experience appropriate to certain kinds/

kinds of problems", amount of experience, in short, characterised by a certain quality. It is clear that quality and quantity are not being separated, the qualitative aspect is implied, although only the quantitative aspect is explicitly talked of.

What then is the purely quantitative aspect of experience, considered apart from its qualitative nature as appropriate or non-appropriate to gaps in the consciousness of problems?

If an attempt is to be made to consider the pure amount of experience in abstraction from the existence of problems, it will mean that the limits of revivable experience must be set. The pure amount of experience will then be the sum-total of revivable experience.

There is, however, no limit to revivable experience; it is infinite and continuous, and there is no end to the possibility of revival. A person may "free-associate" into eternity. Thus, since there are no limits to the amount of revivable experience for any individual, the pure amount of experience is equal for every individual. Pure amount of experience, or amount of experience considered apart from problems, requirements, purposes, is a theoretical abstraction, and has no significance. "Amount of experience" is only a significant term relative to problems and purposes.

It may be concluded, then, that the use of the term "amount of experience" as in ordinary discourse, is justifiable. Quantity of experience is only significant if what is meant is "quantity of experience of a certain quality", i.e., experience of certain kinds of material as the content of certain kinds of problems, or, in other words, as relevant to the gaps in the consciousness of given problems. It follows hence that the widest description that can be given of the quality of experience is the description of it as appropriate or non-appropriate to gaps in the consciousness of problems.

When amount of experience as characterised by the possession of this quality of appropriateness or non-appropriateness is considered, it is clear that it is not an unlimited amount but limited by many different factors. The amount of experience relevant to a gap will be limited A. by Objective limits, e.g., there are a finite number of items in any class or set.

B./

B. by Subjective limits. (1) Individual experience may possibly only include a certain number of the members of a class or set. There are many classes of which it is conceivable that an individual might have full experience. There are many others of which it is inconceivable that he should have full experience. The possibility of having knowledge or experience of all the members of a class or set depends upon the objective nature of the class or set. What is important is that the individual frequently cannot, and more frequently does not, experience all the items of a class or set which exist for him to experience. His experience is thus a selection from the potentially experiencable number of items. Whatever at any time enters the individual's experience, is cognised or attended to, becomes part of the body of his potentially revivable experience. Hence the limits of potentially revivable experience appropriate to any gap are set objectively by the nature of the material of which it is the experience, and set subjectively by the amount of that material which the individual has chanced, or been able to experience.
(2) At the moment of presentation of a problem to consciousness, the amount of the individual's experience is the amount he is at that moment actually able to recall. It is limited by the limits of recall. It is, in short, the amount of appropriate experience actually revived out of the potentially revivable.

These considerations emphasise the point already made. The only significant sense of "amount of experience" is amount of experience, not only appropriate to certain problems, but rather, the amount of potentially revivable experience appropriate to a certain gap, the amount of experience, in short, which the individual could, if revival were complete, recall in answer to the requirements of a problem or problems involving certain kinds of material. Only in such a sense of the term can it be said that amount of experience will ensure a greater likelihood of the relevant to the gap being discovered within/

within it. It is evident that if a large number of potentially revivable items appropriate to a specific gap exist within the "reservoir", a greater number of these items will tend to be revived, and the chances of discovering the item or items exactly relevant to the gap will be increased. It is clear that what is important to the success of a specific problem-solving thought process is, that given appropriate experience exists within the reservoir, i.e., is potentially revivable, as much of this potentially revivable experience as possible should be actually revived.

It is to be concluded, therefore, that the factor which ultimately determines the amount of experience existing for any specific problem is the factor which determines how much of the potentially revivable shall be actually revived.

The Organisation of Experience. Organisation and Revivability.

The widest and most inclusive factor determining the amount of experience which is revivable is the degree to which it is organised. This fact can be substantiated by reference to recognised facts about learning and remembering. For example, experimental investigations of the learning of nonsense syllables has shown that these are always organised by the subjects in some way and remembered as organised. There does not seem to be any material which does not admit of such subjective organisation. Series of dots are organised into patterns, series of sounds into rhythms, and the more easily a material lends itself to organisation the more easily is it reproduced. A student preparing for an examination will try to organise his material in definite ways, arranging it under various headings in logical patterns, and the greater the degree of organisation to which he subjects it, the greater the likelihood of its speedy and adequate recall when it is required.

The organising of experience is to be attributed to several specific mental activities such as, for example, attention, discrimination, or judgment, and it is for this reason, as we had occasion to point out, that intelligence is often defined in terms of one or more of these activities. A Gestalt theory of intelligence such as Ogden's (see Chapter IV) is similarly dependent upon references to the organisation of experience, e.g., "the/

"the nature of intelligence is revealed by the contour and articulateness of experience", the distinctive feature of the Gestalt theories being that the growth in the organisation of experience is considered as an objective phenomen, without reference to any subjective mental activity such as is implied by attention, discrimination or judgment.

The most important generalisation which can be made about the organisation of experience is, however, that experience becomes organised through the solving of problems, and in so far as problems are successfully solved, experience grows in a way which fits reality. However abstract the problem-solving process may be and however abstract the problem itself may be, the success of the solution of the problem can only be measured in terms of its conformity with objective external fact. The criterion of success is thus, in a sense, pragmatic. Experience grows in a way conformable with objective reality because the solutions of problems are measured against objective reality, and this fact holds good for all levels of experience of which it may be said that problems hold for consciousness.

An important consequence of the fact that experience becomes organised through the solving of problems, is that experience will tend to become most highly organised along the lines where most problems are solved. A problem will arise, as we saw, where a conative direction to an end is obstructed. Hence it will tend to be the case that the greatest number of problems will arise in connection with the kinds of material which subserve individual ends, that is, with the kinds of material with which conative interests are bound up. It can be assumed that where conative interests are implicated, the drive factor will be strong. There will be a greater incentive to solve such problems and the number of problems solved involving material in which interest is taken, will tend to be greater than the number of problems solved involving material in which no interest is taken. A strong interest in a certain kind of material will lead to the organisation, and accumulation of organised experience, of such material. Thus when the individual is presented with fresh problems involving this kind of material, there will be a greater likelihood that he will find in his past experience that which is appropriate to the problem, and will have, so far as experience factors go, a correspondingly better chance of solving the problem successfully. The effect is cumulative:/

cumulative: the greater the number of problems involving the given material as content which he solves, the greater the amount of organised experience appropriate to such problems will he have at his disposal, and the greater his chances of successfully solving more such problems. The fact offers a plausible explanation for special abilities, and is the ultimate argument for the efficiency of a high degree of specialisation.

Since, then, experience which is easily revivable is experience which is highly organised, and since the degree to which it is organised may be said, in one aspect, to reflect the amount of conative interest taken in the material of which it is the experience, then the revivability of experience is partially to be attributed to conative factors not directly connected with problem-solving ability as such.

The capacity to organise experience, however, clearly does not depend wholly upon conative factors. To discuss the lines along which experience tends to become organised is not to discuss the capacity to organise experience. The capacity to organise experience differs from individual to individual even relative to the simplest material of experience, and there must exist some general factor or factors which determine the degree of success with which experience is organised.

When we consider that experience becomes successfully organised, i.e., in a way which conforms with objective reality, through the successful solution of problems, it becomes evident that the same factors which account for the successful solution of problems must also account for the organisation of experience.

Thus, of the two groups of factors involved in the successful solving of problems, viz., (a) factors of experience (b) factors determining the adequate functioning of the conditions of the problem, i.e., organising factors, the basic factors determining a general measure of success in problem solving will be the factors determining organising ability. In a specific given problem, if appropriate experience is presumed to exist, it will be possible to separate factors which organise from factors relating to the experience which is to be organised to fill the specific given gap, and to say that the successful solution of the given problem will depend both upon the adequate functioning of the conditions of/

of the problem, and the degree to which the experience upon which they are required to function has been organised and is revivable. Over the course of an individual mental life, however, since the nature of the experience available for the solution of problems is ultimately determined by the efficiency with which the organising factors have operated in all past problems, it will be admitted that the organising factors have priority, and are the ultimate factors to which problem-solving ability is to be attributed.

Hence, since the factors accounting for the ability to organise experience are not accidental, the degree to which any existing experience is organised will not be accidental, but a basic factor influencing the general measure of an individual's success in solving problems.

It is to be noted that the lines along which experience becomes organised, as dependent upon conative interests which have no a priori connection with ability as such, are accidental to the actual existence of problem-solving ability. The lines along which experience becomes organised will account for the existence of appropriate experience for any given problem. It will be a factor influencing the empirical measure of problem-solving ability, that is, the judgment as to the amount of problem-solving ability a given individual possesses based on the measure of the number of problems he is observed to have solved successfully. It is clear that many accidental factors will influence the empirical estimate of problem-solving ability. When the experience factors are ruled out by the device of presuming only a measure of appropriate experience which must be common to all, persons who have been empirically judged to be more intelligent through having successfully solved a greater number of problems, may often be seen to have solved these problems in virtue of the possession of appropriate experience rather than in virtue of their actual ability to solve problems.

Thus, the lines along which experience is organised which will determine the existence or non-existence of experience appropriate to any given problem, is an accidental factor determining success. It is not a factor determining the general measure of problem-solving ability. It will always be present in a successful intelligent problem-solving process, but it may be present in a non-successful problem-solving process.

Again/

Again, it may be present in either a successful or a non-successful unintelligent problem-solving process, i.e., it may be present and not be used because the ability to employ the conditions of the problem adequately, or, in other words, to organise the existing appropriate experience successfully, is absent.

Hence it is to be concluded that the degree of organisation of given existing, i.e., potentially revivable, experience, is the only experience factor to be found which is a determinant of the general measure of ability to solve problems. It has been shown how it depends in a fundamental way upon that ability itself.

It is, in short, the way in which experience is used which is symptomatic of intelligence, and not either the amount of experience of a certain kind of material, or the amount of experience of many diverse kinds of material. It must be recognised that such factors must influence the success of any specific problem-solving process, which will necessarily involve experience of a given specific material. If such appropriate experience is non-existent, the problem cannot be solved intelligently. But the existence or non-existence within the "reservoir" of experience appropriate to a given problem or series of problems has no connection with the actual problem-solving ability of the individual. Given that the appropriate experience exists, it is the degree to which it is organised which facilitates its revival, and provides the problem-solving process with the material of experience to be shaped to fill the gap. Neither "amount of experience" nor "amount of experience having the quality of appropriateness or non-appropriateness" can be considered factors determining a general measure of problem-solving ability. The only sense in which the term "amount of experience" has any ultimate significance for a general measure of ability is when it is used as meaning the amount of potentially revivable experience existing as appropriate to a given problem, which is actually revived in response to the consciousness of that given problem.

Adaptability of Organised Experience.

The degree to which given appropriate experience is organised is not only important to the revival of that experience, but is important also (a) as affecting the speed with which it is revived and (b) the immediate relevance of what is revived.

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This will be clearer if we consider, by way of example, what the organisation of experience will imply as to the nature of that experience considered for the sake of clarity, on a simple level.

The productive-reproductive process by which the revival of the potentially revivable is effected, depends, as was seen, ultimately upon the principle of association. Associative units are always of a complex type. Association is only "association of ideas" if by "idea" is meant the kind of thing which can be expressed in a sentence. They are complex units, wholes of interrelated parts, or configurations. Thus, in such configurations as have been organised - and it was seen that organisation must accompany the act of intelligence (see Chapter IV) - the parts will be articulated in relation to the whole, and most importantly the relations holding between the parts of the configuration will become defined.

Consequently, in an associative process directed to the production of the relevant for a given gap holding for consciousness, the presentation of one item will tend to arouse the more easily other parts of the configuration which are relevant to the gap if the configuration is already highly organised. When experience is articulated and defined, revival of the relevant will be facilitated.

Further, when the parts and relations within the configuration are clearly defined, the releasing of an item from one configuration and its transference to another will be more easily effected. This is particularly important when it is considered that at the ideational level, intelligence does not work by reproduction alone, but by the adaptation of past to present. For this to take place, experience must be "pliable". Configurations must be able to be adapted in various ways to special requirements. One way in which experience is adaptable may be considered by reference to Spearman's principle of the eduction of correlates, or perhaps more simply by reference to Stout's Principle of Relative Suggestion. If, for example, a red circle and a green square are co-presented so that an associative bond is formed between them (i.e., if they are members of the same configuration,) and then if, on some future occasion, a red circle ten times smaller than the original is presented, this red circle will revive a green square of corresponding size.

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The only explanation of such a fact is that association holds between abstracts rather than concretes, and universals rather than particulars. What is important is the relation perceived as existing between the items of the configuration. The principle of Relative suggestion shows how experience is adaptable since it shows how the revival of one item in a configuration in a different form from its original form, will revive the other items in corresponding relation.

Moreover, if, in answer to the requirements of a problem situation several configurations of past experience are adapted in this way an entirely novel arrangement of experience may result. This is one way in which novelty enters, and originality can be accounted for.

These facts are sufficient to illustrate the importance of the degree of articulation and definition, i.e., of organisation of past experience, to the problem-solving process.

It is to be concluded that the degree to which the "reservoir" of past experience is organised is the most important factor determining the revival of past experience, both from the point of view of the speed and the relevance of what is revived. Finally, it is the only factor of experience which is a determinant of the general measure of ability to solve problems, considered apart from the empirical measure of the number of problems which have been successfully solved.

CHAPTER VI.

The Definition and Operation of Controls.

The definition of a control - The statement of the conditions of a problem. - The Operation of Controls (a) in relation to the difficulty of the problem (b) in relation to different levels of operation.

The Definition of a Control.

It has been shown that the adequate functioning of the conditions of a problem in their constitutive, productive and regulative aspects, is the factor upon which the success of the problem-solving process ultimately depends. In the light of the experience factors which have now been considered, this can be restated as, - the ability to solve problems is the ability to organise experience in accordance with the conditions of the problem. The constitutive aspect of the functioning of the conditions can thus be restated as the ability to organise the conditions of a problem so that they constitute a specific gap. We saw that this meant that all the conditions of the problem, through the medium of the gap which they specify, come together to act as one complex regulative condition directing the productive-reproductive process, and that hence, in so far as each condition acts as an agent specifying the gap, the regulative and productive power is ultimately to be referred to the conditions themselves. In the light of this, it can be concluded that in so far as each condition controls the productive-reproductive process, each condition can be regarded as a 'control' of the problem-solving thought-process. The conditions of the problem will in future be referred to as 'controls', and under the term 'control' we shall understand that the three aspects, constitutive, productive and regulative, of the conditions are included, since, as we have seen, all of these aspects are implied by the fact that the problem-solving thought process is directed by the consciousness of the gap.

A control can be recognised by the fact that it is a condition which specifies the gap in the consciousness of/

of a problem. If any condition is stated in a problem which does not have any effect upon the 'shape' of the gap, that is, does not specify or define it further, it is not a significant control. A control then, is any significant condition of a problem. It frequently happens that conditions are stated which do not specify the gap to an appreciable degree. This is one of the methods by which "trick" problems are constructed, for example. Again, when it is said of a problem that it is not "well stated" what is frequently meant is that non-significant controls are included in the statement, or that significant controls are not stated.

The gap in the consciousness of a problem may be conceived as being specified to an additional degree with the addition of each significant control and hence, the productive-reproductive process will be controlled to a corresponding additional degree with the addition of each control. It is clear that the degree to which a control specifies the gap is measured by the degree to which it restricts the range of the productive - reproductive process. If we suppose there to be two controls in a problem, then control A shuts out the possibility of the gap being filled solely by the productive-reproductive process stimulated by control B, and vice versa. Thus the lines of associative reproduction become specified as the gap becomes specified. The existence of control A narrows the gap in the B direction, the existence of control B narrows the gap in the A direction, and hence the lines along which the gap cannot be filled are eliminated as irrelevant, and the lines which are relevant remain. The result of the adequate functioning of controls must be the elimination of the irrelevant and facilitation of the relevant.

The Statement of the Conditions of a Problem.

An interrogative sentence was shown to be the expression of the consciousness of a problem. It expresses verbally a questioning attitude of mind which implies that a gap exists for consciousness. The expression of the questioning attitude is the essential function of an interrogative sentence, but clearly a questioning attitude cannot be expressed without expressing at the same time that which it questions, or, in other words, with regard to what a questioning attitude is held. It must express, in short, where the gap is. Hence an interrogative sentence must indicate (a) that a gap exists and (b) where a gap exists.

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It is to be noted that an interrogative sentence does not necessarily include any statement as to how the gap is specified. The conditions of the problem state how the gap is specified, and the conditions need not be - and frequently are not - expressed in the statement of the question which shows where the gap exists. Thus an interrogative sentence is neither necessarily nor usually the statement in its entirety of the problem as it is apprehended as a whole. The statement of the problem as it exists for consciousness would require that all the controls of the problem should be stated as well as that the place where a gap exists for consciousness relative to these controls, should be indicated. If then the consciousness of a problem is to be expressed verbally at all, it must express the fact that a gap exists and with regard to what it exists, but it need not state how the gap is specified. In the actual expression of stated problems, for example, a statement of conditions may be made and followed by a question indicating the whereabouts of the gap which is to be filled by the functioning of the conditions, as in the problem "Given $A\hat{B}C = 45^{o}$, $A\hat{C}B = 65^{o}$ and BC = 4.2c. What is the length of AB?" Again, the statement of all or some of the conditions can be made within the interrogative sentence itself, as, for example, in the riddle "What is it that can go up a pipe down, but not down a pipe up?" or the question "Who was the most famous English poet living before the sixteenth century?" But the ways in which problems may be stated are innumerable. What is more important is that most often only the whereabouts of the gap in relation to certain material is stated, and the conditions which specify the gap have to be supplied by the individual solving the problem, as, for example, in "What is the relation of ethics to politics?" "What part does capital play in the remuneration of labour?" In both these cases the controls for the problem have to be supplied.

Thus, in dealing with problems which are expressed verbally, the distinction between subjectively and objectively set conditions has to be drawn. Clearly, if an individual sets a problem to himself, or becomes conscious that a specific problem exists, the conditions of the problem are set subjectively, while in a geometrical problem, such as that given above, the conditions are set objectively. The distinction is only valid, however, in reference to stated or expressed problems. So far as the consciousness of a problem is concerned, all the conditions are set objectively, for they are set by the relations/

relations existing between the facts of objective reality.ø

In a verbally expressed problem, where all the conditions are not stated, the problem will most frequently be found not to be a simple problem, where the problem-solving process is directed to the filling of one gap, but a complex problem containing many sub-problems and gaps. For example "What is the relation of ethics to politics?" presents a problem to consciousness, but it is a complex problem, in that the decision as to the controls specifying the main gap will involve the solving of numerous sub-problems.

It must be noted that when problems of this nature are set for individuals to solve, the aim in view is most frequently not the measuring or exercising of problem-solving ability as such, so much as the measuring of the amount and the degree of organisation of the past experience appropriate to a certain kind of problem, i.e., experience of a certain kind of material existing within the 'reservoir' of the individual's experience. Since, however, as we have seen, the degree of the organisation of past experience reflects the number of problems which have been solved in the past, the result is ultimately the same. The immediate object, however, is the measuring of the amount of appropriate experience which exists. This is the aim of most problems set in examination papers, for example, and thus simple (i.e., non-complex) problems are most usually to be found where the aim is to test problem-solving ability in contradistinction from the amount of appropriate experience/

ø It can be said of problems where the conditions do not express necessary connections between objective facts, that they are 'artificial' problems, designed to test ability to solve problems. Problems where the conditions are presumed to represent necessary connections existing between objective facts and do not do so are not valid problems. There are thus two main types of problems, (a) problems where the conditions express purely formal connections between facts, without reference to the conformity of the relations expressed with externally existing relations, and (b) problems where the conditions express connections existing between facts of the external objective world. Each, to be valid, must be consistent with its own type.

experience existing within the reservoir, as in intelligence tests, or problems devised to test ingenuity such as tricks or puzzles. Such problems are commonly described as difficult, but what is meant is that they are difficult in that either the exact relations of the conditions relative to the whole are difficult to determine, i.e., the gap is difficult to specify, or that it is difficult to find an item relevant to the gap. They are not complex in the sense that they include a number of sub-problems.

Most of the problems met with in the course of every day living are complex in the latter sense, whether they are problems specifically set by other persons for us to solve or whether they are problems which are apprehended as existing specifically for an individual consciousness. When a problem of administration is talked of, for example, what is most frequently implied is a series of problems bearing upon a certain point. Even in such a problem as "Shall I appoint an executive committee or deal with the matter personally?", it is clear that many sub-problems are involved. Problems as they are conceived in ordinary discourse then, are inter: related wholes of problems, subsumed under the conscious: ness of and directing the trend of thought processes towards the filling of one main gap. Each of the gaps in the consciousness of the sub-problems will be specified by its own specific controls, and each sub-gap must be filled by the operation of a specific controlled problem-solving process. The judgments which are made as a result of the solutions of these sub-problems will most probably be the controls specifying the gap in the main problem. Hence the controls in the sub-problems are not the controls of the main problem. They relate to a specific gap which is not the same gap as is specified by the controls of the main problem.

It may be concluded that the type of problem which is technically to be known as a complex problem is reducible to a number of simple problems where the controls specify one given specific gap and direct a productive-reproductive process towards the filling of this gap. Simple problems of this type and of a structure such as we have analysed, are thus the elements of processes of directed thought, however complex these processes may seem, and however abstruse the problems with which they deal.

If this is so, a control must be defined so that the definition makes clear the fact that a control is/

is not any condition which may be connected with the larger whole of a complex problem. It is a condition which is significant to one specific gap in the consciousness of a problem, and controls one specific productive-reproductive process.

With these various considerations in view, a control may be defined as any specific significant condition, either stated or unstated, which exists relative to a specific gap in a given problem present to consciousness, and which defines that gap to a specific degree.

The Operation of Controls (a) in Relation to the Difficulty of the Problem.

The difficulty of any given problem may depend either upon the factors of experience involved, or upon the control or organising factors. Both factors may present difficulty in any one given problem.

Difficulties which can be attributed purely to experience factors arise when the appropriate experience is difficult to recall, even presuming it exists as potentially revivable. For example, although the conditions may have been so organised that the gap is adequately specified and there is implicit knowledge of the properties which must be possessed by the item which is to fill the gap, an item possessing exactly these properties may not be revivable. When the fulfilling of one or more conditions of a problem presents difficulties, it most often means that a sufficient number of items fulfilling these conditions have either never been known or that they have not entered experience in such a way as to be easily revivable. Difficulties relative to experience factors, then, relate generally either to the kind of material which is present in the 'reservoir', or to the degree of its organisation.

If, however, the question of the difficulty of a problem is considered apart from the experience factors involved, i.e., apart from its dependence upon certain facts of past experience, it will be seen to depend upon difficulties arising from the control factors. Such difficulties are largely due to the difficulty of organising the controls so that the gap is adequately specified in relation to them. Where the gap is not adequately specified in relation to the controls, knowledge of the properties which an item must possess to fill

the gap adequately will be lacking, and thus the productive-reproductive process will not be directed towards the production of the relevant.

As a general rule, it may be said that the greater the number of controls present, the greater the difficulty in organising them to specify the gap. It is the constitutive aspect of the controls in such case which gives difficulty. The method most frequently used in the constructing of difficult problems (apart from experience factors) is the multiplication of the number of controls. This rule must be qualified in several directions, however. A problem which contains several controls may yet prove easier to solve than one which contains fewer controls, because the gap is often narrowed in such a way when many controls are present that the properties of the item which must fill the gap become fully defined. On the other hand, a problem which contains relatively few controls may leave open so many lines along which the relevant may be found, that much conscious discrimination between the more and less relevant items is entailed. It will depend ultimately upon experience factors whether a gap which is specified to a high degree is easier to fill than a gap which is not so highly specified. Moreover, it is clear that a gap to which only one item is relevant is not necessarily easier to fill than a gap to which several items are relevant, and vice versa. The controls having been organised to specify the gap and the kind of item required being known, all will depend upon whether such an item is easy to find in experience or not.

It may be concluded that the degree of difficulty which any problem presents to a given individual, as depending upon experience factors, will be difficult to estimate, since the quantity and quality (i.e., degree of organisation) of the experience at his disposal will not be easily calculated. In problems where difficulties arising from experience factors can be discounted, as, for example, in certain intelligence test problems where only a common measure of experience is presupposed, the difficulty of the problem will be easier to estimate, since it will be dependent upon

(a) the number of controls present
(b) the complexity of the interrelations of these controls
(c) the amount of re-organisation of past experience which is necessary before it can be adapted to present requirements.

The Operation of Controls (b) in relation to two different Levels of the Problem-Solving Process.

It is clear that any initial process producing the relevant is not complete without either implicit acceptance of what comes or explicit judgment between alternatives as to their greater or less relevancy.

Whatever the factors upon which the difficulty of a problem depends, if it should present difficulty at all, it will tend to involve the conscious process of judgment between alternatives and even possibly a trial-and-error process, either mental or actual, with regard to the items initially produced.

Most problems will involve two processes (A) a process of the initial production of the relevant, (B) a process of conscious selection of more from less relevant. The line of demarcation which it has been found necessary to draw between the two processes gives rise to several important questions. It may be asked, for example, whether the second process is qualitatively different from the first or whether they are both one continuous developing process.

The most obvious difference between the two processes and that in virtue of which the line of demarcation was initially drawn, lies in the fact that the first process, the initial production of the relevant, takes place below the level of conscious direction, while the second process of selection or judgment is fully consciously directed. Both processes must result in the elimination of the irrelevant according to the same criteria of what is relevant, i.e., according to the apprehension of the gap as specified. This becomes evident when we consider that in cases where the first process fails to throw up into consciousness the exactly relevant item or items, the whole process which we have conceived as taking place below the conscious level, i.e., the directing of the productive-reproductive process by controls, takes place on the conscious level. It might be said that it is reiterated on the conscious level. Where the first process fails to produce what is relevant, the procedure most likely to be followed is to re-examine the conditions carefully in relation to the gap, to make certain what exact properties must be possessed by the item which can fill the gap, and then to work backwards over the associative relational contents of each condition, consciously selecting whatever may be relevant to the

requirements/

requirements of the other conditions, (or, in other words, to the gap as specified) and afterwards applying critical tests of suitability.

This process in its entirety will, however, only be gone through where the initial unconscious process fails to throw up relevant items, and there is no question as to the priority in time of the processes relative to a specific effort to solve a problem. The presentation of a problem will always stimulate some ideas. (The case where, on being presented with a problem what is described as "a complete blank" ensues, is to be explained by reference to the intervention of conative or emotive inhibitory factors). Such items as are produced by the initial process may prove, on critical examination, not to be relevant to the specific gap, but they will be characterised in every case by a degree of relevance. When it is said that the initial process fails to throw up the relevant, what is meant is that it fails to throw up the exactly relevant. An initial productive process is thus always present before any conscious process, no matter how unsuccessful it is in producing the exactly relevant.

Since, then, it seems justifiable to distinguish two processes within the thought process directed to the solving of a problem, we must consider how the difference in the degree of consciousness by which the one process is distinguished from the other, is to be accounted for.

The most probable explanation is by reference to the analogy of physical habit formation, which, from a process involving trial-and-error activity, conscious selection of the successful and conscious judgment between alternatives, becomes a process in which none of these conscious activities and efforts are involved, and, as it becomes automatic, sinks below the level of conscious direction. The employing of controls may be a mental habit of a complex order, and if so, the process of acquiring the habit of employing controls will thus pass through the same stages as those through which the acquiring of a motor habit will pass. It is evident, for example, that the solving of problems becomes more like a habit as age and education advance. Children tend to solve the problems with which they are confronted by a process which involves a high percentage of trial-and-error activity and must thus be largely conscious. This is not only the case with children, but with unintelligent adults. It may be taken that the presence of intelligence hastens the/

the acquiring of habits. The inculcation of habits in mental defectives or feeble-minded persons takes considerable time. Thus a feeble-minded individual may never acquire the habit of employing controls, and when such a person attempts to solve a problem, he may do so, but he will tend to do so by non-intelligent methods, by trial-and-error process with regard to material which is frequently entirely irrelevant. It may be said that the outstanding feature characterising an unintelligent problem-solving process is the failure of the initial process to produce the relevant to the gap. Hence the second process of conscious selection takes place with regard to items which are irrelevant.

This failure of the initial productive process can best be described (in all cases where lack of appropriate experience is not a factor) as a failure to employ controls. Where this failure constantly occurs, it may be presumed that the individual has not yet acquired, or cannot acquire, the habit of employing controls. Where the failure is only occasional, the difficulty presented by specific problems as regard to the organising of controls might account for failure.

Hence it may be that failure to solve problems intelligently occurring in the case of children, is to be attributed to the fact that they have not yet acquired the habit of employing controls. It is evident that the habit will only be acquired through intensive practice in problem solving, and this is, of course, exactly what is given in the course of education. In the case of adults who consistently fail to solve problems, failure must be accounted for by the fact that the ability to employ controls must be lacking, since the habit has not been acquired in the course of education and experience. It is a likely hypothesis, then, that there must be some innate factor which determines the ability to employ controls. Clearly, if the ability to employ controls is absent, the employing of controls cannot become a habit. In the second place, it is evident that the ability to employ controls must either be improved by practice or facilitated by practice. That the ability must be present before the facility can be acquired is clear, but it is more difficult to decide whether the increase in capacity to solve problems with the advance of age and experience is due
(1) to increase in experience factors, (2) to improvement in the ability to employ controls, or (3) simply to a facility in the employment of controls gained by extensive practice./

practice. One fact which is certain is that the greater the extent to which the employment of controls has become a habit, the less the degree of consciousness with which the process will be characterised. Thus the greater the facility with which controls are employed, the further will the unconscious initial process of production of the relevant encroach upon the second process where conscious elimination of the irrelevant and selection of the relevant takes place. In other words, the greater the extent to which employment of controls has become a habit, the greater will be the portion of the second conscious process which sinks below the threshhold of conscious direction. For example, in the case where the exactly relevant to the gap instantly presents itself along with the apprehension of the meaning of the problem, the second process is reduced merely to a conscious acceptance of what comes as relevant to the gap. The operation of the controls on the productive-reproductive process takes place wholly below the threshhold of consciousness, and hence no second process, no conscious selection of the relevant, is necessary.

As a general rule, the instantaneous presentation of the relevant only occurs in simple problems. Only occasionally does it happen to the normal individual that the exactly relevant answer to a difficult problem instantly presents itself. When it does happen, it will be regarded as mystifying, since no series of mental events leading up to the production of the relevant idea can be detected by introspection. Such instant solutions are regarded as "inspirations" and it is implied that they lie outside the normal sequence of mental events.ϕ The frequent occurrence/

ϕ Investigators of originality and genius have always taken account of the phenomenon of the sudden rise of the completely relevant. It is generally admitted that such phenomena are to be attributed to the operation of processes taking place below the conscious level. Knowlson says, for example, "Sudden illuminations point to a course of previous unconscious work" (T.Sharper Knowlson. Originality. The same view is expressed by Ribot and Allera (L'Imaginat: ion Créatrice. Sulla Questione del Genio).

occurrence of "inspirations" is commonly taken as evidence of the existence of genius, which is thus consequently conceived of as differing qualitatively from normal intelligence, or as being dependent upon some factor or factors superadded to the normal mental outfit.

The main fact upon which these assumptions are based is the non-introspectibility of the process of the production of the relevant. As we have already considered (see Chapter IV, page 37) the process involved in the production of the exactly relevant answer to a very simple question is too quick to be introspectible. The same can be said of the coming to mind of the exactly relevant in a difficult problem. In the difficult problem, however, the fact that a much more complex operation of controls must be involved, is to be considered. It must be the case in the production of an "inspiration" that complex control and experience factors have operated instantly to produce the relevant. Where the production of an inspiration is an occasional event, it can only be supposed that on such occasions a fortunate concatenation of all the factors making for success in the solving of a problem has occurred. Naturally a certain capacity to use controls and a certain facility in their use must be presupposed.

In the case of an individual who frequently produces solutions of the inspirational type to problems, a very great facility in the employment of controls must be supposed. It must happen that the operation of the controls takes place so quickly and with so little conscious effort that the process of production of the relevant frequently takes place below the level of conscious direction.

In neither of these cases is it necessary to suppose that the process of production of the relevant is a qualitatively different process from the process as it takes place normally with a certain degree of conscious direction. In the case of the person who does not habitually produce so called inspirations, it is most probable that the operation of controls has by chance taken place as a habitual motor action would take place. In the case of the person who frequently produces inspirational solutions to problems, it must be supposed that a habit of employing controls has been acquired. Thus the analogy of physical habit will explain the process in both cases, and there is no/

no need either to suppose the intervention of qualitatively different factors or that the process of the production of the relevant is a qualitatively different process. Further, there is no necessity to suppose that the intelligence which tends to produce answers of the inspirational variety to problems is qualitatively different from the normal intelligence. What may be reasonably supposed is that the first type of intelligence can be explained as a quantitative heightening of the normal intelligence. Before the operation of controls could become a habit perfect enough to explain the frequent operation of controls below the level of conscious direction, it must be supposed that the ability to employ controls is already present. This alone would not be sufficient, however. If facility in the use of controls depends upon other or additional factors than these upon which the ability to employ controls depends, these other factors must also be presupposed as existing before the perfection which the habit of employing controls has reached, can be adequately explained. Given both these factors, which are merely quantitative heightenings of factors present in normal intelligence, the adequate and speedy operation of controls which will result will explain the speed with which the process of production of the relevant takes place, and the degree of unconsciousness which characterises it.

Thus, given the fact that the operation of employing controls can become so facilitated as to present the characteristics of a habit formation and to sink below the level of conscious direction, the initial process of production of the relevant which characterises every normally intelligent problem-solving process can be accounted for. It is that part of the problem-solving process as a whole, in which the controls operate without conscious direction. The greater the extent to which controls can operate automatically, the wider the extent of the initial process of production of the relevant, since a greater part of the work of the direction of the productive-reproductive process by controls will be done within this initial process instead of within the second process where the operation of the controls is consciously directed. The adequacy of the initial process and its extent can be taken as reflecting the degree to which the employment of controls has become a habit. In view of these considerations, then, it may be concluded that the unconscious and conscious processes are parts of one and the same continuous problem-solving process. The same factors/

factors are involved in the success of the process at each level, the end of each is the same, and each performs the same operation. The only difference existing, in virtue of which it proves convenient to speak of two processes in place of one, lies in the fact that the first process is characterised by the lesser degree of consciousness required for the direction of the process by controls.

To consider the question from a different angle, it is often said that types of intelligence fall into two main categories, the intuitive type of intelligence and the logical or rational type.ϕ There is universal recognition of this distinction which is based on the empirical observation that there seem to be two different ways of arriving at a conclusion which characterise two different types of mind. The first method belongs to the rational type of mind which apprehends facts in series of logical interrelations, and follows out each step in the argument. The second method belongs to the intuitive type of mind. Here the relations existing between facts seem to be grasped without the aid of the conscious ratiocinating process characterising the first type of mind. T.S.Knowlson describing this type of problem-solving process says that it depends upon the possession of an "Illative Sense" - "by which the mind draws remote inferences without conscious syllogistic process" (Originality. Chap.I).

When we consider that these descriptions of different types of mind are differentiating the two in virtue of a difference in the method of solving problems which characterises each, the distinction may be seen to bear upon the present discussion.

With the conclusions of the foregoing discussion of the degrees of consciousness characterising different sections of the problem-solving process in mind, it becomes possible to conceive the intuitive type of mind as explained, partially at least, as a type of mind in which the problem-solving processes take place largely below the level of conscious direction. As was seen, when this is the case, the initial process of production of/

ϕ cp. Pascal's "esprit géometrique" and "esprit de finesse"

of the relevant encroaches upon the second conscious process in such a way that much of the conscious process of drawing out the implications of the conditions and of judgment between alternatives becomes unnecessary. In the case of the rational type of mind, however, it may be supposed that the second and conscious process has a larger share of the problem-solving process as a whole, and that hence the larger part of the process of direction of production by controls lies above the conscious level.

Here again there is no necessity to suppose an absolute qualitative difference between the two types of mind. The stage of intuition looks like a stage of practice. The machinery of the mind is so well practised that the operation of the employment of controls is immeasurably speeded up, unnecessary steps are eliminated, and economy of time and effort is effected as in the case of motor habit. But just as in the case of motor habit, the steps must all at one time have been present and made by conscious voluntary effort.

Again, there is no suggestion that the intuitional type of intelligence is superior in reliability to the rational type. It may be the case that the ability to solve problems as judged by the number of problems successfully solved is the same in the case of two individuals, one of whom we shall suppose to have a rational, while the other has an intuitive type of mind. It is not in the ability to employ controls that the differentiating factor lies. The difference is one of the facility with which controls are employed. This may depend solely upon practice in the use of controls, but if this were the case, it would also be the case that where an equal amount of ability to employ controls was present, an equal amount of practice in solving problems would result in equal degrees of facility in the use of controls. It seems that some factor besides practice must be postulated to account for the varying degrees of facility which individuals acquire in the use of controls. It may be suggested that a factor such as the capacity to form mental habits could account for facility. It would hence be a factor of a constitutional kind, and one not necessarily related to the factors which account for the ability to employ controls. But again, the facility with which controls are employed may be an inborn characteristic in some individuals while others may attain facility by practice. C.S.Myers notes that "there can be little doubt that there are wide individual differences in the extent to which we are/

are endowed with intuition. But there can also be little doubt that intuition in any given occupation can be cultivated, and that its value can be improved by careful exercise." (C.S.Myers. A Psychologist's Point of View). Since, as we have seen, intuition is accountable for, at least in part, as facility in the use of controls, Dr.Myers' point may be taken as substantiating the view that facility in the use of controls may be acquired, although it is frequently an inborn trait. Further, in so far as genius is frequently characterised by the intuitional method of solving problems, it may be that genius stands in the same relation to normal intelligence as instinct stands to habit. Genius may be the inborn formation which the intelligent man may come near attaining through practice. As was shown, there is no necessity to suppose qualitative or structural differences between the normal intelligence and genius any more than to suppose such differences to exist between rational and intuitive types of intelligence. Through long practice in problem-solving an individual may come to solve problems by the intuitional method.

This is particularly the case with problems of a certain type involving a certain kind of material. We saw, in dealing with the 'reservoir' of experience that the continual solving of problems dealing with a certain kind of material led to the accumulation of a body of organised experience appropriate to such problems.

With the practice given in solving such problems, the facility with which controls are used will also increase so that the whole process, in virtue both of experience and organising factors, becomes facilitated and sinks below the level of conscious direction. Thus the attainment of the stage of intuition (i.e., the stage of practice) is very much hastened when problems all deal with a specific type of material. A consideration of this nature will account for what is meant in talking of "financial genius", "business sense" or "intuition in business matters". It seems to be a fact that the financial or administrative genius very often does not reason out every step of his procedure, and thus may be said to proceed by intuition. Dr.Myers says "The successful business man or financier owes his success largely to intuition. He often does not know why he takes certain lines of action; frequently, even if he were able he has not time enough to think out reasons for his decisions". In other words, the use of controls in relation to his own specific kind of material has become/

become so much of a mental habit, that the problem-solving processes are characterised by a low degree of consciousness. So great a degree of practice may be attained that difficult problems involving many controls may be solved in this way. Lord Melchett in the Universities Review, 1928, wrote "The business man is compelled, by reason of his trade, to make decisions and to reason often quite subconsciously on problems involving a very great number of factors" (i.e., controls).

Conclusions.

It is evident that the facility with which controls operate accounts for several phenomena of the problem-solving process. Facility in the use of controls implies that the use of controls has become to a greater or less degree, a mental habit. In proportion as the employing of controls becomes a habit, the operation tends to sink below the level of conscious direction. In normally intelligent individuals, the operation of controls attains sufficient independence of conscious direction as to allow of an initial unconscious process of production of the relevant always taking place.

Increase in the facility with which controls are employed will lead to progressive decrease in the amount of voluntary effort required to direct the productive-reproductive process by the controls. As in the case of physical habit, the formation of the habit speeds up the operation. Hence when facility in the use of controls has been acquired, the operation of the controls, which results in the production of the relevant, will take place with greater speed.

The degree of facility characterising the performance of any individual with controls may be attributed either to the result of practice or to an innate factor such as, for example, a factor which might determine capacity to acquire mental habits. It appears to be the case that facility in the use of controls is an innate characteristic in some individuals, while in some others it can be attained through practice.

The speed with which the production of the relevant is effected, does not imply anything as to its success. The facility with which controls operate is not the same thing as the adequacy with which they operate. The intuitive type of intelligence may solve problems/

problems more speedily, but it will not, of necessity, solve them more successfully than the rational type of mind.

Facility in the use of controls must ultimately depend upon the ability to use controls. An individual must be able to organise experience by controls before the operation can be speeded up through practice. Where ability to use controls is not present at all, facility in the use of controls cannot exist. Ability to use controls is more basic than facility in the use of controls. More facility in the use of controls than ability to use controls might characterise the problem-solving activity of a given individual. This would mean that he tended to solve problems quickly, but that his solutions were frequently unsatisfactory. On the other hand, in another individual the ability to use controls might be present to a high degree while facility was almost entirely absent. Such a person would tend to solve problems successfully, but slowly and painstakingly.

Whether we are dealing with a normal or with a high level of intelligence, with an intelligence in which controls operate largely on the unconscious level, or an intelligence in which controls operate largely on the conscious level, what is important is that the controls should operate adequately in order that the problem-solving process is successful.

It is evident that the ability to employ controls differs from individual to individual as does facility. Just as the facility with which controls are employed may be either an inborn formation or acquired through practice, so it is possible that ability to employ controls may be improved through practice in the solving of problems.

The degree of success which will attend the problem-solving activity of any given individual will depend upon his ability to employ controls, that is, on his ability to keep all the controls of a given problem before his mind and to organise them in such a way that they act through the medium of the gap which they specify as one complex regulative condition directing the problem-solving thought process towards the production of what is relevant to the gap in the consciousness of a given problem.

It is probable that there are two variables involved in the problem-solving process
(a) Facility in the use of Controls. This may depend on/

on some inborn factor, but it seems certain that the facility with which controls are employed can be improved by practice. Facility determines the speed of the operation but not its success.

(b) Ability to use Controls. Here again an inborn factor may determine the degree of ability present, or on the other hand, ability may be improved by practice. There is not the same evidence for increase in the ability to employ controls with practice as there is for the improvement of facility with practice. It may be the case that what appears to be increase in the ability to solve problems with the advance of age and education can be accounted for as increase in the quality and quantity of the experience within the 'reservoir', and, in the second place, as increase in the facility with which controls are employed. Neither experience factors nor the degree of facility in the use of controls which is attained will be determinants of the success of problem-solving process.

CHAPTER VII.

A Genetic Treatment of Thought Processes with Reference to the Kind and Degree of Control Present.

Problem-solving process directed to solution of specific problem most highly controlled of problem-solving thought process. - Degrees of control in other processes. - Factors directing reflective thought processes. - Nature of Controls on Undirected thought.

It has been said that all mental processes with the exception of certain routine activities such as habit, are motivated by the consciousness of problems. Hence all thought processes, with these stated exceptions, may be said to be problem-solving thought processes. Further, the intelligent thought process, directed towards the solution of a given specific problem, was provisionally cited as being the clearest case of a thought process motivated and directed by the consciousness of a problem. Analysis of a specific problem-solving process has shown it to be directed by certain specific regulative principles, i.e., controls. Hence it is to be concluded that the clearest case of a thought process directed by controls is to be found in the intelligent problem-solving process, although in so far as other thought processes have also been described as problem solving thought processes, we should expect to find controls of some description operative upon them also. There naturally arises out of these considerations a question as to whether the thought process directed towards the solution of a specific problem can justly be described as the most highly controlled thought process.

In so far as it is inconceivable that there should be a thought process more highly controlled than that directed to the solution of a specific problem, then such a process must mark the upper limit of the degree to which thought processes can be controlled. Hence specific problem-solving processes are the most highly controlled of thought processes, and other thought processes, if they are controlled, must be controlled to a less degree. It is conceivable that degrees of control may exist among the residue of thought/

thought processes, and should this be so, it should be possible to set the lower limit of control, that is, the point at which a thought process begins to be controlled, and after which it ceases to be controlled.

It should thus be possible to treat thought processes genetically in respect of the degree to which they are controlled.

There is another aspect to be considered in a genetic treatment of thought processes. It is possible that the kind of controls which have been found to operate on intelligent thought processes directed towards the solution of specific problems may not be the kind of controls which are operative upon thought processes other than these. There may be qualitative as well as quantitative differences to be taken account of in tracing the development of problem-solving thought processes up to the specific intelligent problem-solving process. In such a genetic treatment of thought processes, then, both (a) the quality and (b) the degree, of control present must be considered.

Analysis of Directed and Undirected Thought Processes.

Normal thought processes habitually regarded as non-controlled can be subsumed under the heading of reflective thought, or undirected thought. Normal thought processes habitually regarded as controlled can be subsumed under the heading of directed thought.

The question as to the kind and degree of control operating on these processes may best be discussed in relation to two main questions

(a) Is undirected thought ultimately undirected - and if not, by what principles or factors is it directed?

(b) Can the principles or factors directing reflective thought processes be said to be controls? How do they compare with the controls which are operative in a thought process directed to the solving of a specific problem?

The answer to these questions will decide what quality and degree of control exist in undirected thought processes, and again, at which point the line of demarcation between directed and undirected thought may be drawn.

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(1) The Directing of Reflective Thought Process.

If everyday thought processes are examined, some will be seen to be occupied with the perceptual environment, some are reverie, some are occupied with specific tasks and problems, while emotions and conations permeate the whole complex pattern.

With the thought processes involved in the carrying out of specific tasks or the solving of specific problems, we have no immediate concern. These have already been analysed in detail. Nor, again, shall we consider aspects of thought processes such as cognitive affective or conative aspects, in abstraction from their participation in concrete thought processes. What we are immediately concerned with is all thought processes which are not occupied with the fulfilling of the ad hoc conditions of a given task or problem. It must be considered in what respect these can be described as problem-solving processes, and what factors determine their general direction.

It is an accepted fact that undirected thought processes are not either aimless or chaotic. All thought processes are ultimately directed by the widest and most pervasive controlling principles of all, i.e., the individual's 'propensities'. These are always to be taken for granted. To talk of the trend of an individual's thought process as determined or directed by his individual propensities is only another way of saying that each individual stream of consciousness is a thing unique in itself.

Within the interinfluential unity of ar individual stream of consciousness, and within what may be described as its general conative trend, more specific trends of thought processes can be distinguished. If a time-section of thought process is examined, it will be found to consist in various trains of thought which begin and end at specific points in time. Each train of thought is distinguished from the train of thought which precedes or follows it in virtue of the fact that each is occupied with some specific theme and its related associational context. It is guided and directed by the consciousness of that theme for a greater or less period of time. It is only by reference to such a theme, that is, by reference to the content of a train of thought, that with which it deals, that specific trains of thought can be separated and considered in abstraction from the continuous unity of which they are part.

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The themes with which trains of thought are occupied may be provisionally regarded as motivating and directing, and hence, as controlling, these trains of thought. Further, analysis of a theme will generally reveal it as concerned with the consciousness of a problem of some kind. Both retrospective and prospective trains of thought will be found to begin with the consciousness of a gap. The wide spread nature of the associative content of trains of reflective thought is to be explained by the fact that the consciousness of the problem by which they are motivated is either an indefinite consciousness, that is, the gap is not clearly specified, or, on the other hand, it is a consciousness of a very complex problem in which the main gap could be specified only through the filling of innumerable sub-gaps. For example, when we speak of "an end in view" what is implied is that something is not yet attained, that a major gap or incompleteness exists which can only be filled if numerous sub-gaps are filled, - if the problems constituted by the obstacles in the path of the end are solved. An unattained end presents a problem, but it is a remote problem, and one in which the gap is not specified by a given number of conditions, as in the case of specific problems such as have been discussed.

In reflective trains of thought, sometimes only the main gap is apprehended. It will tend not to be clearly specified, and hence awareness of the existence of the sub-gaps may only be implicitly present, as involved in the consciousness of the main gap. Thus the productive-reproductive process stimulated by such a consciousness of a problem does not become crystallised into lines relevant to specific gaps, but spreads out in many directions. Another factor explaining the wide spread nature of the associative content is to be found in the fact that the intention to solve the problem, in so far as the gap is not specific, cannot be a specific intention. Specific intentions are only to be found correlated with specific gaps. What is more important is that most frequently it is not an intention to solve the problem immediately.

Evidence for these facts about the nature of the problems holding for reflective thought is supplied by the fact that if an individual who has been indulging in reverie is asked of what he is thinking, he will tend to reply "I was just wondering why .... or what.... or how ....so-and-so." That a problem of some kind is in the forefront of consciousness is evident, but it is also evident that the problem is not specific, and that the individual/

individual has no immediate intention of solving it. He may wish to solve the problem at some future date, or merely wish that the problem were solved, but since his wish is not specified into an immediate intention to act with regard to the problem, he does not specify the gap which he wishes to fill in relation to definite objective conditions which must define it before it can be filled.

Thus, although the consciousness of a problem acts as a stimulus to a given train of undirected thought, the train of thought is not controlled by the conditions of the problem, so that only associations relevant to a specific gap are admitted to consciousness. The productive-reproductive process spreads out in all directions, is diverted into new channels by the arising awareness of the existence of a sub-gap, and is finally switched over into an entirely new train of thought as a different problem comes to occupy the focal point in the field of consciousness.

It may be said that the consciousness of a problem gives the impetus to a train of thought, and it may even be said that it controls the train of thought in so far as it decides that the train of thought will take a certain direction in preference to any of the other innumerable directions it might have taken. A train of thought is thus only definable quantitatively (span) and qualitatively (content) in terms of the problem with which it ultimately deals, and in so far as this is the case, it may be said to be controlled by the consciousness of a problem.

Again, in so far as a problem only arises when the path to an end is obstructed, the problems with which undirected thought is occupied will lie along the lines of conative interests. Ultimately then, since conative impulses constitute the problems which exist for an individual consciousness, it is the conative impulses which direct the trend of undirected thought. These conative impulses become specified in the awareness of problems, and hence the general trend of undirected thought process is specified in relation to these problems into more specific trains of thought. But it is clear that the ultimate controlling factors are the conative impulses and interests. Undirected thought is thus not undirected in any literal sense. In so far as it is occupied with the problems arising in connection with the ends of conative activity, it is controlled by the consciousness of these ends.

The Nature of the Controls Operating on Undirected Thought Processes.

It is evident then, that undirected thought processes are directed, that they are occupied with problems existing for consciousness, controlled by the awareness of the existence of these problems, and ultimately by conative impulses. The nature of the controlling factors operative upon undirected thought must now be examined and compared with the nature of the controls existing in thought directed to the solution of specific problems.

Relative to directed thought, "controls" were defined as "any specific significant conditions, either stated or unstated, which are relative to a specific gap in the consciousness of a problem, and which each define that gap to a specific degree".

In normal undirected thought processes, the factors which ultimately control these processes, conative impulses, drives and interests, certainly direct the processes towards given ends. We saw that an end, as something not yet attained, represented an incompleteness and a gap. Hence an unattained end, as was seen, presents a problem to consciousness. The problem presented by an unattained end is very different, however, from a problem of the kind which stimulates directed thought. In the first place, the gap is merely apprehended as existing. It is a complex gap and there is also almost invariably present an implicit awareness of the sub-gaps implied by the main gap. Further, a specific immediate intention is not correlated with the main gap, nor, in consequence with any of the sub-gaps. Hence the gap implied by the consciousness of an end is not a gap specified by, or in relation to, specific objective conditions, or by a definite number of such conditions. If neither the number nor the exact nature of the conditions specifying the gap are clearly apprehended, the gap is only apprehended as a gap and not as a specific gap. In consequence, the productive-reproductive process which is stimulated by the existence of such a gap cannot be controlled by the consciousness of the gap as specified. It cannot, therefore, be controlled so that it produces only what is relevant to the gap, because specific controls do not exist to decide exactly what is relevant and to eliminate the irrelevant.

Hence a conative impulse, for example, cannot

be/

be regarded as a significant control in the sense defined. It neither constitutes a gap, nor does it control a process directed to the production of what is relevant to a gap. As we saw, it determines the lines along which gaps will be found. In deciding where an end of activity shall lie, it is the presupposition of the consciousness of gaps, and at the same time, the presupposition of thought processes directed towards the filling of such gaps, in that drive is a necessary factor in problem-solving thought processes. It is not a factor which controls the organising of experience to fill any gap.

We saw, however, that the general trend of undirected thought could be analysed into specific trains of thought definable in terms of more specific ends, or, in other words, in terms of the consciousness of more specific problems, such as are implied by the controlling themes of trains of ideas.

It might be supposed that where the problem motivating reflective thought process is more specific than the problem which is implied by the awareness of an unattained end, the thought process which it stimulates might be controlled more in the sense in which a specific directed problem-solving process is controlled. Hence it might be expected that a train of reflective thought motivated by the consciousness of a comparatively specific problem would embody controls in the sense defined, and that in the case of such trains of thought a degree of control qualitatively similar to that present in directed thought, but quantitatively less, might be reached.

Here again, however, it is the case that most problems which form the controlling themes for unit trains of thought, do not contain gaps specified by a definite number of significant controls. What is present is the awareness "that a gap exists relative to such-and-such an end". It is, moreover, clear that the specificity of the gap and the specificity and immediacy of the intention to fill the gap are correlative and concomitantly varying factors. The intention to fill the gap which motivates a train of thought is no more specific or immediate than the intention relative to a more remote end.

The existence of an immediate specific intention to fill a gap which is recognised to exist, will mean that/

that the gap will be specified in relation to a definite number of specific objective conditions, i.e., significant controls. But in so far as it is the essence of undirected thought that specific immediate intentions to fill gaps which are apprehended as existing, are absent, the specification of the gaps will not take place. Hence the controls which would, if the gap were to be specified, direct the productive-reproductive process to the production of some specific kind of item, are only implicit in the awareness "that the gap exists", and never become explicit unless conative activity becomes similarly specified into an intention to fill the gap as specified and further, to fill it immediately. As soon as the intention becomes specified in this way, the whole nature of the thought process is changed from undirected thought to directed thought. The awareness "that a gap exists" is no longer sufficient. The specific intention to fill a gap requires that the exact nature of the gap should be known, and hence the controls implicitly present are made explicit. They become controls in the significant sense, and consequently change the nature and range of the thought process stimulated by the awareness of the problem, controlling and directing it along the narrower lines of what is relevant to the specific gap.

Hence it is clear that as thought processes are narrowed down by degrees from general trends of thought directed to general ends by ultimate conative interests, to more and more specific trains of thought dealing with correspondingly more specific ends and problems, the degree to which significant controls are potentially present, is increased.

At the same time as the thought processes become narrowed, the drive factors are also narrowed, but controls which are potentially existent or implicit in the awareness that a gap exists never become explicit, and hence never become significant controls until the conative impulse itself becomes specified in a specific immediate intention to fill a defined gap in the consciousness of a given problem occupying the focal point of the field of consciousness.

Thus the nature of the process changes with the specification of the intention. The change from undirected thought to directed thought is an abrupt one. It is a qualitative rather than a quantitative change. The problem which motivates undirected thought processes may become gradually more specific in relation to its/

its subject matter - it may vary from the consciousness of an unattained end to a problem such as is expressed in "I wonder who left this gate open?" without affecting the nature of the thought process. The only difference is that the controls which would specify the gap in a problem such as "Who left the gate open?" are potentially present to a higher degree. There is an implicit awareness of the kind of conditions which would determine the question as to which person did leave the gate open, which is largely absent in the apprehension of an unattained end. Immediately, however, that the wish to know who left the gate open becomes a specific intention to find out immediately who left the gate open, a new factor enters, and the thought process is qualitatively changed.

It is to be noted that when thought processes are considered as narrowing down from general directions to ends to trains of thought concerned with more specific problems, what is meant is not that the gap in the consciousness of the problems is more specific but that the problem itself relates to more specific ends subsumed under the general conative trend. They hence imply a more specific content, and thus tend to be much less complex than the kind of problem which is present to consciousness in an unattained end. But, as we have seen, the content of the problems motivating trains of undirected thought can be indefinitely specified without the gap becoming specified. It will still be a gap existing in relation to a given content of experience. The qualitative change in the thought process consequent upon the specification of the gap demands the intervention of the factor of a specific immediate intention.

Hence it may be concluded that no degrees of control exist among undirected thought processes, if by control it is implied that the thought processes are controlled by controls in the technical sense of the term. In this sense, a thought process is either controlled, i.e., directed to the immediate filling of a specific gap, - or it is non-controlled. When a thought process is undirected, it is motivated by the awareness "that a problem exists", but it cannot be controlled, since the awareness "that a gap exists" can only mean that the gap is not specified and that hence significant controls which might direct the thought process are non-existent for consciousness. Thus an uncompromising line of demarcation must be drawn between directed and undirected thought. The one does not shade off into the other. On the one side of the line there are thought processes directed/

directed to the filling of specified gaps, and correlated with immediate specific intentions, - all thought processes concerned with the solution of given problems. On the other side, are all other thought processes. Whether they are motivated by the consciousness of problems dealing with a more or less specific content, the specific immediate intention to solve the problem is absent, and hence the gaps are not specified ϕ, and the thought processes are not controlled.

In the technical sense, then, thought is either controlled, or it is not controlled. There are no degrees of control existing between directed and undirected thought.

ϕ Note.
There is one special case of an undirected thought process which is worthy of note.

It is possible that an undirected thought process may be occupied with the consciousness of a specific problem where the gap is defined by a given number of significant controls, as for example, when one muses over a given geometrical problem. Here the controls are explicitly present to consciousness, but they do not operate as controls until there is also present a specific intention to find the answer immediately. It can be seen from this that it is the specificity and immediacy of the intention which are the determining factors.

CHAPTER VIII.

Directed and Undirected Thought under Laboratory Conditions.

Undirected thought is equivalent to Free Association, Directed thought to Controlled Association. - Free Association as compared with undirected thought. - Controlled Association as compared with directed thought.

Normal thought processes as they pass from undirected to directed thought pass from trains of thought motivated by the consciousness that problems exist, to problem-solving processes directed by controls relative to the gap in the consciousness of given specific problems. On the one hand are trains of undirected thought, on the other, thought processes concerned with specific problems.

Passing now to the consideration of how these thought processes can be dealt with in experimental investigations, the first consideration is the question of how directed and undirected thought processes are represented within the laboratory.

Undirected thought spoken of relative to laboratory conditions, is free association, and when undirected thought is investigated for the purpose of measuring its quality, (the nature of associative connections), its content (nature of material to which reference is made) or its facility (speed of association, or length of trains of associated ideas,) free association tests in some form are employed.

Thus thought processes not directed to the solving of specific problems when they are investigated with the basic distinction between directed and undirected thought in mind, are represented by free association, and undirected thought under laboratory conditions will hence-forward be referred to as free association.

When directed thought processes have been investigated in the past, they have invariably, as is naturally to have been expected, been investigated relative/

relative to specific problems. The problems used in laboratory investigation are necessarily, in their essential structure, similar to the problems with which normal directed thought is occupied. They may be adjusted for the investigation and measuring of experience factors, as, for example, when it is desired to measure the organisation or quality of certain parts of experience, or, on the other hand, they may be adjusted so as to suppose only a minimum universal measure of experience, and to test ability to employ controls in abstraction from factors of experience. But in either case, the structure of the problem remains unchanged and is necessarily the same structure as is to be found in all problems whether they are constructed to answer specific investigatory requirements, or are found with normal thought processes. There is, for example, no essential difference between the problems set in intelligence tests and these to be met with in the course of ordinary existence, as e.g., in business.

Directed thought under laboratory conditions is, however, to be found in a much simplified form, viz., in controlled association tests. It is evident that such controlled association tests as Opposites, Analogies or Synonyms represent very simple types of problems. For example:-
Apple is to fruit as sheep is to __ ?
This is a problem, but it is structurally very simple. Few controls are present, and the gap is clearly indicated and defined by the explicitly stated significant conditions. Only a necessary amount of experience is presumed, and moreover, the response given in answer to the presence of the stimulating situation must before have been linked with part of the stimulus. Controlled association, in short, is another name for the simplest type of problem.

Hence controlled association tests offer a simple and convenient means for investigating directed thought at a primitive and non-complex level, while the qualitative difference between directed and undirected thought is still maintained. It may be considered that directed thought under laboratory conditions is represented by controlled association, while undirected thought is represented by free association.

It must be evident that a thought process taking place within a laboratory must differ in some ways from the same thought process taking place within normal experience./

experience. New factors must enter, and it must be considered whether the thought processes are not thereby qualitatively changed in such a way that the processes taking place under experimental conditions do not adequately represent their normal counterparts.

We shall consider then, how far it may justifiably be said that free and controlled association represent normal undirected and directed thought, and in doing so, it will be well to bear in mind the possibility of a qualitative difference being introduced by the transition to the conditions necessary for experimental investigation and measurement.

Free Association and Undirected Thought.

The trains of thought which compose the stream of undirected thought, as motivated by the consciousness of problems are series of complex associational units, questions, images, judgments, percepts and concepts, all bound together in the interrelated interinfluential unity of the individual stream of consciousness.

In free association, in place of this, there is a series of discrete words to take the place of the series of thoughts.

If it should be considered for a moment that a series of discrete words could adequately represent a train of thought, it would be implied that a train of thought was a succession of unit 'ideas' in the classical atomistic sense of the term. But it is clear that a thought process such as that represented by free association under laboratory conditions can very rarely happen apart from such conditions. It does happen that an individual may have a series of images in place of a series of thoughts, and since images come closest of all mental phenomena to the classical concept of an 'idea', when it does happen, there is an undirected train of thought which may be more or less adequately represented by a series of discrete words.

But a train of images occurs very rarely, and even should it occur, it is unlikely that such images could be neatly parcelled out and adequately labelled or expressed by a single word. An image, although it is psychologically unitary, is most frequently an image of a complex phenomenon. I may have an image of the college quadrangle, but the word "quadrangle" expresses my image very far from adequately.

Normal thought processes then do not take the form of a series of unit ideas except on very rare occasions. Where it can be presumed that series of images or something corresponding to unit 'ideas' frequently occur in trains of thought, pathological states of mind are suspected. In insanity, for example, where we have the opposite of intelligent thinking, there is a breakdown of the unity and continuity of mind whence all relations, associative as well as logical, (since the latter depends upon the former,) come. Hence there is a breakdown of normal integrating power, and in such a case, a series of unit ideas frequently takes the place of the normal thought process. The spasmodic interrupted type of association response, where the connection between the stimulus and response words is esoteric and remote and does not follow the lines of logical association, is, as Jung has shown, indicative of the breakdown of normal inter: relations, and hence of a pathological state of mind. Utter discontinuity is the extreme case.

There is general agreement that in intelligent thinking the same controlling idea (theme) will serve a certain span of associative process. The length of the span has frequently been taken as correlating highly with intelligence. Hence, in the opposite state of insanity, the thought process governed by a controlling idea shrinks in length, and may often be represented by a single response item. Changes of controlling idea are frequent, continuity is lost, and the whole character of the process is jerky and spasmodic.

In normal thought, the existence of a controlling idea will stimulate associational contexts where relations are integral and articulate, and thus the mind will pass smoothly from one item to another within the interrelated whole. The association is not, hence, from one discrete item to another, but from one part of a configural whole which can be expressed in a sentence to another part which can be similarly expressed. Since the units of thought are complex in this way, thought can only adequately be expressed in a series of linking propositions or sentences.

The free association test in its standard form was originated when the atomistic associational theory of mind held the field, and it is this concept of mind which is reflected in the theory that a free association test can represent adequately a train of thought. What today is recognised as a thought and a complex/

complex unit was described by the Associationists as an association between two ideas. "Chalk is white" for example represented the association of the idea white with the idea chalk, and hence a train of ideas could be analysed into unit elements expressible in discrete words. It might thus very well be adequately represented by the response words in a Continuous free association test. Since, as has been shown, a train of thought as now conceived could only be adequately represented verbally by a sequence of sentences, it may be concluded that the standard forms of free association tests as demanding discrete words in response, do not give an adequate representation of a train of thought. Undirected thought outside the laboratory is very different from the form of it which is investigated and measured inside the laboratory.

If the change which is effected on undirected thought by bringing it inside the laboratory is reflected upon, it will be seen that what has actually happened is that the undirected thought process (which was shown to be in its normal form non-controlled in the technical sense of the term) becomes controlled. The addition of the necessary condition that the subject must respond with words, does, in an ultimate sense, control the associative process in directing it to the production of words, whereas, as we have seen, normal undirected thought is non-controlled, far less being restricted to items expressible verbally in discrete words.

Again, whereas a train of undirected thought is stimulated by the consciousness "that a problem exists", in the case of each unit train of thought, this problem will be either different or differently conceived. Free association is always artificially stimulated by the request to begin free associating, which if it does, in asking for something to be done, represent something which will be apprehended as very similar to the consciousness "that a problem exists", will also be much the same problem in every case. A fact such as this cannot be said to control the thought process in a significant way however; it means only that the process will be stimulated in a way in which it is not stimulated in normal thought. It accounts for still further differences between the trains of normal thought and the items in a free association series, but it is not a controlling factor in the technical sense.

Free association however may be controlled by

further/

further controls which, although accidental, are neverthe: less significant controlling principles. These are the controls which the subject invents for himself. He may imagine, for example, that words are not to be repeated, or that only words of a certain kind are to be given. In either of these cases, the subject would be controlling the free association process by subjectively set controls which are nevertheless significant.

Again, the whole environmental context, for example, the laboratory or the presence of the experimenter, induce a certain "mental set" which, although it is not to be regarded as a significant control factor does decide that certain kinds of response words shall be given without requiring that they should be given, as a significant control would do. For example, if speed is presumed to be required, short words will tend to be chosen. Again, series of rhyming words will very commonly be found, and it is clear that these would only occur in a normal undirected thought process under exceptional conditions. Experimental investigation has shown also, that the presence of the experimenter will retard association time with the majority of subjects and will have a definite effect on the quality of the responses, as e.g., making for perseveration.

It is evident, however, that all these factors only determine the lines which will be taken by the free association process, in the same way that a conative impulse will determine the trend of undirected thought. Except in the case where the subject invents significant controls for himself, such facts as "mental set" do not specify by requirement the kind of word which must be given. In so far as the gap remains unspecified, no significant controls are present.

The one significant control which is invariably present in free association as compared with undirected thought is to be found in the condition that the responses must be expressed either verbally or in writing, and must take the form of discrete words. It is clear that it must also be a condition which is present in all association tests, free or otherwise, which take place under laboratory conditions, for before associations can be investigated or measured, they must be expressed.

The exact nature of the significance of this control must be considered. As we have seen, the requirement that the subject is to respond, constitutes a/

a gap which, to all intents and purposes, is a gap of the same kind as that found in the consciousness of the problem motivating a train of undirected thought. The instruction given by the experimenter, in short, indicates "that a gap exists". The gap is not specified, and hence the intention correlative to the gap is not specified; it is purely an intention to respond. The fact of the consciousness "that a gap exists" stimulates the associational process, but since the gap is non-specified, there are no significant controls operating upon the process if we except the condition that the response must take the form of words.ϕ This condition clearly specifies the nature of the response to some degree, for it indicates that a gap exists which must be filled by words. It has been shown, however, that this control must exist, and exists common to all association tests, (and indeed, many other tests) as a condition necessarily presupposed by experimental investigation and measurement. Thus it may be discounted since it is the universal precondition of investigations of thought processes.

Apart, therefore, from the existence of this one significant control which can be discounted, it is evident that free association is controlled to the least possible degree which is conformable with experimental conditions. The awareness "that a gap exists" stimulates an associational process which is not controlled in any significant sense. The words which it produces are not required to be relevant to any specific gap, they are not required to be any specific kind of word, and hence the direction taken by the free associational process is determined purely by subjective conative directing factors.

It/

ϕ It may be considered that the standard form of free association test, as requiring the production of discrete words, adds two significant controls to the process. A more adequate representation of undirected thought could, of course, be obtained if the free association test consisted in sentences. These, however, would present difficulties of measurement.

It may be concluded that free association cannot be less controlled than it is without ceasing to be a process open to measurement.

Again, it cannot be a process more controlled than it is without ceasing to be free association.

This will be clearer if it is considered that the least requirement necessary to change free association to controlled association would be the existence of some condition which specified the nature of the gap, changing the awareness of the gap from the simple awareness of the existence of a gap, to an awareness that a gap of a specific kind existed. At the same time, the intention would become specified. From an intention merely to respond, it would become the intention to respond with a certain kind of word, fulfilling certain conditions required by the nature of the gap. The associational process directed to the filling of the gap would be controlled by the existence of one significant control, towards the production of the relevant to a specific gap, and all the essentials of directed thought would therefore be involved. For example, the free association process stimulated by "What does the word black suggest to you?" (or "Reply with the first words which enter your mind to the following stimulus words:- black -"), becomes controlled association as soon as a condition is present which specifies the relation in which the response item must stand to black, as e.g., "What is the opposite of black?"

Thus, as soon as a condition is present which stipulates what kind of word shall be replied, the whole nature of the process is qualitatively changed. The gap is specified by one significant control, and the intention becomes specified in relation to the specific gap. The change from free to controlled association is all the more noticeable in a case such as that cited above, in virtue of the fact that the addition of one control is sufficient to reduce the number of items from an infinite possible number, as in the free association, to the one item relevant to the gap in the controlled association.

It is evident that the transition from free association to controlled is as abrupt as the transition from undirected to directed thought, and that the line of demarcation between the two is equally definite in both cases. Free association, as the laboratory counterpart of undirected thought, cannot then, be less controlled without ceasing to be a process which can be measured, and/

and cannot be more controlled without ceasing to be free association and becoming controlled association.

Controlled Association and Directed Thought.

The decision as to the relation of controlled association to directed thought must hinge upon the question whether the form of the problem set in a controlled association test is the same as the form of the problems met with in the course of normal directed thought.

The question has already been touched upon. We have seen that problems as found in the course of ordinary living are complex, that they are interrelated wholes of problems composed of several sub-problems subsumed under the consciousness of one main gap. But it was clear that such problems could be reduced to elements, in the form of simple problems containing one gap specified by a definite number of specific related objective conditions. The problem which is set in a controlled association test, for example in an Opposites, Synonyms or Analogies test, is a simple problem of exactly this type. In either "What is the opposite of black?" or "Apple is to fruit as sheep is to -?" there is a gap specified by a small definite number of significant controls, and correlated with a specific intention to fill the gap with material relevant to the specific requirements. Controlled association tests, therefore, present problems similar in their essential structure to the simple problems which are the elements of all problems, however complex, with which directed thought is occupied. The structure of a problem is universally the same. All will require that experience shall be organised by the conditions of the problem to fit the gap, and hence it is true that the solving of all problems must depend upon the kind of process which is involved in a controlled association test, in short, on the controlling of association.

The problems met with in the course of normal experience, (and problems constructed in the laboratory for specific purposes, e.g., intelligence tests) appear different from the problems set in controlled association tests for two reasons.

In the first place, in controlled association, experience factors can be discounted, for only a measure of experience which is common and universal is presumed, as/

as may also be the case with problems constructed for the specific purpose of measuring ability to employ controls. In the same way, in the controlled association test, interest is concentrated by this device on the actual operation of the control of associative process by the conditioning factors, and the success which attends the operation.

Controlled association thus lacks the difficulty which may characterise normal problems in virtue of the experience factors involved in the latter. This is one reason why giving the answer to a difficult problem appears to involve very different processes from those involved in giving the response to a stimulus word in a controlled association test, where the response has previously been linked with the same stimulus. As the difficulties resulting from experience factors in normal problems have been shown to be either (a) difficulties relative to the revival of appropriate experience or (b) difficulties relative to the adaptation of past experience, it will be evident that such difficulties are both eliminated in controlled association test problems. The only difficulty which such problems could theoretically present would be a difficulty of specifying the gap.

The controlled association test problem is, however, quantitatively simpler than most normal problems. Very few controls are present, most frequently either one, two or three. Thus the last possible difficulty is removed in that the gap is necessarily easy to specify.

As a result of both of these facts (a) the elimination of experience difficulties (b) the elimination of organising difficulties, the problems presented by controlled association tests appear very different from normal problems where, although only one gap may exist, and the problem is hence non-complex, a great many controls may be present. When controlled association problems are compared with problems so constituted as to make it possible to discount experience factors, it is this quantitative difference in the number of controls present which accounts for the appearance of disparity. Whether problems of the type found in association tests, or non-complex problems as met with in normal directed thought, are being considered, the essential structure must be the same. There is either a problem, or there is not a problem. - There are no kinds and degrees in the essential structure of problems, and hence the essential principles/

principles involved in a thought process directed towards the solution of a problem must be always the same. Thus, however, quantitatively simple (or if we choose to consider simplication of experience factors as a qualitative difference) however qualitatively simple a controlled association problem may be, as long as it presents a problem to consciousness, the process involved in solving the problem must present the essential characteristics of a problem-solving process.

Moreover, in virtue of the very fact that the controlled association test problem is qualitatively and quantitatively simple, the process directed to its solution will show very clearly the operation of the controls in specifying the gap and directing the productive-reproductive process into lines relevant to the gap. In the controlled association test, the operation of the controls on the associative process is found in abstraction from all the accidental factors which complicate the investigation of their operation within normal problems. Controlled association tests, in short, provide a means for examining the way in which experience, the associative stream, is directed and controlled by the requirements of the gap in the consciousness of a problem. They provide a convenient and schematic form of problem, which, since it preserves the essential structure of a problem, will demonstrate the nature of a problem-solving process, and the principles which determine it, in its simplest possible form.

Moreover, if, in controlled association, the simplest structure of a problem stimulating a process directed to the filling of a specific gap is to be found, then it should be possible, taking the controlled association test problem as the lower limit of a problem structure, to construct a continuous series of graded problems, which will become increasingly complex quantitatively as controls are increased in number. Such a series would thus preserve a qualitatively simple structure, i.e., complexity of gaps or difficulty of experience factors would not enter, while quantitatively increasing in difficulty. With every additional control, the difficulty of organising the controls to specify the gap would be increased to an additional degree. Such a series would provide a means for measuring the ability of any individual to employ a number of controls. It would supply, in short, a possible means for measuring ability to employ controls in abstraction from factors of experience, which, as we have seen, have not, except in a remote sense, any a priori connection with intelligence.

A Summary of Conclusions arrived at by Theoretical Analysis.

I. Ability to solve problems is an essential aspect of intelligence.

II. The success of any specific problem-solving process will depend (a) upon the existence of appropriate experience within the "reservoir", (b) upon the adequate functioning of the conditions of the problem in their constitutive, productive and regulative aspects.

III. Of the three aspects of the function of the conditions of a problem, the constitutive aspect is basic. Only in so far as the conditions of a problem co-operate with each other in specifying the gap in the conscious: ness of the problem can they act as controls upon the associative process stimulated by the awareness that a problem exists, and direct it to the production of what is relevant to the gap.

IV. Such conditions of a problem as are specific objective conditions relative to a gap in the consciousness of a specific simple (i.e., non-complex) problem, and define that gap to a measurable degree, are to be known as "Controls".

V. Thought processes motivated by the consciousness "that a problem exists" are not necessarily "Controlled". Since controls in the technical sense of the term are only found correlated with a specific gap in the consciousness of a specific non-complex problem, the only thought processes which are technically controlled are thought processes directed towards the solution of such problems. Such thought processes will constitute "directed thought" in the specific meaning of the term.

VI. The degree of success which will attend the problem-solving activity of any given individual will depend upon his ability to employ controls adequately, i.e., on his ability to keep all the conditions of a given problem before his mind and to organise them in such a way that they act, through the medium of the gap which they specify, as one complex controlling condition directing the associative process to the production of what is relevant to the gap in the consciousness of a given problem.

The measure of an individual's problem-solving ability is determined by the degree of his capacity to employ controls.

Part II (Experimental)

Part II (Experimental)

Section I.

The Statement of the Hypothesis.

If an essential aspect of intelligence is the ability to solve problems, then success in solving problems will be a measure of intelligence. But success in solving problems depends upon ability to employ controls and this ability is ultimately reducible to the ability to hold all the controls of a given problem before the mind and organise them in such a way that they act as one complex condition directing the problem-solving process.

Hence the capacity to hold the controls of a problem before the mind and to organise them into one complex control is a capacity which should have a high correlation with intelligence. Further, the greater the number of controls in any problem, the greater will be the difficulty of holding them all before the mind, and the greater the difficulty in organising them into one complex controlling condition. It is to be expected that the number of controls with which a subject can work will be a measure of his ability to employ controls, and hence a measure of his problem-solving ability.

Therefore it is to be expected that the coefficient of correlation with intelligence will increase in passing from the measure of an individual's performance with few controls to the measure of his performance with many controls.

Hence the hypothesis to be tested by experimental investigation is:- that if an essential factor in intelligence is the ability to solve problems, and if success in the solving of problems depends ultimately upon the extent to which an individual can manage a complex group of controls, then the higher the intelligence of an individual, the greater will be the number of controls with which he can work successfully.

Section II.

Inquiry into Methods of Investigating the Hypothesis.

Alternative methods of measuring ability to employ Controls. - Measurement of complex groups of Controls. - Adaptation of Controlled association tests to measure (a) relevance of what is produced in relation to varying numbers of controls, and (b) amount of relevant material produced in relation to varying numbers of controls.

The investigation of the hypothesis will require

A. a measure of individual intelligence
B. a measure of individual ability to employ a varying number of controls.

A method of measuring individual intelligence is not difficult to find. Any standard measure of general intelligence will suffice. A method of measuring an individual's ability to employ groups of controls of varying numbers has yet to be found. The first question to be considered is therefore that of what methods may be used to measure ability in the employment of controls.

Methods of Measuring Ability to Employ Controls.

Ability to employ controls can only be measured by measuring the performance of an individual under the direction of controls. In other words, what is required is a measure of directed thought, or thought directed to the solving of problems. It should be possible to measure both the qualitative and quantitative aspects of directed thought, and hence performance with controls might be measured either (a) by measuring the relevance of the items produced under the direction of controls (qualitative aspect), or (b) the amount of relevant material (i.e., the number of relevant items) produced under the direction of controls (quantitative aspect).

If (a) the relevance of items produced under the direction of controls, is to be measured, a series of problems must be constructed. Within this series, the number of occasions on which the relevant to each specific gap is produced, when compared with the number of occasions/

occasions on which the irrelevant to each specific gap is produced, will give a measure of the individual's ability to produce the relevant under the direction of controls.

If (b) the amount of relevant material (i.e., number of relevant items) produced under the direction of controls, is to be measured, it will be necessary to find some way of measuring the amount of relevant material actually revived in response to the consciousness of existing controls. A type of problem must be found in which there are many items relevant to the gap in the consciousness of the problem.

In the majority of ordinary problems, however, there is only one item relevant to the gap, and even in the case of such ordinary problems as allow of more than one item being produced which is relevant, the number tends to be strictly limited by objective limits, as for example, by the nature of the material with which the problem deals. It will be necessary, in order to obtain an adequate measure of (b) to find a type of problem in which the number of items relevant to the gap is such that preferably none of the individuals solving the problem can produce all the items relevant to the gap.

Should it prove possible to find problems of this type, it will be possible to measure by means of them, the amount of experience (i.e., number of relevant items) actually revived under the direction of a given group of controls.

Measurement of Complex Groups of Controls.

The investigation of the hypothesis demands not only the measurement of the relevance of, or the amount of relevant, material produced under the direction of controls, but also the measurement of what is produced relative to groups of controls of varying complexity. Performance with few controls must be compared with performance with many controls. For example, a subject's ability to produce items relevant to two controls must be compared with his ability to produce items relevant to five controls.

Certain further specifications as to the nature of the controls must be made in view of this requirement.

If the performance with a given complex group of controls is to be measured against the performance with a/

a quantitatively larger or smaller group of controls, the degree of complexity of each group of controls must be measurable. Before a group of controls can be measured, it must be analysable into specific units, so that the quantitative size of the control groups may be increased or decreased by measurable amounts. Practically this means that it must be possible to add or subtract controls, and be able to measure objectively the degree of difference thereby made to the specification of the gap. This would be impossible if one control could not be isolated from another. In the problems ordinarily met with, controls are frequently so closely interrelated as to render this difficult. If it is to be possible to isolate each control from the other controls along with which it specifies the gap, it is necessary that each control should be unitary in nature, a specific significant unit detachable from the group of unit controls defining the gap. Again, in ordinary problems, it is frequently impossible to eliminate one condition without destroying the significance of the whole problem. The controls must therefore be such that they can be added to, or subtracted from, the group of controls specifying the gap, and still leave the problem standing as a significant whole.

If each control is of this nature, then the complex groups of controls which they compose will be analysable into units, and their quantitative complexity will be measurable in so far as each unit control is measurable.

Further, in order that a complex group of controls shall be <u>easily</u> measurable, each unit control must specify the gap to an equal degree. Ultimately the effect of a control upon the gap is only measurable in terms of the degree by which it limits the associative process, and hence what will be meant by each control limiting the gap to an equal degree, will be that each control will have an effect in limiting the associative process equal to the effect of each other control. If controls are equalised in this way, each group of controls becomes a complex of equal individual units. It may be increased or decreased by objectively measurable amounts in adding or subtracting controls, and in so far as the effect of one unit control upon the associative process is known, that is, in so far as the number of items produced under the direction of one control can be measured, the cumulative effect of the addition of like equal controls can be investigated relative to this measure.

In conclusion, then, the effect of a varying

number/

number of controls may be measured if the nature of each control is such that (1) each is an explicit unit objective condition defining the gap, and hence limiting the associative process, to a definite degree; (2) each defines the gap to the same degree as each other, i.e., limits the associative process to the same degree as each other; (3) the sum of such controls forms a complex whole of conditions referring to, and specifying, the same gap in the consciousness of a problem.

The Adaptation of Controlled Association Tests to measuring Relevance of Produced Items.

We have seen that the problems given in controlled association tests such as Opposites or Analogies, are examples of easy non-complex problems. In such problems the experience factors, which account for the difficulty of many ordinary problems, are eliminated, the controls are explicitly stated significant objective conditions, and are few in number. The controlled association test problem is thus qualitatively and quantitatively simple. In the directed thought process involved in the answering of a controlled association test problem, only the bare essentials of a problem-solving process remain. It represents the schematic form of that process, while preserving its essential characteristics. It shows the directing of the productive-reproductive process by one or a few simple controls.

In so far as the controlling of the associative process must be an integral part of every problem-solving process, and since the controlled association test problem shows this operation in its simplest form, it was seen that it should be possible to construct a continuous series of problems ranging from the simple controlled association problem to more intricate problems involving numerical complexity of controls. (See Part I Chapter VIII).

If such a series were constructed, it would offer a means of measuring the performance of an individual with groups of controls of varying complexity. Moreover, it should be possible to embody in such a series the principle of equally graded controls which is necessary to the scientific measurement of the performance of an individual with groups of controls of varying complexity.

If, for example, a group of tests could be constructed in which a series of problems, A, containing one control, was followed by series of problems, B,C,D.....

N/

N, containing respectively two, three, four .....n controls it would provide a means for measuring the relevance of the items produced by an individual working with one, two, three, four .....n controls.
E.g.
Problem Series A (1 control).Problem Series B (2 controls)

Problem A	Problem B
1	1
2	2
3	3
.	.
.	.
.	.
.	.
n	n

The number of successful solutions in the A series would be the measure of ability to work with one control, the number of successful solutions in the B series, the measure of ability to work with two controls, and the number of controls could be increased as desired. Such a group of problems might then provide a method for measuring the relevance of what a given individual can produce when working with groups of controls of varying complexity.

When such a scheme is examined in the light of its practicability, however, various objections emerge. For example, if it is necessary to construct a series of unit problems each involving three controls, it will, in the first place, be difficult to find a number of ordinary problems each involving three, and three only, unit specific objective conditions, and at the same time, to make certain that the relevant response is equally difficult to find in the case of each problem in the series. Since each problem in each series is a separate unit, the content of each problem composing any one series will be different. Hence it will be difficult to guarantee that the experience factors involved in each problem are of a difficulty equal to those of every other problem in the series. Again, since the controls are different for each problem, it will be difficult to guarantee that the operation of organising the controls to specify the gap is equally difficult in each problem of the given series.

The difficulties relative to each single series of problems, however, are not so great as the difficulties which are met with in constructing several series. It must be certain that each series presents problems which are exactly one degree more or less complex than the preceding or following series. Thus not only would each series/

series have to contain problems of exactly equal difficulty both with regard to (a) experience and (b) organising factors, but also each problem within a given series would have to be one degree more or less controlled than each problem in the preceding or subsequent series.

These difficulties will be found to be so great as to render the construction of a group of series of varyingly complex problems an impossibility. The most serious difficulty, that of ensuring that the problems in, for example, a B series, are exactly one degree further controlled than the problems in an A series, can be avoided if the series of problems are so constructed that the problems in series B, are the same problems as those in series A, but that the gaps in the B series are specified by one further consecutive additional control.

In place of
Series of problems A embodying e.g. three controls.
Series of problems B embodying e.g. four controls.
Series of problems C embodying e.g. five controls.
we shall have
Series of problems each embodying one, two, three ..... n controls
E.g.

Problem 1	(a)	one	control,	(b)	two	controls,	(c)	three	controls.
2	(a)	"	"	(b)	"	"	(c)	"	"
3	(a)	"	"	(b)	"	"	(c)	"	"
4	(a)	"	"	(b)	"	"	(c)	"	"
.									
.									
.									
.									
n	(a)	"	"	(b)	"	"	(c)	"	"

Such a group of tests has the advantage that the number of successful solutions produced with two controls can be directly compared with the number of successful solutions produced with one or three controls, since the same gap is implied by each series and only the degree of its specification differs. There only remains the difficulty of ensuring that each problem in the (a) series is of equal difficulty both as regards experience and organising factors as each other problem in the (a) series.

By such a serial group of tests it should prove possible/

possible to measure the relevance of what any given individual can produce working with groups of control, of graded quantitative complexity.

Adaptation of Controlled Association Tests to measuring Number of Relevant Items Produced.

It is clear that to measure the relevance of what an individual produces working with quantitatively varying control groups, is not the same thing as measuring the amount of material he can revive relevant to the requirements of quantitatively varying control groups. In order to measure this, it was seen to be necessary to construct a type of problem where there might be innumerable items relevant to the gap.

Is it possible to adapt the principle of the Controlled association test to this form, and to embody in it the principle of equally graded controls?

In previous investigations, controlled association tests have been used to measure either the speed or the relevance of the response. A series of controlled association problems have been given, and the speed or correctness of the responses calculated over the whole series, as e.g. in the Opposites test. This is the form of controlled association test which corresponds to the Discrete free association test where a different stimulus is given for each response required. In both the Discrete free association test and the Discrete controlled association test, the object is to measure the quality of the response, or the speed of each unit reaction. On the other hand, when the object is to measure the quantity of free association, as e.g. the length of trains of connected items, the Continuous form of the free association test is used. In the present circumstances then, when concern is neither with the specific quality nor the specific reaction time of the controlled association response, but with the measurement of the amount which can be produced under the stimulus of control groups, the construction of a Continuous controlled association test parallel to the Continuous form of the free association test, will meet the requirements.

Where, in the free association test, the process is stimulated by the awareness "that a gap exists", in the controlled association test, there must be the awareness "that a gap of a specific kind" exists, and the associative process stimulated by the awareness of the gap must be limited by the presence of at least one control. For example, in place of instructing the subject to "write/

"write a list of the first words which enter his mind", he will be instructed to "write a list of any words he can think of characterised by such-and-such a property". In both cases a task is set, and a gap holds for consciousness, but whereas, in the first case, the gap is unspecified, in the second case it is so specified that only a certain class of items, those possessing a certain given property, are relevant to the gap.

Into the Continuous form of the Controlled association test, the principle of equally graded controls can be fitted. All that is required is that the gap should be specified to additional degrees by the addition of equally graded controls, each of which will limit the range of the associative process to an equal degree. At each stage of increase in the number of controls, the subject will be working with a group of controls of measurable complexity, and his ability to manage a group of controls of that quantitative complexity will be measurable in terms of the amount of material relevant to the control group which he can produce.

Further, the limiting effect of each control on the associative process will be shown. It will be possible to observe the progressive steps by which the addition of controls specifies the gap and narrows down the range of the associative process. The measurement of the effect of a quantitatively complex group of controls on performance could, however, best be judged if the effect of the progressive steps in the attainment of complexity were measured. Ultimately, for purposes of adequate comparison, performance with a complex group of controls should be measured against performance with one control. What is required then is the progressive addition of equally graded controls, beginning with one control. Again, the effect of one control upon the associative process, that is, the amount of material which can be produced relevant to a gap specified by one condition, can only be adequately considered if it is compared with the amount of material which can be produced relevant to an unspecified gap. Performance under the stimulating consciousness "that a specified gap exists", must be compared to performance under the stimulating consciousness "that a gap exists".

The series of tests embodying progressively increased equally graded controls may thus conveniently be preceded by a free association test of the Continuous form. Although it is recognised that an absolute qualitative difference exists between the thought processes implied/

implied by free and controlled association, it is nevertheless possible, in such a series, to regard free association as the limiting case of the controlled association series, as well as providing a means of measuring the degree of limitation placed on performance by the existence of one control.

The test series must then be of the form:

A. List of words.
B. List of items fulfilling condition a
List of items fulfilling conditions ab
List of items fulfilling conditions abc
List of items fulfilling conditions abc.....n

By such a series of tests, it will be possible to measure the amount of relevant material (i.e. number of relevant items) produced by a subject working with groups of controls of progressively increased graded complexity, and, in the second place, to compare performance with any one given group of controls with performance when no controls are present.

Conclusions.

I. The ability to employ controls may be measured either (a) by measuring the relevance of items produced working with groups of controls of varying complexity, or (b) by measuring the amount of material (i.e. number of relevant items) produced working with groups of controls of varying complexity.

II. The complexity of the groups of controls will be rendered measurable if equally graded controls are employed.

III. To measure (a), a series of controlled association problems may be used. In the case of each problem in the series, the gap is progressively specified by the addition of unit equal controls.
(Discrete Controlled association form)
To measure (b) a Continuous controlled association test may be used, and the gap is to be progressively specified by the addition of unit equal controls.
(Continuous Controlled association form)
A Continuous free association test may precede the Continuous controlled association series.

Section III.

Construction of a Series of Tests to investigate the Hypothesis.

Essentials of the test-series. - Measure of intelligence chosen. - Preliminary experiments, I, II and III with controlled association test series.-

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The consideration of methods by which the hypothesis may be investigated leads to the conclusion that a test series constructed for the purpose must include
(a) A test measuring general intelligence.
(b) A series of tests measuring ability to employ controls. Since two alternative methods of measuring ability to employ controls present themselves, two types of controlled association tests may provisionally be included, (1) a test series to measure the relevance of items produced (2) a test series to measure amount of relevant material (i.e. number of relevant items) produced.
(c) The controlled association series of tests is to be preceded by a free association test of the Continuous form.

The essential points to be observed in the construction of a test series to investigate the hypothesis are that, in the first place, an adequate measure of general intelligence should be found, and in the second place, that the principle of progressively increased controls should be carefully observed.

Measure of Intelligence.

The measure of intelligence chosen is Otis Group Test, (Advanced form B). This test has the advantage that it can be applied to a large range of ages, and is of such a nature that a large group can be tested in shortly over an hour. Small groups were tested with N.I.I.P. Test no.34, and with the Binet-Semon scale. The main section of the statistical analysis is based on the results of the Otis intelligence scale, and the three main groups were tested by this measure.

Preliminary Experiments in the Construction and Application of a Controlled Association Test Series.

Two alternative means of measuring controlled association presenting themselves, the resolution to attempt to include both in the series of tests demanded the/

the construction of A. a series of problems where the gap in each problem is progressively specified by the addition of equally graded controls. (To measure relevance. - Discrete Form)

B. a Continuous form of controlled association test, where the range of the associative process is progressively limited by the addition of equally graded controls. (To measure amount of relevant. - Continuous form)

Number of Controls.

Tentative efforts to construct tests with five, six and seven controls had shown the difficulty of finding so many controls relative to the same gap. It was therefore decided to set the upper limit of increase of controls at four.

Material.

The following types of material suggested themselves as suitable. Names (literary). Words, Letters, Names (geographical). Percepts, Concepts, Numbers, any material or class of objects which might be progressively specified.

It was realised that both geographical and literary names must ultimately be disqualified as specialised material. They were employed initially to gain as wide a view as possible of the general trend of scores. The difficulty is to find material which is (a) non-specialised (b) common to subjects of all ages (c) lends itself to the principle of progressive specification by controls.

First Preliminary Experiment.

The tests in this first tentative series were confined to the Continuous controlled association form. They were preceded by a free association test of the Continuous form.

Each test took the form:-

1. Write a list of words of one syllable (one condition).
2. Write a list of words of one syllable containing four letters (two conditions).
3. Write a list of words of one syllable containing four letters, one of which must be s (three conditions).
4. Write a list of words of one syllable containing four letters, one of which must be s, and another t (four conditions).

Tests of similar form were constructed for Percepts, Concepts, Names (literary), Names (geographical). Sixty seconds was allowed for each separate list of words. The test was applied to five first year students, and five graduates.

The purpose of the test was to discover
(1) Some indication of the effect of additional controls.
(2) The suitability of different types of material.
(3) Suitable methods of scoring, and of tabulating individual and group results.

The tables which follow are

Table I Specimen individual result sheet.
II Group results.
III Analysis of different test scores.

TABLE I.

Date - Time -	Name - Sub.no.4 Age -			
A Free Assoc.	25			
B Contd.Assoc.	I.	II.	III.	IV.
Words	22	12	9	4
Percepts	10	10	11	4
Concepts	9	13	14	12
Names (Geog.)	22	13	7	4
Names (Lit.)	23	13	11	8
Totals.	86	61	52	32
Average.	17.2	12.2	10.4	6.4

Words per minute.

TABLE II.

Sum of Results of 10 Subjects in each of five Tests.					
	I.	II.	III.	IV.	% Red. I-IV.
Words	286	161	120	86	69.93%
Percepts	136	91	84	48	32.4%
Concepts	123	129	123	111	9.7%
Names (Geog.)	236	199	155	167	25.9%
Names (Lit.)	246	167	144	98	60.16%
		AVERAGES.			
Words	28.6	16.1	12	8.6	
Percepts	13.6	9.1	8.4	4.8	
Concepts	12.3	12.9	12.3	11.1	
Names (Geog.)	23.6	19.9	15.5	16.7	
Names (Lit.)	24.6	16.7	14.4	9.8	

TABLE III.

No.of Sub.		F.Ass.	Cont.Ass. Av.words per minute. I.	II.	III.	IV.	% Red. (I-IV).
1st Year Students.	1	24	13.8	9.8	6.8	6	56.52
	2	22	12.2	9.8	7.6	6.8	46.26
	3	23	13.6	10	10	8.4	38.23
	4	25	17.2	12.2	10.4	6.4	62.8
	5	29	17.2	15.2	15.6	8.8	48.54
Graduates.	6	36	25.6	16.4	14.4	13.4	46.87
	7	24	23.8	18.6	15.8	13.2	48.62
	8	24	27.4	17.2	19.2	11.8	56.93
	9	36	32	23.8	15.8	10.6	66.88
	10	22	19.6	14.4	11.6	9.8	50

Conclusions.

1. Material.

The low scores and the small percentage reduction between one and four controls in the Concepts test showed that despite efforts to ensure the equal specification of the gap by each additional control, the material was of such a nature that equal grading of the controls could not be guaranteed. The geographical names test exhibits the same features as the concepts test, although not to such a marked degree. The percentage decrease between one and four controls is 25% as compared to the 60% decrease shown by the words and names test, and 32% in the percepts test. Clearly in both the concepts and the geographical names test, the addition of controls has failed to add a corresponding degree of specification to the gap.

In the percepts test, the score is low, but the percentage decrease is higher, although only half of what it is in the words test, where the graded nature of the controls is evident. The low number of items produced is to be attributed to the nature of the material. It is more difficult to think of perceptual objects having certain properties than to think of words having certain specifications.

Although the names (literary) test gave results similar for both score and percentage decrease to the words test, it was recognised that it involved specialised knowledge. The use of the test in the present series was to afford further illustration of the degree to which controls might be expected to limit the associative process.

2. The experiment as a whole was tentative and the results only judged as giving a possible indication of the lines more detailed investigations might take. The effect of addition of controls is clearly marked in all tests save those which are invalidated by the nature of the material. There is a clear distinction between the two small groups tested (i.e. first year students and graduates) in respect of controlled association scores, the older group scoring more highly with almost complete consistency. The high scores in the free association test are scattered indiscriminately between the two groups. Although the group was too small for any conclusions to be drawn from the data, it was thought that a higher correlation of controlled association with intelligence or age was indicated than of free association with intelligence or age.

Second Preliminary Experiment.

In the second experiment, both forms of the controlled association test were used, preceded, as before, by a free association test.

The Continuous controlled association form was used with words and percepts as in the last experiment. The concepts test was discarded, but the names (geographical) and names (literary) tests were allowed to remain, since the group to be tested were all students and the specialised knowledge might be presumed. As much data as possible was desired for the purpose of examining the general directions taken by the scores.

The Discrete controlled association form was used in the construction of a series of twelve discrete problems embodying diverse contents. The problems were printed on four sheets, the first sheet presenting a series of twelve class names. The following sheet gave the same twelve class names adding one specifying property to each class name. The two subsequent sheets each added one further specifying property. The form of each sheet was as follows:-

Sheet II.

Class.	Control.	Answer.	Class.	Control.	Answer.
1.Animal	large	-	7.Flower	yellow	-
2.Mineral	white	-	8.Person	fictitious	-
3.Word	containing P	-	9.Quality	literary	-
4.Bird	water	-	10.Author	modern	-
5.Fish	edible	-	11.Thing	round	-
6.Town	seaboard	-	12.Book	satirical	-

One minute was allowed for the answering of each sheet.

The test series thus comprised
A. Free association test
B. Controlled association tests (1) Continuous form
Words
Percepts
Names (literary)
Names (geographical)

(2) Discrete form
Mixed Test.

The series of tests was applied to a group of fifty students.

The/

The results of statistical analysis of the scores follow.

Analysis of Scores. 2nd Preliminary Experiment.

A. Continuous Form Tests. Average over 4 tests for each control.
B. Discrete Form Test. (Mixed Test).
C. Free Association.

Tests A.

	F.A.	I.	II.	III.	IV.	% Reduction (I-IV).	M.V.
M	22.66	17.89	12.12	10.2	7.58		
F	20.47	16.63	12.07	10.92	7.32		
Both	21.81	17.40	14.14	10.48	7.44	57.23	8.587
Test B.							
M		16.33	8.56	6.1	2.88		
F		17.68	9.57	5.97	2.97		
Both		16.87	8.96	6.05	2.92	82.76	5.373

Mean Variations From Group Average.

	I.	II.	III.	IV.
Tests A	2.64	2.52	1.51	1.42
Test B	2.62	1.52	1.0	.77

Test A. Group Averages in Separate Tests.

	I.	II.	III.	IV.
Words	21.55	14.69	10.63	7.97
Percepts	8.81	4.34	4.36	1.9
Names (Geog.)	19.12	16.71	12.4	11.16
Names (Lit.)	18.71	12.83	12.4	9.22

Coefficients of Correlation.

Free Assoc. with A.Av.Control I - R = .128, r = .2
Free Assoc. with A.Av.Control IV - R = -.02, r = -.03
Free Assoc. with B.Av.Control I - R = -.013, r = -.01
Free Assoc. with B.Av.Control IV - R = .05, r = .07
Test A.Av.Control IV with Test B Av.Control IV - R = .238, r = .37
Percentage Reduction A with Percentage Reduction B - R = .205, r = .32

Correlation/

Correlation	of	rank	in	class	with	Test	A.	Control	I .31
"	"	"	"	"	"	"	A.	Control	IV .32
"	"	"	"	"	"	Test	B.	Control	I .24
"	"	"	"	"	"	"	"	Control	IV .11

Conclusions.

One of the objects of this experiment was to discover whether any significant sex differences in score were present. Since it is clear from the first table that these differences are small and variable, it was resolved to discount the sex factor in further investigation.

The correlations of free association with controlled are negative in three cases out of four.

There is a small positive correlation between the percentage reduction between one and four controls in Test A, and that in Test B.

The correlation between Control IV Test A and Control IV Test B is .37.

When class results are correlated with Test A Controls I and IV, the coefficient of correlation remains constant, but in Test B it decreases. It is low in both cases.

Possible Explanation of the Correlations.

It is clear that in Test B, the Mixed Test, each problem differs from each other problem in the series, and hence it is not certain that the answer is equally difficult or easy to give in each problem of the series. Each will differ (a) as regards difficulty of organising controls to specify the gap (b) as regards the experience content. This is important since subjects did not work straight through each sheet, but selected some problems and omitted others.

It is however most important that it is impossible to guarantee that the addition of Controls actually specifies the gap to an additional degree when material of this nature is used. In the same way, it is difficult to ensure that the control added to each problem makes it exactly one degree more difficult, and equally as difficult, as the control added to another problem. For example, not only is it the case that the addition of the control "squeaking" to Animal, small, does not really add one degree of difficulty, but also one cannot be certain that the addition of squeaking to "Animal, small", adds the same degree of difficulty as the addition of "white" to "Mineral, hard".

It is evident that with material of this kind

it/

it will be impossible to have an objective standard of the equal gradation of controls, and further, since experience factors of a non-uniform nature are involved, it cannot be guaranteed that the experience factors will present the same difficulties to every subject.

These factors probably account for the low correlations with the class results, and the fact that the correlation even decreases when performance with four controls is correlated with class results.

The Discrete form of controlled association test, then, as presenting difficulties of construction, the most serious of which is the guaranteeing of the equality of the added controls, must be discarded. If the number of relevant items is to be measured as well as the amount of relevant material produced, some other method must be found.

Review of the last two experiments.

Of tests of the Continuous form only two remain to go forward for more extensive application, the words test and the percepts test. The form of the tests seems satisfactory and may be styled "Production according to Graded Controls". It measures, as has been shown, the amount of material which is produced working with groups of controls of graded quantitative complexity.

Having discarded the first suggested method of measuring the number of relevant responses by a series of controlled association problems, it was resolved to attempt the adaptation of the principle of the Cancellation test to the present purposes, i.e. to adapt the form for use with increased graded controls. The operation involved in cancellation with graded controls would be the selection of items relevant to a progressively specified gap. The subject, having apprehended the requirements in the items to be cancelled, would hold these as controls before his mind in selecting from a number of given items those relevant to the specified gap.

In the past, cancellation tests have been most frequently employed as requiring the cancellation of one item, i.e. one condition only was to be satisfied, but cancellation tests have also been used where several items/

items were required to be cancelled.ϕ The cancellation of several items, however, involves a different principle from the cancellation of single items fulfilling several conditions, but with some adjustment to the customary form, it was found possible to employ the cancellation test to measure the number of times the relevant to gaps of varying degrees of specification could be selected. The test may be called "Selection according to Graded Controls". It provides a possible method of measuring the relevant, in distinction from the amount of relevant, and has none of the disadvantages of the series of discrete problems which was tried out in the former experiment as a means for measuring the relevant.

Material used for Selection Tests.

Various tentative series of tests were constructed on the principle of selection, using materials such as words, numbers, shapes and letters. Words were presented in columns, numbers were printed in columns with eight in each row, and the subject was instructed to cancel whichever word or set of figures contained

(a) one specified item
(b) two specified items
(c) three specified items
(d) four specified items

Letters were arranged in groups of nine, viz.

K R P	R L N
G S Y	O S A
L T Z	P B T

The subject was then instructed to cancel each set of letters where he found, e.g. an R to the N.E. of an S, - and so on, increasing the specification of the set of letters to be cancelled at each step.

On an analogy with Whipple's perceptual cancellation/

ϕ For example, by Binet, four or five items were to be cancelled; by Burt, two items. Woodworth and Wells, Kent and Bering both used cancellation tests where items were to be cancelled if they fulfilled certain conditions.

cancellation test of shapes, geometrical shapes were printed in rows of ten, the subject being instructed, for example (1) to cancel every isosceles triangle (2) to cancel each isosceles triangle which followed a circle, etc.

On the strength of preliminary experiments with material, geometrical shapes were discarded for practical reasons of printing and unwieldiness.

The materials left for selection tests were thus:- Words, Numbers, Letters.

Third Preliminary Experiment.

A test series including both production and selection controlled association tests was now constructed.

The series consisted in A. Free association test.
B. Controlled association tests

Production	Words
	Percepts
Selection	Words
	Numbers (a)
	Numbers (b)
	Letters

The production tests were in their previous form. Selection tests were printed on four sheets, since it had been found impossible to construct a single form which could be used for all four controls. There was also the difficulty that when the fourth control was reached, the subject had become too familiar with the position of items on the sheet. On the first sheet (one control) in each test, were forty items out of which ten fulfilled the given conditions and were to be cancelled. Each test sheet was so constructed that each item which fulfilled the given conditions was placed within a group of three other items (not demarcated from the column) which did not fulfil the conditions.

For example:-

Sheet I.	Sheet II.	Sheet III.	Sheet IV.
Cancel A.	Cancel AB.	Cancel ABC.	Cancel ABCD.
non - A	A non B	A non B non C	AB non C non D
non - A	AB	non A,B,non C	ABCD
A	non A-B	A,B,non C	non A, BCD
non Ā	non A-non B	ABC	non A,non B CD

Thus in each separate selection test, there were 40 items to be selected from a total number of 160 items, there being 10 items fulfilling the conditions at each stage of increase of controls. (Samples of the tests found in Section IV).

These tests were applied individually to forty students, and after the lapse of four months, applied again.

The objects in view in this preliminary experiment/

experiment were (a) to examine the validity of the tests in the selection series (b) to decide what timing should be allowed for the tests in extensive group application (c) to obtain introspective reports (d) to study by means of the retest, the constancy of individual scores.

Conclusions.

(a) The selection tests, with the exception of the Letters test (directions) seemed adequate. Controls appeared equally graded, and the gap seemed, from the objective point of view, to be specified to an additional degree by each additional control. In the Letters test, the configuration principle entered too strongly for the addition of controls to make much difference after the number of two was reached. The material was more directly perceptual than in the case of any other test in the series, and further complication of the pattern for which the subject was searching made it easier to select instead of more difficult.

Although it is clear that from the subjective point of view the difficulty does not, in the case of any test, increase concomitantly with increase in the number of controls, yet, in this specific test, the nature of the material was such as to render selection in many cases as simple with four controls as with one. The fact is clearly brought out by the introspective reports (see Appendix). This test was consequently discarded.

(b) Subjects had been instructed to work equally for speed and accuracy, and were timed in the selection series by a stop watch. Examination of the average time taken by the group resulted in the fixing of the time limit for group application at sixty seconds for each list. (Thus one selection test occupied four minutes, the subjects being stopped and started for each fresh list, in group applications).

(c) A short account of introspective reports is given in an appendix.

(d) A conservative estimate of the retest scores as compared with the scores on first testing, together with the conclusions arrived at by examination of the introspective reports, make it possible to say that a given subject's score remains constant (within the space of four months' time). There was a small increase in performance in the retest as compared with the first test scores, but this would appear to be due/

due to familiarity with the form of the tests, with the general trend of the requirements, and with the experimental conditions in general. Small variations were taken to be indicative of accidental factors, such as differences in physical condition. It could be taken that performance remained constant.

SECTION VI.

Final Form of the Test Series.

Final Form of the Test Series - Instructions - Application - Experimental Conditions - Groups of Subjects Selected - Treatment of Data.

SECTION VI.

FINAL FORM OF TEST SERIES.

A. Otis General Intelligence Scale, Advanced Form B.
B. Free Association Test, Continuous Form.
C. Controlled Association Tests with four increased

(1)	Production	1	Words Test (a)
		2	Perception Test
(2)	Selection	3	Words Test (b)
		4	Numbers Test (a)
		5	Numbers Test (b)

Instructions given for tests.

B. Free Association.

"Write down as quickly as you can a list of thewords which enter into your mind. Any words will do . Dont stop to think what you are writing or whether you are repaating words. Just write down all the words you can think of as quickly as you can. You will be allowed one minute."

C. Production, Controlled Association Tests.

1. In the next 60 seconds write down as many words of one syllable as you can think of.

2. In the next 60 seconds write down as many words of one syllable and four letters as you can think of.

3. In the next 60 seconds write down as many words of one syllable and four letters, one of which must be S, as you can think of.

4. In the next 60 seconds write down as many words with one syllable and four letters, one of which must be s and another t, as you can think of.

II. Perceptual Test.

1. In the next 60 seconds, write down the names of as many white things as you can think of. (Always white; sometimes white; thought of as white; silver-coloured.)

2. In the next 60 seconds, write down a list of things that are white, and at the same time flat,

3. In the next 60 seconds, write down a list of things that are white, flat and smooth.

4. In the next 60 seconds write down a list of things that are white, flat, smooth and circular in shape.

Notes.

Subjects were instructed that words already given in one test might be repeated in another, as long as both sets of conditions were fulfilled.

Subjects were asked to note that in II (4) the existence of the conditions flat and circular excluded such things as "golf balls".

In the Words Test two examples of a word fulfilling each set of conditions were given. In the Perceptual Test, one example of a thing fulfilling the conditions was given, but further examples in all cases were given if it seemed necessary.

The forms and instructions for the Selection Tests follow.

SELECTION TESTS.

Instructions IA.

Cross out all words containing the letter R.

WORDS TEST

I A

dependent	selection
practice	gratitude
champion	immune
swallow	sanguine
gratuities	sanctuary
attaché	community
pencil	submission
commonwealth	svelte
feasible	time
royalty	strychnine
tempest	pigeon
limped	kinetic
megalomania	radiator
justice	banjulele
morality	peaceful
fustian	translucent
mendacious	plunge
dahlia	willow
analytic	possibly
bifurcate	anomalous

Instruction. IB.

Cross out words which contain both R and F.

WORDS TEST

I B

reserved	enfetter
repugnant	royalty
facile	pinnacle
evil	enfold
fully	melancholy
cataclysm	pioneer
formulate	profligacy
dorsal	mafia
differentiate	camera
fixation	fraught
pillow	confession
ermine	homily
robust	endorse
enfranchise	general
dispassionate	folium
feeble	fictitious
genetic	translucent
glanders	roseate
gruff	ratify
fortunate	preference

Instructions. IC.

Cross out words which contain the letters R, F and G.

WORDS TEST

I C

fresh	refurnishing
redintegration	gallantry
gospel	formamint
gratify	groundsel
regain	running
bifurcate	reproof
forgiven	cognate
lugubrious	glandiferous
forgathering	forgotten
transgress	fortify
gambit	agnostic
forsaken	gravitate
fury	thing
graphic	glorification
unguent	boring
refulgent	fervid
throughout	reference
reforming	gunnery
garnish	grafting
fermentation	margin

Instructions. ID.

Cross out words which contain the letters R, F, G and T.

WORDS TEST

1 D

glorification	remigrate
regret	fortification
fetters	refitting
forgetting	glorify
great	refrangibility
gruffness	foretaste
refiltering	rectangular
perfect	grafting
preferring	transference
garter	fearnought
fitter	forgery
restuff	regimental
target	fragment
figure	foreign
forthright	regatta
faster	turf
glandiferous	generation
turgid	font
fortune	graffito
regretful	golfer

Instructions. IIA.

Cross out any number which contains at least one 3.

NUMBERS TEST

II A

1 4 7 1 8 1	6 9 8 8 4 5
2 3 6 4 7 0	9 8 4 2 1 4
1 8 2 9 1 2	3 4 2 0 5 1
8 8 1 8 1 0	1 7 7 9 1 2
2 9 8 4 1 8	8 4 2 0 1 5
4 8 7 9 4 7	9 8 8 7 6 9
3 1 2 4 5 0	4 3 2 9 0 8
5 6 9 8 1 6	5 7 7 9 1 4
3 6 7 7 1 5	3 0 1 2 4 0
4 8 2 9 9 4	4 8 9 2 1 1
5 6 7 8 7 0	8 7 8 6 7 1
1 4 2 8 5 9	5 6 6 7 8 7
5 7 7 9 1 8	8 1 4 1 1 6
2 3 4 4 2 7	2 3 0 6 4 5
9 8 7 6 6 8	1 8 1 2 9 2
2 4 8 1 9 9	1 1 1 4 8 0
1 8 7 9 1 1	4 7 9 9 4 1
2 8 4 0 3 0	3 1 0 2 4 4
8 7 9 6 2 1	5 6 6 9 8 5
4 8 8 9 6 2	2 9 8 4 1 6

Instructions. IIB.

Cross out all numbers which contain both 3 and 6.

NUMBERS TEST

II B

4 3 9 8 8 2	9 4 3 1 1 2
4 5 9 1 1 1	8 2 0 4 1 9
1 3 0 5 6 0	7 6 9 3 7 8
7 9 8 6 1 1	1 6 1 5 0 8
8 9 8 7 1 4	2 1 7 0 9 8
6 0 0 8 2 5	4 6 9 1 4 1
9 3 0 9 1 1	8 9 3 4 0 5
8 6 7 6 3 4	1 6 5 8 0 3
1 5 6 2 0 5	4 6 8 9 1 7
1 6 5 8 3 9	2 6 0 0 3 1
5 8 1 2 4 8	1 1 9 5 4 7
7 3 9 2 1 1	9 8 9 0 4 3
3 0 8 5 6 0	7 3 8 5 6 1
3 4 9 9 8 9	7 1 2 9 3 7
9 8 7 1 2 8	2 4 2 0 1 5
9 0 6 5 4 7	1 6 4 9 4 7
1 2 3 4 7 7	8 9 0 0 5 3
9 0 4 0 2 2	4 2 4 8 7 0
8 3 7 9 6 1	2 9 8 7 6 2
8 1 5 4 6 0	9 1 3 0 5 6

Instructions. IIC.

Cross out all numbers which contain 3, 6 and 2.

NUMBERS TEST

II C

2 4 5 3 6 1	1 6 2 8 5 3
1 0 3 5 6 7	9 3 0 6 7 6
2 1 3 9 9 2	4 3 0 0 1 2
9 8 2 5 1 9	7 2 7 4 5 1
9 4 2 3 6 8	8 6 0 0 3 9
6 8 0 9 2 7	9 2 9 3 6 4
4 2 5 9 1 7	1 2 5 7 8 9
9 3 0 1 2 1	1 9 0 3 1 2
2 8 8 9 3 2	5 6 5 3 0 1
5 4 3 4 6 5	4 6 3 5 4 2
2 0 5 6 3 5	5 1 5 2 8 9
2 8 4 0 0 1	7 1 9 5 2 4
9 8 7 5 2 0	8 2 1 1 3 9
5 1 2 3 3 9	9 6 3 2 4 9
9 3 0 0 6 0	8 2 9 0 8 6
4 6 3 9 2 8	1 6 7 3 5 5
6 1 6 0 3 7	7 3 9 8 8 2
2 7 7 3 1 4	2 3 0 6 5 2
3 5 8 2 6 0	8 4 2 8 1 1
5 0 4 1 2 1	4 5 8 9 1 0

Instructions. IID

Cross out all numbers which contain 3, 6, 2 and 9.

NUMBERS TEST

II D

3 0 6 5 2 1	4 3 5 0 6 2
9 1 1 2 3 4	1 3 8 8 2 9
8 9 6 3 0 5	7 4 3 9 8 6
2 3 1 6 9 0	7 3 9 2 4 6
1 2 9 4 3 0	8 3 0 0 9 2
9 8 7 6 3 7	1 6 6 3 9 1
2 9 5 6 3 8	8 6 3 2 7 9
2 3 0 6 1 1	4 2 6 0 3 1
6 9 8 3 4 8	5 3 6 1 9 8
6 4 2 9 3 1	7 9 6 1 3 2
2 6 3 1 4 7	1 2 5 6 0 3
9 2 8 3 1 5	8 3 2 7 1 9
9 8 2 3 6 4	7 2 9 8 6 3
2 1 9 0 3 0	8 3 8 8 2 9
3 0 0 6 2 1	8 9 6 0 3 1
1 9 3 6 1 8	5 2 6 1 1 3
3 5 6 9 2 7	4 3 6 5 9 2
1 3 8 6 9 7	8 3 6 7 8 9
6 0 7 3 2 1	8 1 1 6 3 2
9 1 2 8 3 4	1 3 4 9 2 1

Instructions. IIIA.

Cross out 4 whenever it comes immediately after a number greater than 6.

NUMBERS TEST

III A

2 4 3 5 9 2	2 1 4 9 7 9
1 3 8 6 7 3	5 3 4 2 0 3
1 5 7 4 2 0	6 8 0 8 4 1
2 4 6 5 4 1	1 3 2 6 9 8
1 2 5 6 9 9	9 7 6 5 8 4
1 3 4 2 5 8	3 1 1 3 2 1
9 8 7 3 4 6	2 8 9 7 6 2
8 4 2 0 3 7	1 3 1 1 4 5
5 7 9 4 1 1	1 9 0 0 7 1
2 3 4 2 5 0	7 5 4 7 4 3
8 6 9 1 4 3	3 2 3 6 5 2
3 2 0 4 1 4	2 1 1 3 4 2
5 6 8 2 9 7	6 8 6 5 9 4
7 4 3 0 1 9	1 3 0 4 2 3
8 3 9 7 6 8	5 1 2 9 8 7
1 1 2 3 4 3	1 8 3 0 5 1
5 4 1 2 3 2	9 1 1 5 3 2
9 4 7 8 1 1	2 4 6 0 5 3
4 5 6 8 9 0	8 8 1 2 7 3
1 0 4 3 1 7	3 2 1 1 9 4

Instructions. IIIB.

Cross out 5 whenever it comes

(a) immediately after a number greater than itself.

(b) immediately before a number less than itself.

NUMBERS TEST

III B

6 5 7 1 1 3	4 6 9 9 5 9
9 4 5 1 7 4	3 1 4 5 4 9
6 7 9 3 2 2	2 4 9 7 3 2
2 6 5 1 4 6	1 9 9 5 2 1
4 6 3 5 4 7	9 4 2 5 3 3
2 9 5 9 3 8	7 2 6 5 8 7
9 7 5 3 4 9	8 8 7 5 4 3
1 2 3 6 9 3	6 9 8 1 0 1
9 4 0 0 3 4	1 4 3 1 3 2
2 8 5 4 0 2	2 1 9 8 5 1
4 2 8 5 8 7	4 3 8 5 7 1
2 5 3 7 1 6	3 8 1 5 2 7
1 7 5 1 9 4	7 6 5 2 0 0
4 7 6 3 1 2	6 7 7 9 7 0
5 1 5 2 2 9	8 6 4 5 4 3
7 7 5 7 6 8	9 4 9 5 9 3
9 8 3 5 1 7	2 9 1 5 3 2
1 8 5 8 3 3	1 8 7 5 6 1
4 9 5 2 3 1	3 1 2 8 5 4
2 3 1 8 4 2	4 3 4 7 9 5

Instructions. IIIC.

Cross out 6 whenever it comes

(a) immediately after a number greater than 4.

(b) immediately before a number less than 4.

(c) whenever the difference between the figure two places before 6 and the and the number immediately before 6 is 4.

NUMBERS TEST

III C

3 5 6 1 0 0	9 8 9 6 3 9
3 7 6 1 9 1	1 4 8 6 2 3
1 5 6 9 1 2	8 4 8 6 5 3
9 8 1 2 3 3	2 1 2 3 4 1
8 1 5 6 2 4	7 2 5 9 6 3
2 6 6 8 9 9	3 1 5 6 7 4
4 6 6 2 5 8	1 6 8 6 2 6
1 2 4 3 0 7	2 4 5 9 8 6
3 3 9 1 2 5	7 5 8 1 3 4
4 8 6 3 7 4	9 3 7 6 3 1
4 8 6 7 8 3	3 2 6 6 6 2
9 6 6 3 4 0	6 5 7 6 1 8
3 7 6 5 7 1	4 9 9 6 0 8
7 0 0 7 1 2	5 2 3 9 2 1
1 7 6 3 3 9	3 8 9 6 1 4
6 5 9 6 1 1	2 9 1 5 6 1
5 8 6 1 0 8	1 7 7 6 3 3
2 6 6 3 4 2	9 5 9 6 2 8
8 9 8 8 5 7	5 4 5 9 8 0
5 9 6 6 9 3	6 4 8 6 9 1

Instructions. IIID.

Cross out 7 whenever

(a) it comes immediately after a number greater than 3.

(b) it comes immediately before a number less than 3.

(c) the difference between the figure two places before 7 and the figure immediately before 7 is 3.

(d) the difference between the figure immediately following 7 and the figure two places after 7, is 7.

NUMBERS TEST

III D

3 6 7 2 2 1	4 2 5 7 2 6
1 4 7 1 8 6	3 4 7 7 1 8
9 5 7 2 9 2	1 2 7 7 1 8
2 3 9 5 0 8	2 5 9 9 4 1
8 4 7 1 8 3	6 9 4 7 2 9
1 4 7 1 9 9	8 4 7 7 2 5
4 0 0 3 1 4	9 1 2 3 6 5
6 9 7 2 9 2	8 6 9 7 1 8
2 5 3 1 3 1	6 1 0 5 0 3
5 6 7 2 9 3	1 7 8 7 1 8
3 6 7 2 9 5	2 2 5 7 1 8
2 5 7 2 1 6	3 5 8 7 1 7
5 8 7 1 8 9	5 5 8 7 2 9
4 7 7 7 9 7	4 3 2 1 4 5
1 7 7 1 8 3	1 6 6 7 2 9
2 5 7 2 4 2	1 4 7 7 2 1
6 3 3 1 2 1	3 6 5 0 3 9
1 4 8 2 9 0	4 9 7 7 1 8
6 9 7 2 3 0	2 1 4 7 1 8
3 8 7 2 9 1	1 3 6 7 1 0

APPLICATION OF TESTS.

Experimental Conditions.

The actual apprehension of the meaning of each condition, or the group of condition, was no part of the test. The work of the experimenter was to make certain that each subject had a thorough grasp of the meaning of the conditions with which he was going to work, before proceeding. Differences in speed or apprehension of conditions were to be eliminated at the outset, in so far as explanation and illustration made it possible. The object is to measure the individual's ability to work with controls, not his speed in apprehending conditions as such.

Emphasis was to be laid equally on speed and accuracy. Subjects were to be instructed that they were to work as quickly as was compatible with accuracy. As arising from the experience of past tests, the subject was warned that in the Selection Tests one single light stroke of the pencil was sufficient, while in the production tests, he was instructed to write as quickly as possible while preserving reasonable legibility.

Notes on Application.

Tests were applied to groups of 20 - 30 subjects at once. In most cases, the Intelligence Test was given a day before the Association Tests. Since the Intelligence Test occupied more than one hour and the Association Tests over 40 minutes, it was not considered advisable to proceed to one after the other without a rest period.

Since the majority of the subjects were school children, the tests were given in classrooms. Ideal experimental conditions were not attained for most groups.

Groups of Subjects Selected.

All subjects were taken either from schools or from university.

The aim in view in selecting the subjects was to have as many subjects as possible for each year of age between 10 and 21 years of age, and to make a special study of one age group. Since it was possible to procure large groups of schoolchildren between the ages of 12 and 13 (High School entrants) the largest group is of that age.

If the groups used in preliminary tests are excepted (i.e. one group of 50 students and one group of 40 students) the following are groups where results are included in the statistical analysis.

I. Alloa School Group. (50 subjects (12-18) No intelligence tests).

II. Bell Baxter School Group (90 subjects (12-18) No intelligence test).

III. Madras College Group. (20 subjects (13-14) No intelligence tests).

IV. Kirkcaldy High School Group (215 subjects (9-14) Tested Otis group test. Mean I. B. 125.5. Selected group tested by N. I. I. P. test No. 34. Retested Association Series.)

V. Waid Academy Group. (96 subjects (13-18) tested Otis Group Test. Mean I. B. 129.7.)

VI. Student Group. (General Logic Class) (56 subjects 1st and 2nd year, 18-21) Tested Otis Group Test. Mean I. B. 142.8.

Since Groups I, II and III were not subjected to any intelligence test, their results have been used in the calculation of Age Norms only.

The main section of statistical analysis is based on the data obtained from Groups IV, V and VI.

In these three groups the required range of age is present, and Group V (K. H. S.) gives the opportunity for a more detailed study of High School entrance age.

Groups IV, V and VI are tested as one group of 367 subjects (Age 9 - 23). Mean I. B. 126.1.

Notes on Groups IV, V and VI.

Group IV (I. B. - 125.5) as consisting of High School entrants is a group which is unselected by any intelligence factors. Since all children have to attend school until the age of 14, this group contains children of all levels of intelligence. Group V, on the other hand, consisted largely of children 14 - 18 years. It would tend to be the case that such children remained in school because it was considered that they had the capacity to reach or Leaving Certificate standard. (I. B. 129.7). Such a group would tend to be self-selected, a higher mean I. B. is only to be expected.

Group VI, again, tend to be yet more highly selected since it is clear that individuals in a university have had the capacity to reach and to pass University Entrance examinations, and must presume that they have the capacity to attain degree standards. (Mean I. B. 142.8)

Thus a process of self-selection of more from less intelligent is illustrated by these three groups, and cannot be discounted in considering the results of this investigation.

Treatment of Data. Statistical Analysis.

As a result of the application of the series of tests, the following data were obtained for each subject in Groups IV, V and VI.

Name, Age, Class, Free Association Score (Words per minute), Relevant Items per minute for each of four control groups in five different Controlled Association Tests. Absolute Score in Otis Intelligence Test, I. B. (i.e. Difference between Absolute score and Age Norm added to 100).

The data for each subject were tabulated thus:-

Name	Class School IC	Age	I. B.	Absolute Score	Free Association
I.R.Smith	K.HHS.	12/3	151	144	23

Controlled Association.

I				II				III				IV				V			
I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
15	13	10	7	9	8	7	5	10	10	6	4	10	9	8	7	10	7	5	4

The next step was to add all scores in the five Controlled Association Tests together, and to get the sum over five tests for each control, viz:-

Name	Class School IB	Age	I.B.	Absolute Score	F.A.	I	II	III	IV
J.D.A	K.H.S.	13/1	160	149	21	43	37	31	28

Results were treated statistically in three main ways.

A. For each of Groups IV, V and VI the total number of subjects in each group were arranged and ranked according to I. B. They were divided into groups.
(1) According to every 10 units decrease on the I. B. score, i.e.

Group I (180-190) all subjects with I.B. between 180 - 190.

Group II (170-180) all subjects with I.B. between 170 - 180

Etc.

The Average Free and Controlled Association Score (per each control) was then calculated for each of these groups.
(2) The subjects in each of Groups IV, V and VI ranked according to I. B. were then divided into five groups, each being 20% of the total number in each group. The same calculation of group average scores for Free and Controlled Association was made as in the last grouping.
(3) The subjects in each of Groups IV, V and VI were divided into3groups of 25%, 50%, 25% of the total number respectively. Corresponding Association scores were calculated for these.

Groups IV, V and VI were treated as one and divided into groups by each of these methods in turn. Mean Variations and Absolute and Percentage Decrease between Controls I and IV were added for each grouping.

B. Age.

The subjects in Group IV were arranged an d ranked according to each year of age, and Free and Controlled Association Scores calculated for each age group.

The subjects in Groups V and VI together Groups I, II and III were ranked similarly to give another set of age norms.

Age Norms were then calculated with all subjects (Groups I - VI).

From the total group a selection of subjects was made, and Association scores calculated for each year group of Mental Age. Association scores were then calculated for corresponding year groups of Chronological Age, and the two compared.

C. Coefficients of Correlation.

Correlation Coefficients were calculated for:

(1) Otis I. B. with Association (a) Free
(b) Controlled, I,II,III,IV
(a) for Groups IV, V and VI and (B) for total Group (IV, V, VI).

(2) Otis I. B. with Controlled Association, I, II, III, IV for Production and Selection Test series taken respectively. (GroupV).

(3) Free Association with Controlled Association, I, II, III, IV (for Groups IV, V and VI).

(4) Controlled Association Scores, I with II, III, IV.
II with III, IV.
III with IV.
for Groups IV, V and VI.

(5) Absolute Scores with Controlled Association Scores I, II, III, IV (Group IV). Absolute Scores with Production and Selection Group V.

(6) Small selected group from Group IV tested N. I. I. P. No. 34, and (a) correlated with Controlled Association Series I, II, III, IV, (b) with Otis I. B. for same group.

(7) Age with Free Association and Controlled Association I, II, III, IV (for Groups I - VI).

SECTION V.

TABLES AND GRAPHS.

A. Group Average Free and Controlled Association Scores.

B. Age Norms.

C. Coefficients of Correlation.

Section V.

Tables and Graphs.

A.

Group Average Free and Controlled Association Scores.

Table I. Total number of subjects ranked according to I.B. and divided into groups according to each ten units decrease in the I.B. score. Group average scores for Free and Controlled association are given. It is apparent from the table that the average number of items produced by the higher I.B. groups exceeds the average number produced by the lower I.B. groups.

GROUP-I.B.		NO.IN GR.	F.A.	I.	II.	III.	IV.
I	(170-194)	19	24.1	13	10.61	8.75	7.52
II	(160-170)	21	25.3	12.9	10.52	8.4	7
III	(150-160)	35	20.28	11.74	9.42	7.78	6.18
IV	(140-150)	54	23.5	12.17	9.23	7.77	6.45
V	(130-140)	41	23.02	11.53	9.07	7.26	6.29
VI	(120-130)	55	20.8	11.27	8.74	7.01	6.34
VII	(110-120)	35	16.41	9.95	8.22	6.32	5.25
VIII	(100-110)	42	19.52	10.2	8.59	6.35	5.54
IX	(90-100)	26	19.16	9.77	8.48	5.81	5.23
X	(below 90)	36	17.17	9.26	7.48	5.9	5.11
	Totals.		209.26	111.79	90.36	71.35	60.91
	Averages.		20.92	11.18	9.04	7.13	6.1

A. Fig (1)

Association Scores of Subjects as in Table I graphed.

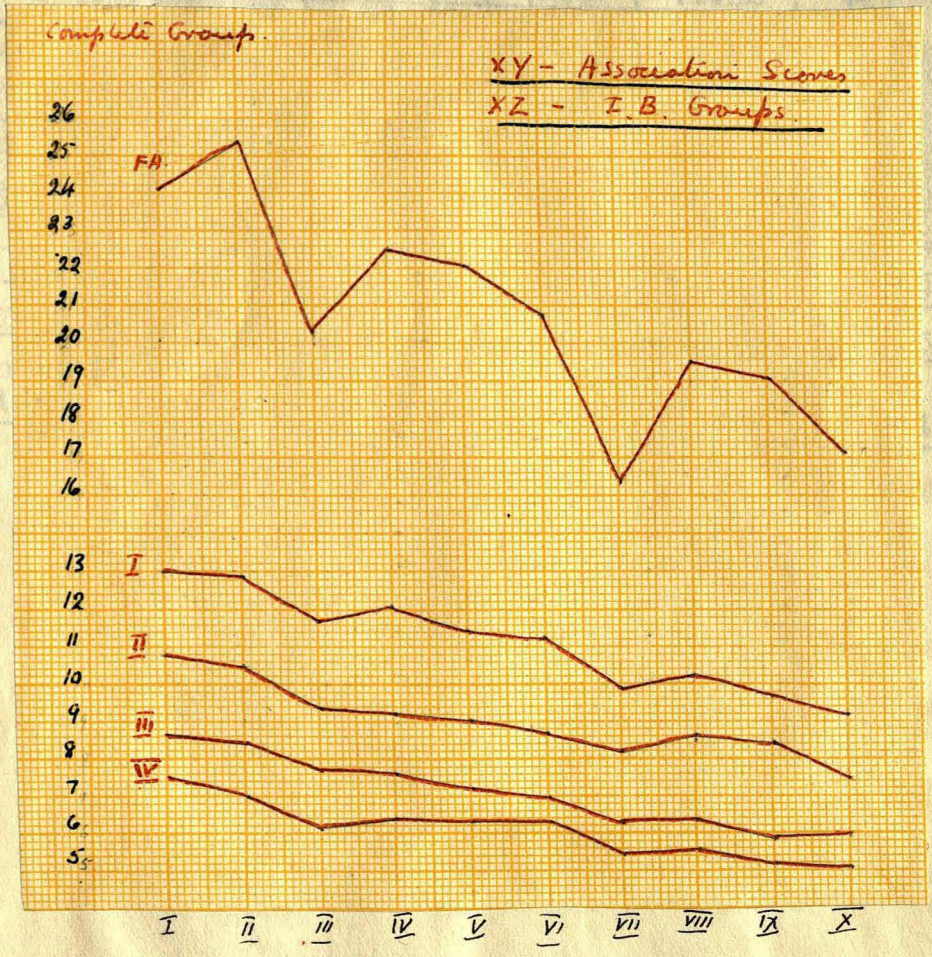


Table Ia. Mean Variations from Group average scores in Free and Controlled association as in Table I.

Average of I.B.Group.	Variation on F.A.	I	II	III	IV
I	+3.18	+1.82	+1.57	+1.62	+1.42
II	+4.38	+1.72	+1.48	+1.27	+0.9
III	-0.64	+0.56	+0.38	+0.65	+0.08
IV	+2.58	+0.99	+0.19	+0.64	+0.35
V	+2.1	+0.35	+0.03	+0.13	+0.19
VI	-0.12	+0.09	-0.3	-0.12	+0.24
VII	-4.51	-1.23	-0.82	-0.81	-0.85
VIII	-1.4	-0.98	-0.45	-0.78	-0.56
IX	-0.76	-1.41	-0.56	-1.32	-0.87
X	-3.75	-1.92	-1.56	-1.23	-0.99
Totals.	23.42	11.07	7.34	8.57	6.45
Mean Variation.	2.34	1.11	.73	.85	.64

Table Ib. Group average percentage and absolute decrease between Free Association and Controlled Association (one control). Group average percentage and absolute decrease between Controlled Association (one control) and (four controls). The table shows that the percentage decrease effected when one control is imposed in the free association process is approximately equal to the percentage decrease effected by the further addition of three controls to performance with one control.

	Control I on Free Association				Control IV on Control I			
Group	Abs. Decr.	%Age Decr.	Abs. M.V.	%Age M.V.	Abs Decr	%Age Decr.	M.V.A.	M.V.P.
I	11.10	46.58	+1.453	.633	5.48	42.11	+.382	-3.532
II	12.40	48.99	+2.753	1.777	5.9	45.72	+.802	+.078
III	8.54	42.11	1.107	5.103	5.56	47.35	+.462	+1.708
IV	11.33	48.21	1.683	.997	5.72	47	+.622	+1.358
V	11.49	49.90	1.843	2.687	5.34	46.3	+.242	+.658
VI	9.53	54.18	.177	6.967	4.93	43.74	-.168	-1.902
VII	6.46	39.36	3.187	7.853	4.7	47.23	-.398	+1.568
VIII	9.32	47.74	.327	.527	4.66	45.69	-.438	+ .048
IX	9.39	49.00	.257	1.787	4.54	46.47	-.558	+.828
X	7.91	46.06	1.737	1.153	4.15	44.81	-.948	-.852
	96.47	472.13	14.524	29.484	50.98	456.42	5.02	12.512%
	9.647	47.213	1.452	2.948%	5.098	45.642	.502	1.25%

Table II. Total number of subjects ranked according to I.B. divided so that each group represents 20% of the total number. Group average scores for Free and Controlled Association.

Group.	No.	F.A.	I	II	III	IV
I	75	22.62	12.4	10.03	8	6.75
II	72	22.36	12.16	9.3	7.83	6.61
III	72	21.26	11.47	8.68	6.81	6.1
IV	72	17.83	10.04	8.46	6.47	5.48
V	73	18.43	9.72	8.21	5.96	5.24
Average		20.5	11.15	8.93	7.01	6.03

Standard Deviations for each group in the foregoing table.

Group.	Control I	Control IV	Free Assoc.
I	1.97	1.5	7.15
II	2.34	1.66	8.41
III	2.16	1.41	7.62
IV	1.96	1.55	7.92
V	1.24	1.19	6.73
Average	1.93	1.46	7.56

A. Figure (11.)

Association Scores of Subjects as in Table II graphed.

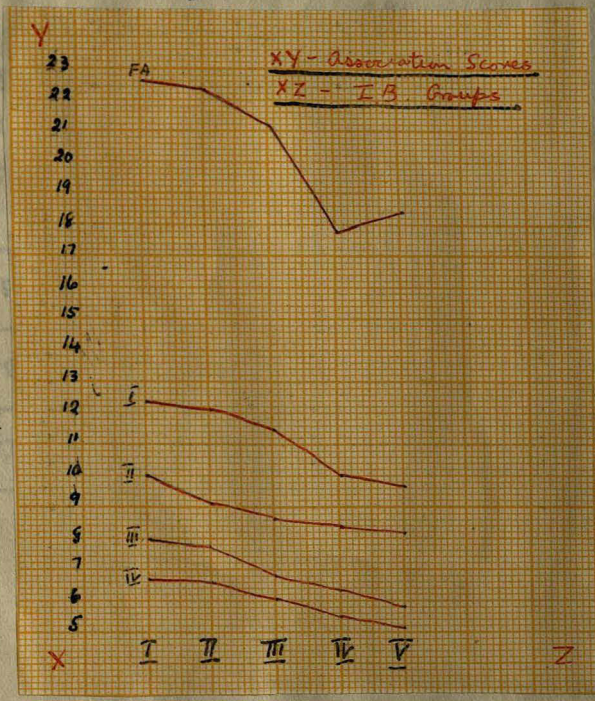


Table IIa. Subjects grouped as in Table II. Group average percentage and absolute decrease between Free Association and Controlled Association (one control). Group average percentage and absolute decrease between Controlled Association (one control) and Controlled Association (four controls).

	Free Assoc. & Control I.		Control I & Control IV.	
Group	Absolute Decrease.	Percentage Decrease.	Absolute Decrease.	Percentage Decrease.
I	10.22	45.18	5.65	45.56
II	10.2	45.61	5.55	45.65
III	9.79	46.04	5.37	46.81
IV	7.79	43.68	4.56	45.41
V	8.71	47.26	4.48	46.09

Table III. Total number of subjects ranked according to I.B. and divided into groups such that the first group represents the upper 25% of the subjects, the centre group the middle 50%, and the last group, the lower 25% of the subjects. Group average scores for Free and Controlled Association.

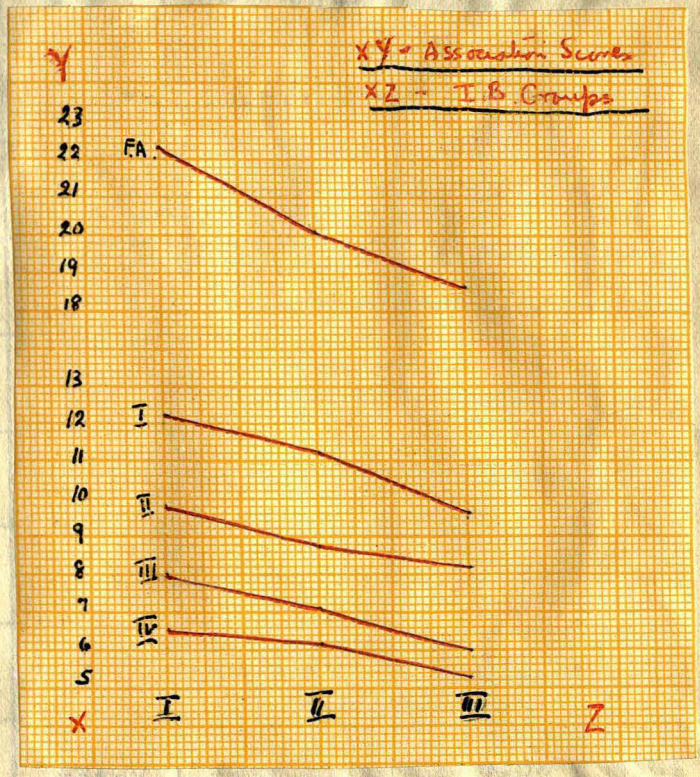
Group.	No.	F.A.	I	II	III	IV
A	91	22.37	12.24	9.87	8.03	6.61
B	182	20.98	11.2	8.79	7.11	6.13
C	91	18.63	9.58	8.17	5.99	5.29

Table IIIa. For the above grouping, the group average percentage and absolute decrease between Free Association and Controlled Association (one control). Group average percentage and absolute decrease between Controlled Association (one control) and Controlled Association (four controls).

	Control I on Free Association.				Control IV on Control I			
Gr.	Absolute.	%Age.	A.M.V.	P.M.V.	Absol.	%Age.	A.M.V.	P.M.V.
A	10.13	45.28	.477	1.36	5.63	45.99	.64	.65
B	9.78	46.61	.127	.03	5.07	45.26	.08	.08
C	9.05	48.04	.603	1.4	4.29	44.78	.7	.56
Total	28.96	139.93	1.207	2.79	14.99	136.03	1.42	1.29
Av.	9.653	46.64	.402	.93	4.99	45.39	.473	.43

A. FIGURE (III.)

Association Scores of Subjects as in Table III graphed.



Group IV (K.H.S.)

Subjects in group IV (age 9-14). No. 215.
Mean I.B. 125.5

Table I. Subjects ranked according to I.B. and divided into groups according to each ten units decrease on the I.B. score. Group average scores for Free and Controlled Association given. The same features are exhibited by the trend of the association scores as in the scores for the total group. (First Testing Scores)

Gr.	I.B.	No.	F.A.	I	II	III	IV
I	(170-194)	8	20.25	11.32	9.25	6.47	6.57
II	(160-170)	6	17.33	10.56	8.7	6.56	5.36
III	(150-160)	21	18.28	10.62	8.39	6.86	5.66
IV	(140-150)	24	17.37	10.47	7.84	6.62	5.3
V	(130-140)	17	17.17	9.83	7.87	6.15	5.22
VI	(120-130)	36	17.33	10.36	8.28	6.44	6.25
VII	(110-120)	26	13.72	9.18	7.92	5.94	4.94
VIII	(100-110)	27	14.85	9.14	7.97	5.62	5.04
IX	(90-100)	19	17.31	9.18	8.12	5.58	5.13
X	(80-90)	16	16.06	9.25	7.48	5.9	4.81
XI	(70-80)	15	16.86	9.01	7.32	5.56	5.28

Table Ia. Group average percentage and absolute decrease between Free Association and Controlled Association (one control) and between Controlled Association (one control) and Controlled Association (four controls).

	4th Control on 1st.				4th Control on F.A.			
Gr.	Abs. Decr.	Percent Decr.	Dev. I	Dev. II	Abs. Decr.	Percent Decr.	Dev. I	Dev. II.
I	4.75	42.03	.263	3.95	8.93	44.09	.966	2.7
II	5.2	49.25	.713	3.27	6.77	39.07	1.194	2.32
III	4.96	46.69	.473	.71	7.66	41.9	.304	.53
IV	5.17	49.39	.683	3.41	6.9	39.72	1.064	1.67
V	4.61	46.89	.123	.91	7.34	42.8	.624	1.41
VI	4.11	39.56	.377	6.42	6.97	40.28	.994	1.11
VII	4.24	53.68	.247	4.7	4.54	33.09	3.424	7.3
VIII	4.1	44.85	.387	1.13	5.71	38.45	2.254	2.94
IX	4.05	44.06	.437	1.92	8.13	46.96	.166	5.57
X	4.44	48.00	.047	2.02	6.81	42.4	1.154	1.01
XI	3.73	41.39	.757	4.59	7.85	46.55	.114	5.16
	49.36	505.79	4.507	33.03	87.61	455.31	12.258	31.72
	4.487	45.98	.409	3.002	7.964	41.39	1.114	2.885

4th Control on 1st.
Absolute M.V. - .409
Percentage M.V. - 3.002%

1st Control on F.A.
Absolute M.V. - 1.114
Percentage M.V. - 2.885%

Table II (Retest Scores). Group of 137 subjects Division into I.B. groups as in Table I. Table shows average group scores in both Free and Controlled Association as higher on the retest than in the first test.

Gr.	No.	I.B.	F.A.	I	II	III	IV.
I	6	(170-194)	21.33	12.6	11.2	8.86	7.02
II	5	(160-170)	18	11.68	10.2	7.44	6.64
III	15	(150-160)	19.93	11.13	9.96	7	5.66
IV	19	(140-150)	19.1	11.57	9.46	7.54	6.21
V	10	(130-140)	20	11.8	9.44	7.52	6.22
VI	27	(120-130)	19.1	11.52	9.35	7.35	6.08
VII	13	(110-120)	18.16	10.61	8.49	6.23	5.52
VIII	14	(100-110)	17.5	10.94	9.14	6.35	5.65
IX	20	(90-100)	17.35	10.8	9	6.95	5.61
X	8	(80-90)	14.5	10.4	7.7	5.77	5.22

Group IV (K.H.S) FIGURE I

Association Scores of Subjects as in Table I (First Test) and Table II (Retest) graphed.

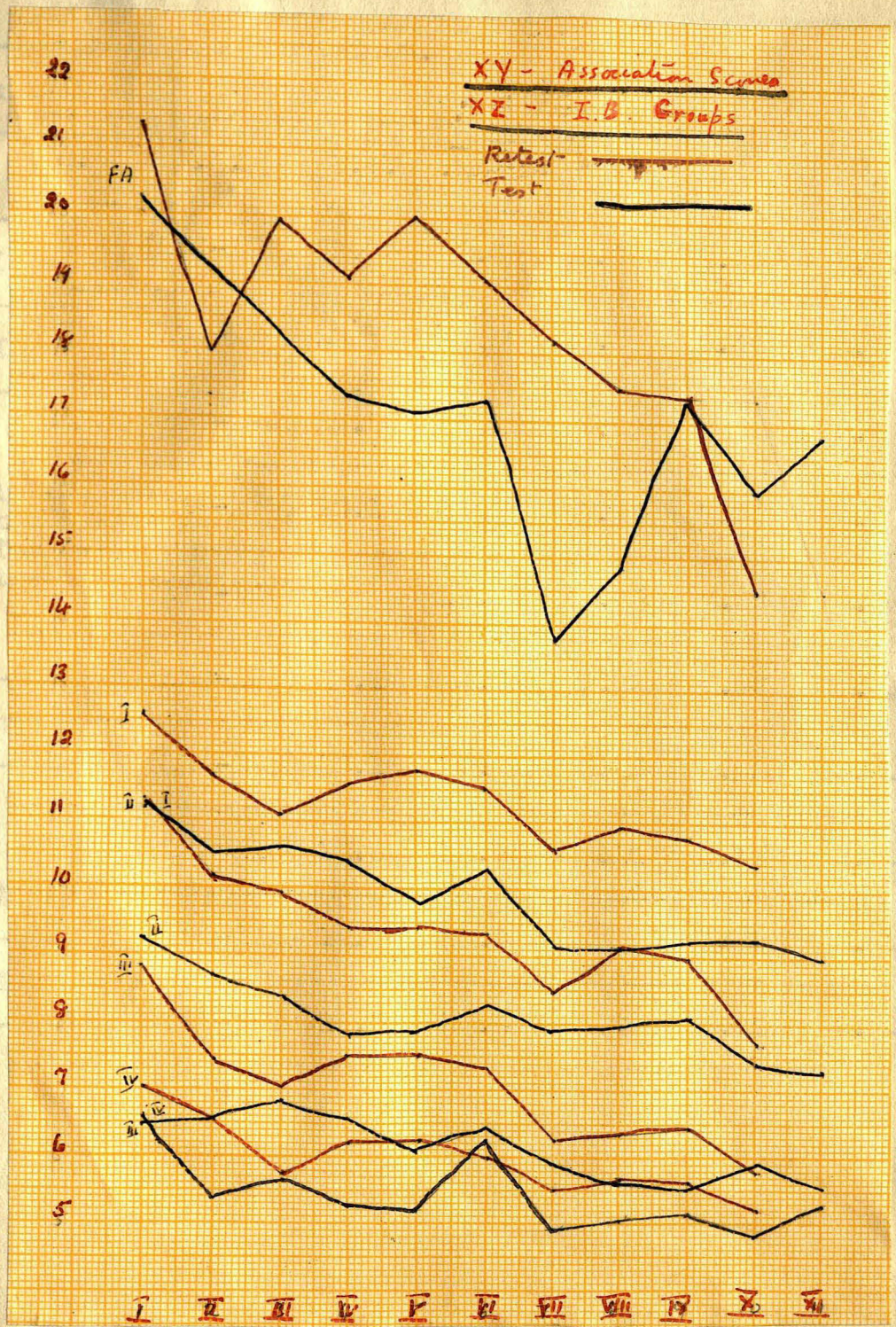


Table III. Scores on first testing ranked according to I.B. and divided into groups of 25%, 50%, 25% respectively. Group average scores for Free and Controlled Association.

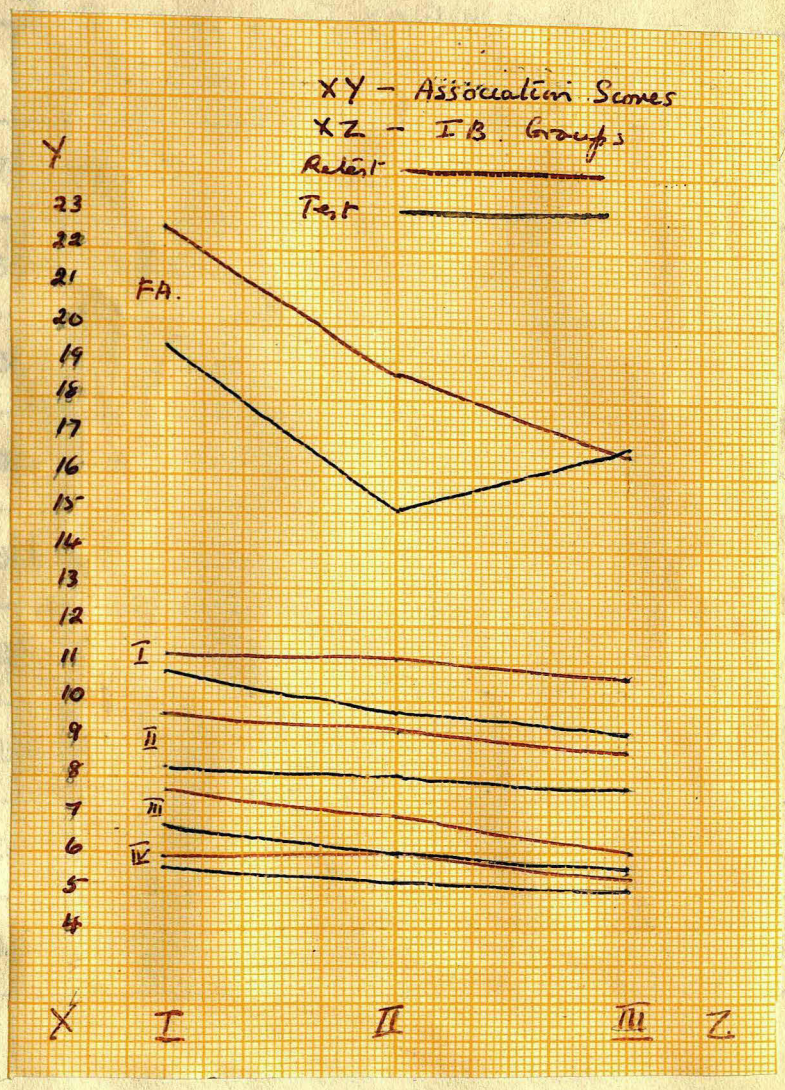
Group.	No.	F.A.	I	II	III	IV
I	54	18.42	10.76	8.37	6.73	5.7
II	107	15.17	9.69	8.06	6.09	5.21
III	54	16.71	9.19	7.71	5.71	5.09

Table IV. Scores on retesting. Group of 137 subjects ranked according to I.B. and divided into groups as in Table II. Group average scores for Free and Controlled Association.

Group.	No.	I.B.	F.A.	I	II	III	IV
I	34	(190-150)	22.64	11.31	9.76	7.74	5.93
II	69	(150-110)	18.75	11.3	9.19	6.99	5.99
III	34	(110-80)	16.64	10.67	8.76	6.56	5.54

Group IV (K.H.S) A. Figure (11.)

Association Scores of Subjects as in Table III (Test) and Table IV (Retest) graphed.



Group V (W.A.)

Subjects in Group V (age 13-18) 96 subjects
Mean I.B. 129.7

Table I. Subjects ranked according to I.B. and divided into groups according to each ten units decrease on the I.B. score. Group average scores for Free and Controlled Association.

Gr.	No.	I.B.	F.A.	I	II	III	IV
I	4	(170-180)	31	14.3	11.05	9.3	8
II	7	(160-170)	31.1	14.05	10.6	9.37	8.05
III	10	(150-160)	25.1	13.16	10.64	8.82	6.7
IV	14	(140-150)	30.9	13.48	10.2	8.7	7.8
V	20	(130-140)	26.8	12.46	9.6	7.87	7.04
VI	12	(120-130)	28.33	12.45	9.5	8	6.65
VII	7	(110-120)	25.3	12.25	9.34	7.7	6
VIII	11	(100-110)	29.3	12.25	9.85	7.87	6.52
IX	10	(below 100)	28.82	10.18	8.14	6.12	4.9

A. Group V (W.A) FIGURE (1.)

Association Scores of Subjects as in Table I graphed.

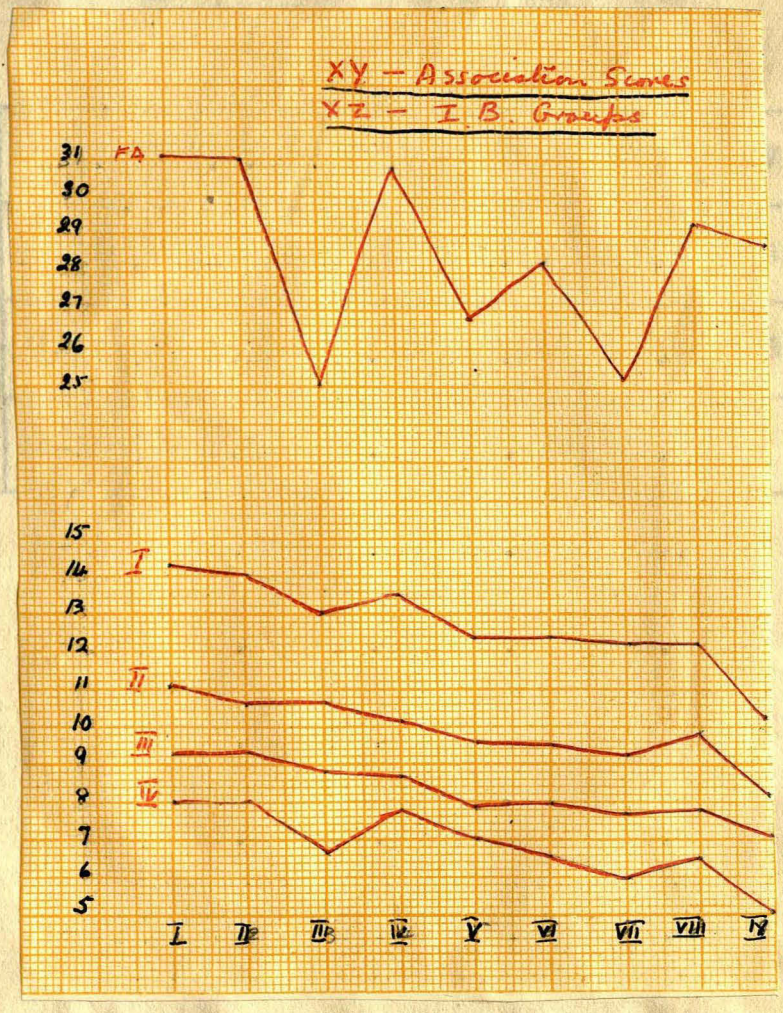
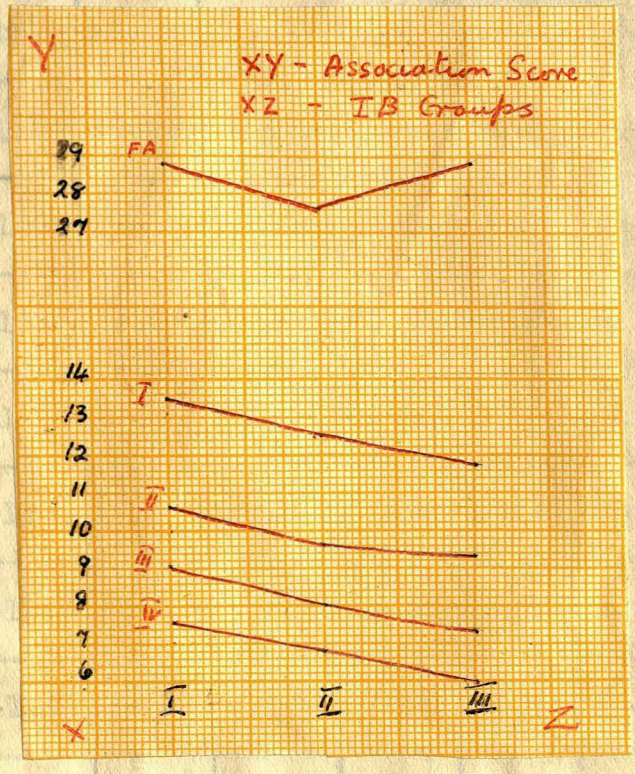


Table II. Subjects ranked according to I.B. divided into groups of 25%, 50%, 25% respectively. Group average scores for Free and Controlled Association.

Group.	No.	I.B.	F.A.	I	II	III	IV
I	26	(175-146)	28.8	13.54	16.6	9.04	7.62
II	49	(146-115)	27.66	12.66	9.67	8.04	6.86
III	22	(115-75)	28.9	11.78	9.39	7.38	6

A. Group V (W.A) Figure II

Association Scores of Subjects as in Table II graphed.



Group VI (G.L.C.) Age (18-21. 1st and 2nd year students) Mean I.B. 142.8. 56 subjects.

Table I. Subjects ranked according to I.B. and divided into groups according to each ten units decrease on the I.B. score. Group average scores for Free and Controlled Association.

Gr.	No.	I.B.	F.A.	I	II	III	IV
I	7	(170-181)	24.28	14.14	11.9	11.05	8.34
II	8	(160-170)	26.28	13.72	11.82	8.92	7.32
III	6	(150-160)	19.16	12.96	10.66	8.96	6.96
IV	16	(140-150)	26.28	13.2	10.48	7.95	7
V	4	(130-140)	29	14.33	11.55	9	7.15
VI	7	(120-130)	25.7	13.97	9.88	8.28	6.28
VII	2	(110-120)	19	11	8.2	6.4	7
VIII	4	(100-110)	24.2	11.75	9.25	7.1	6.2
IX	2	(below 100)	13	9	8.2	6.2	6.2

A. Group VI (G.L.C.) Figure (1.)

Association Scores of Subjects as in Table I graphed.

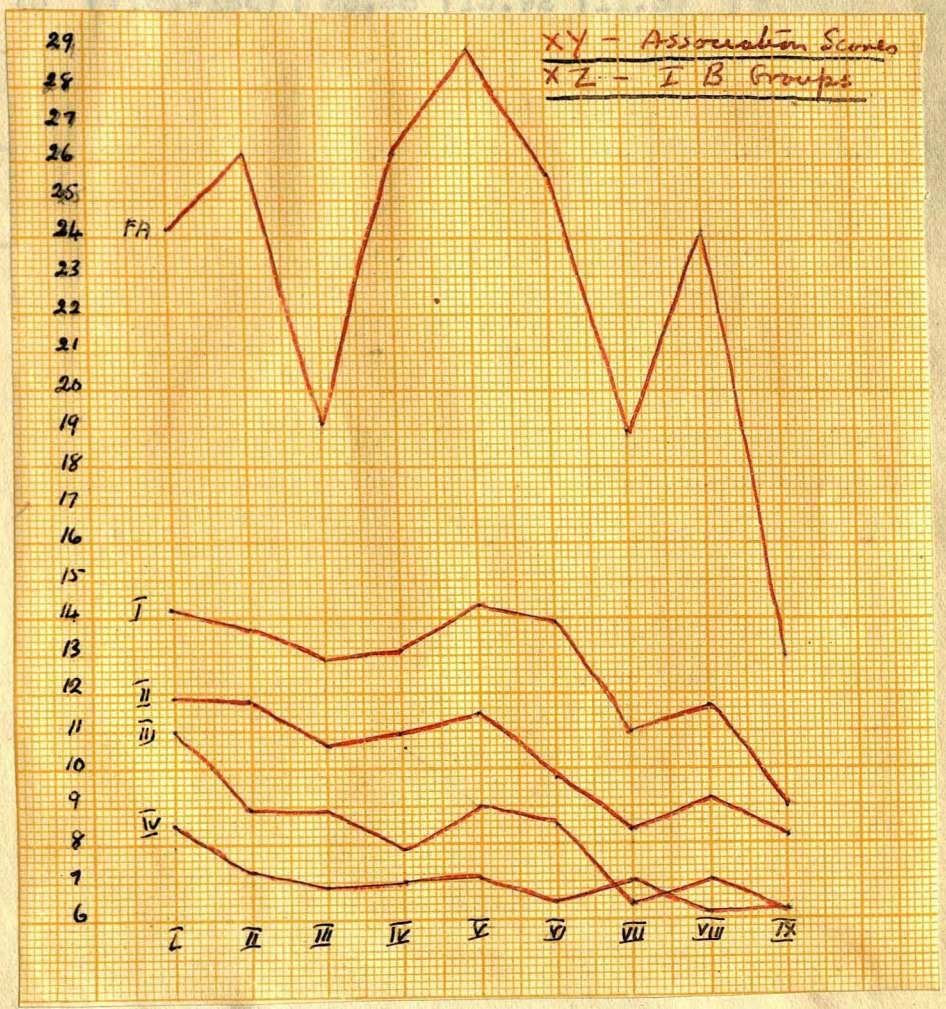
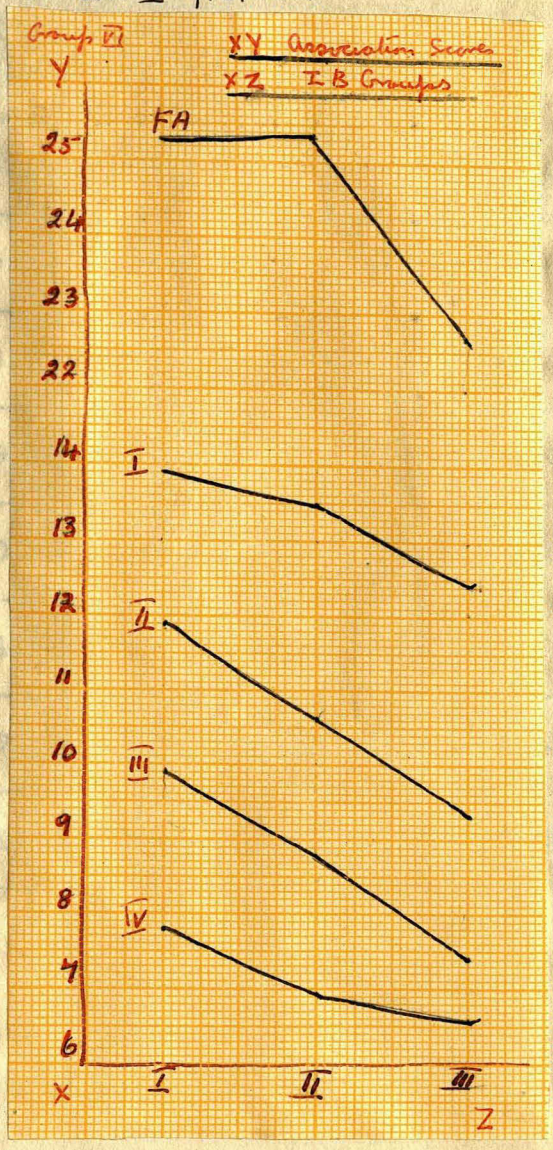


Table II. Subjects ranked according to I.B. and divided into 25%, 50%, 25% groups. Group average scores for Free and Controlled Association.

Gr.	No.	I.B.	F.A.	I	II	III	IV
I	15	(181-160)	25.28	13.92	11.87	9.92	7.8
II	27	(158-129)	25.36	13.5	10.6	8.77	6.97
III	14	(127-163)	22.07	12.47	9.33	7.41	6.51

A. Group VI (G.L.C.) FIGURE (II.)

Association Scores of Subjects as in Table II graphed.



B.

AGE NORMS.

Table I. Total number of subjects divided into groups according to each year of age. Age group average scores for Free and Controlled Association. Table shows increase in average number of items given by older groups.

	Age	No.in Gr.	F.A.	I	II	III	IV
I	10-11	9	15.88	9.53	7.84	5.95	5.53
II	11-12	36	15.14	9.43	7.62	5.67	4.76
III	12-13	123	16.27	9.75	8.01	6.08	5.23
IV	13-14	122	19.16	10.9	8.67	6.98	5.98
V	14-15	63	20.41	11.48	9.21	7.27	6.04
VI	15-16	52	24.44	12.1	9.66	7.93	6.69
VII	16-17	40	27.75	12.6	9.63	7.85	7.03
VIII	17-25	76	24.6	13.11	10.21	8.46	6.92

B. FIGURE (1.)

AGE NORMS.

Association Scores of Subjects as in Table I graphed.

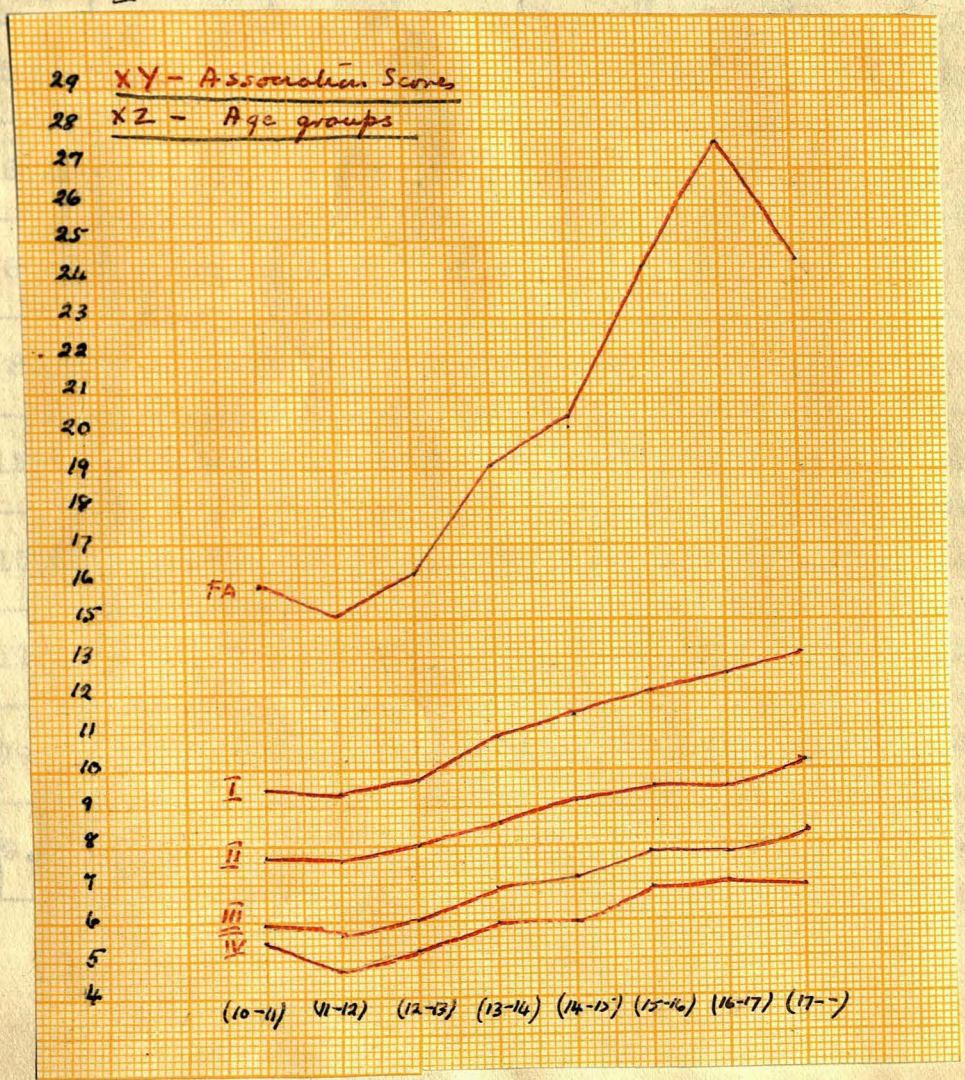


Table Ia. Age group average percentage and absolute decrease in score between Free Association and Controlled (one control). Age group average percentage and absolute decrease between Controlled Association (one control) and (four controls).

	Control I on Free Association.				Control IV on Control I			
Gr.	Abs. Decr.	Percent Decr.	Abs. Var.	%Age Var.	Abs. Decr.	%Age Decr.	Abs. Var.	%Age Var.
I	6.35	40.00	2.993	3.582	4.00	41.96	1.09	3.86
II	5.71	37.71	3.633	5.872	4.67	49.52	.42	3.7
III	6.52	36.38	2.823	7.202	4.52	46.35	.57	.53
IV	8.26	43.11	1.083	.672	4.92	45.13	.17	.69
V	8.93	43.75	.313	.168	5.44	47.38	.35	1.56
VI	12.34	50.49	1.997	6.908	5.41	44.80	.32	1.02
VII	15.15	54.59	5.707	1.008	5.57	44.21	.48	1.61
VIII	11.49	42.63	2.147	.952	6.19	47.21	1.10	1.39
Total.	74.75	348.66	20.696	26.364	40.72	66.56	4.50	14.36
Aver.	9.343	43.582	2.5	3.295	5.09	45.82	.562	1.794

Table II. Selected group of 176 subjects arranged in groups (1) according to each Chronological year of age (2) according to each Mental year of age (i.e. the age for which the Absolute Score is the norm). The table shows real age norms invariably higher than Mental age norms.

Gr.	M.A.	No.	F.A.	I	II	III	IV
I	10-11	13	16.3	8.49	7.24	5.32	4.61
II	11-12	30	16.43	8.93	7.46	5.53	4.93
III	12-13	29	16.1	9.63	7.85	5.66	4.9
IV	13-14	40	15.89	9.62	8.18	6.11	5.35
V	14-15	33	18.3	10.25	8.41	6.48	5.54
VI	15-16	11	17.83	10.54	8.23	6.54	5.43
VII	16-18	20	19.6	10.83	8.43	6.61	5.59
CHRONOLOGICAL AGE GROUPS OF SAME.							
I	10-11		15.8	10.2	7.64	5.64	5.32
II	11-12		14.75	9	7.75	5.36	4.51
III	12-13		14.06	9.72	7.78	5.72	5
IV	13-14		17.47	10.24	8.35	6.44	5.44
V	14-15		21	10.66	9.22	6.66	5.42
VI	15-16		35.2	12.45	8.75	6.85	6
VII	16-17		36.3	11.93	9.26	8.4	6.06

B. FIGURE (11.)

MENTAL v. CHRONOLOGICAL AGE NORMS

Association Scores as in Table II graphed.

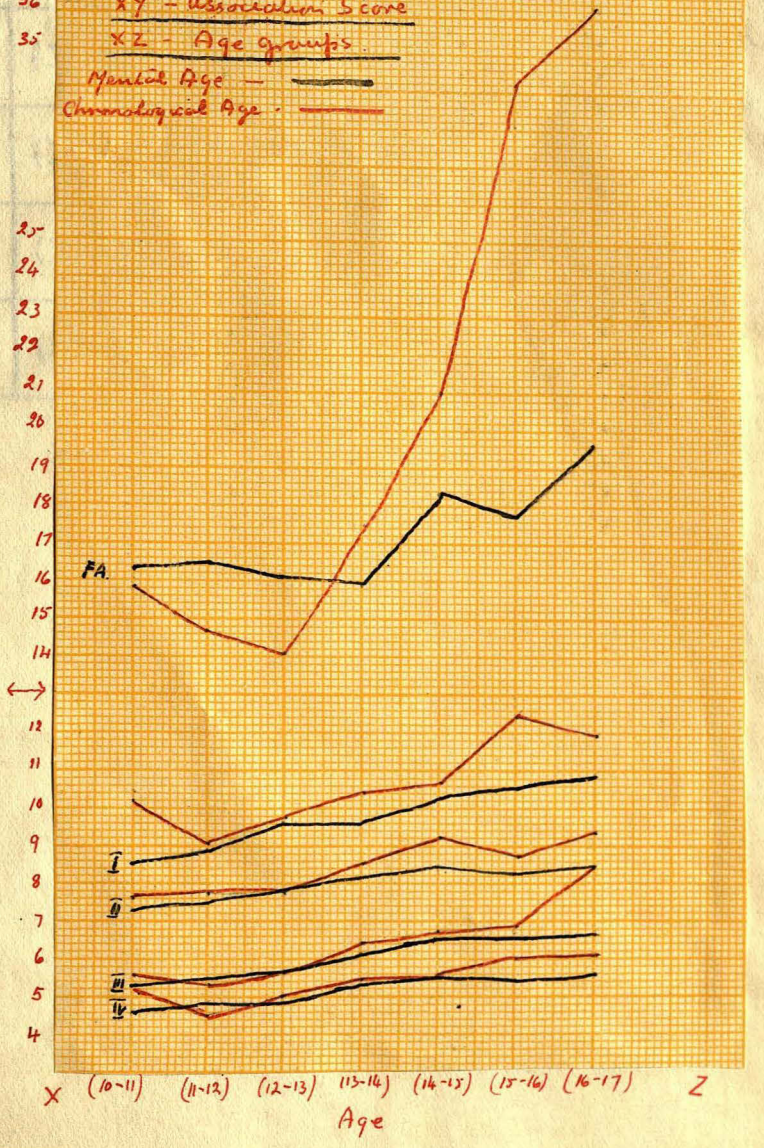


Table III (Group V only) Subjects arranged in groups according to each year of age. Age group average scores for Free and Controlled Association.

Gr.	No.	Age.	F.A.	I	II	III	IV
I	41	(13-14)	20.58	11.81	9.3	7.55	6.68
II	38	(14-15)	21.5	11.89	9.52	7.86	6.57
III	34	(15-16)	26.94	12.67	10.1	8.45	7.25
IV	22	(16-17)	32.95	13.49	10.32	8.60	7.94
V	11	(17-18)	30.71	12.74	9.43	8.09	7.11

GROUP V only.

B. FIGURE VII.

AGE NORMS.

Association Scores as in TABLE III graphed.

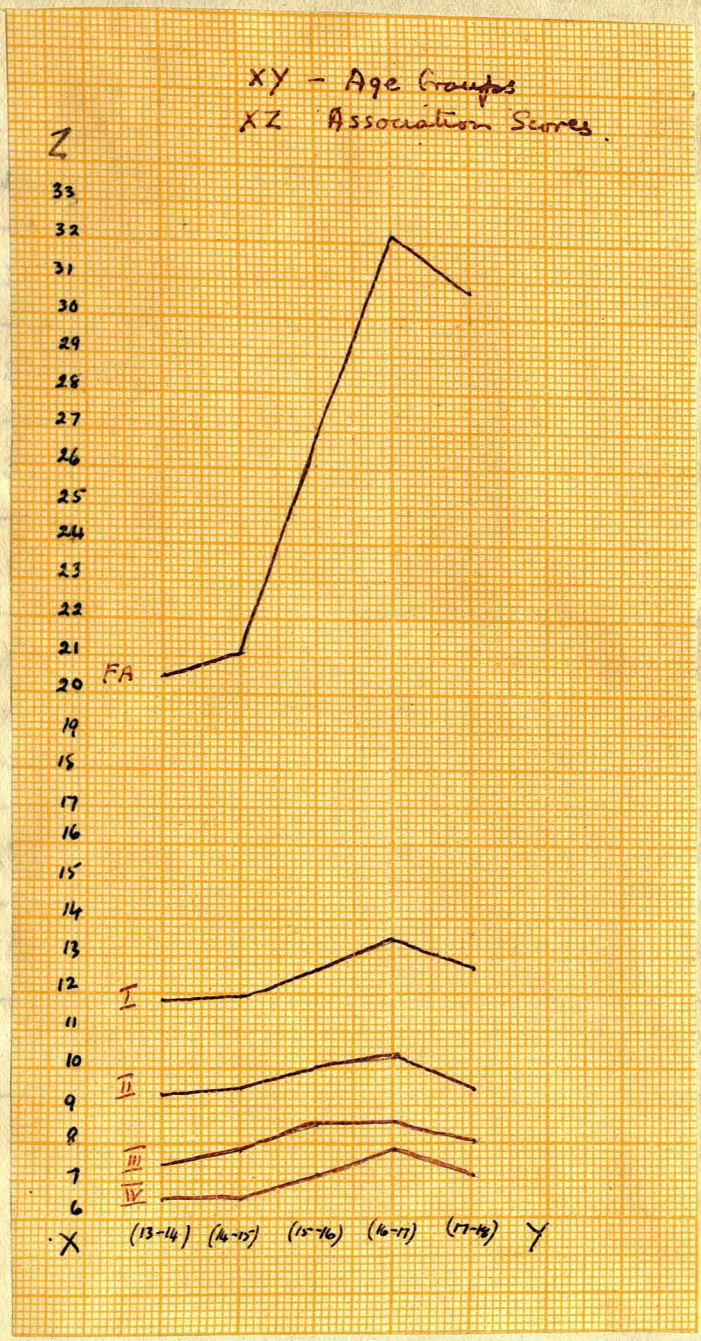
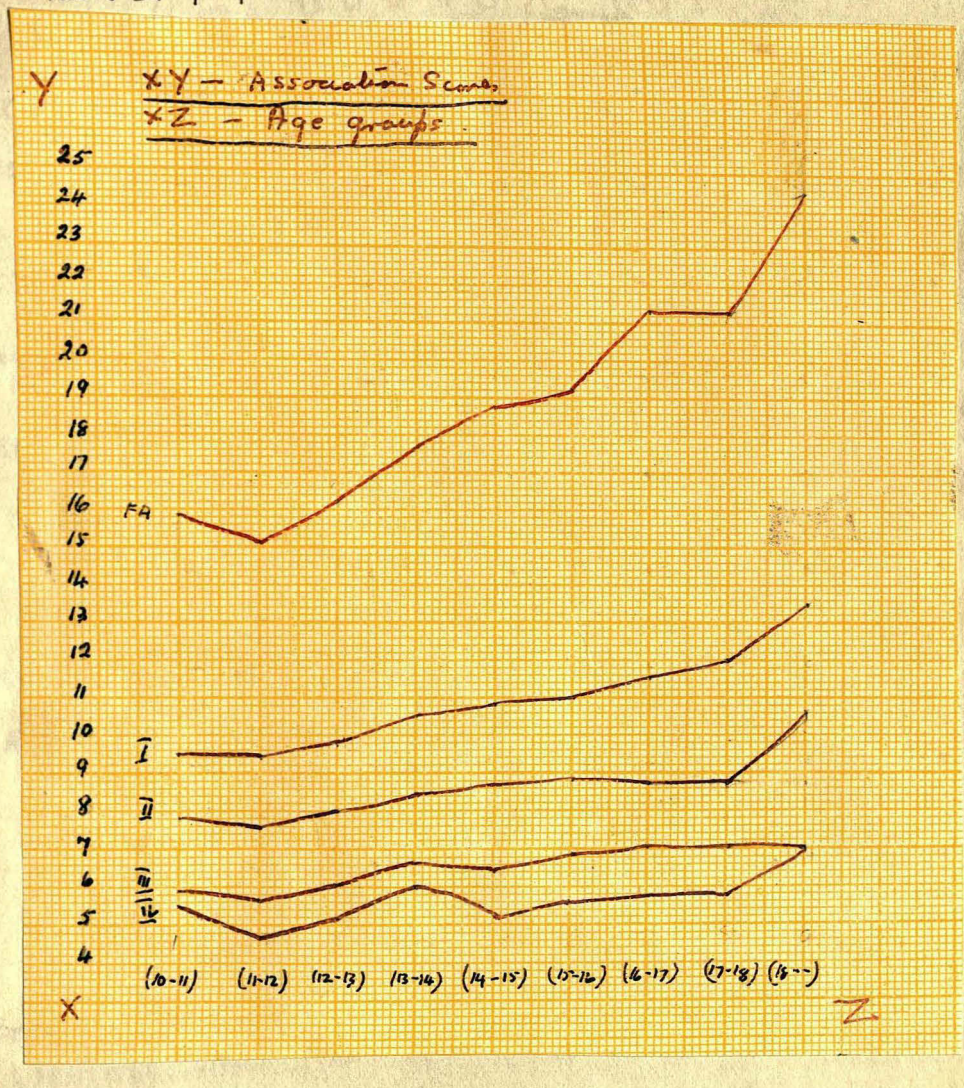


Table IV. (Part of total group, including Group IV (K.H.S.) and VI (G.L.C.) subjects from other schools). Subjects arranged in groups according to each year of age. Age group average scores for Free and Controlled Association.

Gr.	No.	Age.	F.A.	I	II	III	IV
I	9	(10-11)	15.88	9.53	7.84	5.95	5.53
II	36	(11-12)	15.14	9.43	7.62	5.67	4.76
III	123	(12-13)	16.27	9.75	8.01	6.08	5.22
IV	81	(13-14)	17.71	10.58	8.46	6.69	6.05
V	25	(14-15)	18.76	10.81	8.75	6.41	5.25
VI	18	(15-16)	19.28	11.03	8.82	6.95	5.64
VII	18	(16-17)	21.38	11.51	8.77	7.01	5.92
VIII	9	(17-18)	21.33	12	8.64	7.17	5.91
IX	56	(Adult)	24.45	13.35	10.62	8.74	7.04

B. Groups (IV + V etc) FIGURE (IV.)

Association Scores as in Table IV graphed.



COEFFICIENTS OF CORRELATION.

I

		Group IV (K.H.S.)	Group V (W.A.)	Group VI (G.L.C.)
(a)	Otis I.B. with Free Assoc. -	.31	.13	.11
	" " " Cont. Assoc.I -	.39	.41	.32
	(Production + Selection Tests) II -	.32	.42	.52
	III -	.27	.45	.54
	IV -	.26	.44	.39

		IV	V	VI
(b)	Otis I.B. with Free Assoc.	.31	.131	.11
	Cont. Assoc.I	.39	.36	.22
	(Production Tests only) II	.29	.35	.33
	III	.33	.34	.42
	IV	.45	.36	.44

		IV	V	VI
(c)	Otis I.B. with Free Assoc.	.31	.13	.11
	Cont. Assoc.I	.24	.09	.04
	(Selection Tests only) II	.17	.17	.53
	III	.09	.25	.64
	IV	.06	.42	.37

II

Group IV (K.H.S.)

Absolute Score with Free Assoc. - .32
" " " Cont. Assoc.I- .48
II - .41
(Production + Selection Tests) III - .38
IV - .33

III

Group V (W.A.)

Absolute Score with Free Assoc. - .29
Cont. Assoc.I - .44
II - .34
(Production only) III - .73
IV - .54

IV.

Group IV (K.H.S.)

Otis I.B. with N.I.I.P. Test no.34 - .73

N.I.I.P. no.34 score with Controlled Assoc. I .46
II .34
III .35
IV .32

V.

Groups IV + V + VI.

Otis I.B. with Controlled Assoc. I .48
II .46
(Production + Selection Tests) III .46
IV .40

VI

		Group IV.	V.	VI.
Free Association with Control	I	.56	.48	.48
	II	.39	.25	.42
	III	.34	.29	.36
	IV	.42	.44	.32

VII.

Controlled Association.

I with	Group IV.	V.	VI.		IV.	V.	VI.
II	.74	.63	.61	II with			
III	.53	.68	.48	III	.57	.68	.72
IV	.57	.43	.39	IV	.44	.44	.64

	IV	V	VI
III with			
IV	.64	.54	.70

VIII.

Age (10 upwards) with Free Association - .53
" " " with Cont.Assoc. I - .54
II - .47
III - .59
IV - .39

Section VI.

General Summary of Results.

A. Tables and Figures. I.B.Groups with Association Scores.
B. Age norms.
C. Coefficients of Correlation.

A. Intelligence and Group Average Association Scores.

Tables and figures in this section show

(1) Average number of items given for progressively increased equally graded controls, i.e., the effect of the addition of objectively equal controls in limiting the number of relevant items produced or selected.

(2) Differences in the number of items given in free association and controlled association tests.

(3) Differences in the number of items produced by groups of differing average I.B's.

(4) Effects of retesting on group average production of items.

(1) and (2). Average Number of Items Produced. Effect of Additional Controls.

The most general indication of average number of items produced will be found in tables relative to the total group, viz., Tables I, II and III.

e.g. Table I Free Association - 20.92
Controlled Association (1) - 11.18
(2) - 9.04
(3) - 7.13
(4) - 6.1

or Table II Free Association - 20.5 (S.D.7.56)
Controlled Association (1) - 11.15(S.D.1.93)
(2) - 8.93
(3) - 7.01
(4) - 6.03(S.D.1.46)

Inspection of S.D's and M.Vs show that the range of variation is considerable, more particularly in free association, where accidental factors of many kinds must be present. In the complete group, the large

range/

range of ages accounts for the range in the size of the scores.

Inspection of the tables of average number of items given for free and controlled association shows very clearly the effect of the presence of one control. Calculations of group average percentage reduction between the number of items produced in the free association test and the number of items produced in the controlled association test with one control, show that the presence of one control reduces the number of items produced 43% - 47%. Within controlled association scores, the addition of three controls to one reduces the number of items produced by an average 45%. Thus the effect of the addition of one control to free association is approximately the same as the effect of the addition of three controls to one control. That the percentage reduction in scores either between free association and one control, or between one control and four controls, remains constant, is substantiated by the fact that when age group average association scores are calculated, the results show an approximately similar percentage decrease. (Tables BI, Ia) When one control is present, the reduction on free association is 43.5% (M.V.3.2), and when three controls are added to one, the reduction is 45% (M.V.1.79%)

All tables of group average scores whether grouped according to I.B. or age, show that the progressive addition of objectively equal controls has a progressively less effect in reducing the number of items produced, i.e. the addition of the fourth control to the third reduces the number of items given to a less degree than the addition of the third control to the second, or the second to the first.

(3) Differences in Number of Items produced by groups of differing average I.B's.

Inspection of tables and figures show that the group averages for both free and controlled association decrease with the decreasing I.B. of the groups. In no case does the group with the lowest average I.B. have a higher score either for free association or for controlled association (with any given number of controls) than the group with the highest average I.B.

(4) Effects of Retest on Group Average Scores.

In every case the number of items given in both free and controlled association was increased in the retest scores. It is impossible to decide whether the/

the increase is due to (a) increased familiarity with the experimental procedure, (b) memory of the tests as given on the former occasion, (c) additional six months training in the solving of problems, combined with the age factor. If the introspective reports of the individually retested group (3rd preliminary experiment) are considered, it seems most likely that the increase is largely to be attributed to familiarity with the conditions of the tests, although the actual content was probably forgotten. It seems most likely that an age factor, expressed e.g. in increasing facility in writing, would also enter.

B. Age norms.

Increase in the age of the year groups gives corresponding increase in the number of items produced both in free and controlled association. In no case does the youngest age group produce a greater number of items either in free or controlled association (any given number of controls) than the oldest age group. (Table B I).

Chronological age norms for both free and controlled association tend to be almost consistently higher than mental age norms. Chronological age norms for free association are lower, however, in the younger groups and much higher in the older groups, than the corresponding Mental age norms. Within the controlled association scores, the distinction between Chronological and Mental age norms tends to lessen in passing from one to four controls. (Table II. Fig.II) (Note. The dip in controlled association scores indicated at age (11-12) may be due either (a) to the fact that the (10-11) age group is small and possibly composed of self selected bright children - They are rather less than average entrant age, and would therefore have a higher than average I.Q., or (b) to the fact that, as many educationists have noted, there does tend to be either a lowering or a static state, of ability about this age.)

C. Coefficients of Correlation.

The correlation between I.B. and controlled association is positive but low. (Range .26-.54).
In Group IV (K.H.S.) the range of r is .26-.39
(Mean I.B.115.5)
In Group V (W.A.) the range of r is .41-.45
(Mean I.B.129.7)

In/

In Group VI (G.L.C.) the range of r is .32-.54 (Mean I.B. 142.8) (see Table Ia).

The correlation of I.B. with Production controlled association tests taken separately from Selection controlled association tests is positive. (Range .22-.45).

PRODUCTION controlled association tests.

In Group IV (K.H.S.) the range of r is .29-.45 (Av.r .36)
V (W.A.) the range of r is .34-.36 (Av.r .35)
VI (G.L.C.) the range of r is .22-.44 (Av.r .35)
(Table Ib)

SELECTION controlled association tests.

The correlation of I.B. with Selection controlled association tests is positive but very low.

In Group IV (K.H.S.) the range of r is .06-.24 (Av.r .14)
V (W.A.) the range of r is .09-.42 (Av.r .23)
VI (G.L.C.) the range of r is .04-.64 (Av.r .39)
(Table Ic)

The correlation with I.B. is thus higher for production tests than for selection tests, and the range of the coefficient of correlation in the selection tests is greater. In production controlled association tests, the coefficient of correlation of I.B. with controlled association is thus
(a) higher
(b) less variable, than in selection tests.

Correlation of other Measures of Intelligence with Controlled Association Scores.

In Group IV (K.H.S.)

N.I.I.P. test no. 34 correlated with Otis I.B. gives r - .73 (Table IV)
N.I.I.P. test no. 34 correlated with controlled association scores in Group IV (K.H.S.) gives a higher correlation than Otis I.B. correlated with the controlled association scores of the same group.
Decrease of r (I.B. - Cont.Ass.) between Controls I and IV - .13
Decrease of r (Score N.I.I.P. - Cont.Ass.) between I and IV - .14

Absolute Score (Otis test) correlated with controlled association scores in Group IV (K.H.S.) gives a higher correlation than I.B. (Otis test) correlated with controlled/

controlled association scores in the same group. (Table II). Decrease of r (Absolute Score - Cont.Ass.) between I and IV - .15

Thus the decrease in r in Group IV (K.H.S.) remains constant whatever measure of intelligence is correlated with controlled association.

The higher correlation of N.I.I.P. with controlled association, and Absolute Score with controlled association in comparison with the correlation of I.B. with controlled association, is to be explained by the fact that each of these measures contains an age factor which is eliminated in I.B.

In Group V (W.A.)

Absolute Score (θtis) correlated with production tests only, gives a higher correlation than when I.B. is correlated with production tests only in the same group. The intervention of the age factor again explains the difference. (Table V).

Direction taken by Coefficients of Correlation between One and Four Controls.

Summary table of trend of r (I.B.-Cont.Ass.) between Controls I and IV.

	Group IV (K.H.S.)	Group V(W.A.)	Group VI (G.L.C)
(1) Selection tests	Decrease	Increase	Increase
(11)Production tests	Increase	Constant	Increase
(111) ((1) + (2))	Decrease	Increase	Increase

The increase in correlation with I.B. in passing from one to four controls in the production tests, is the result looked for in support of the principal hypothesis of the investigation. The fact that this result is not obtained from the selection tests is to be attributed to the inadequacy of the selection test for its purpose. The failure of the selection tests explain why the hypothesis is not supported by the test as a whole, i.e. production + selection tests (Table Ia)

Although in the selection tests the correlation with I.B. increases between one and four controls in Groups V and VI, the lowness of r in Controls I and II in both groups, and its variability in Group VI lay the increase open to suspicion as a possible chance increase. The decrease of r in Group IV in selection tests is consistent/

consistent and marked (Group IV is the largest and most uniform group) and will account for every decrease in the correlation of any measure of intelligence with production and selection controlled association tests taken together in this group, which is the only group showing such a decrease of correlation with intelligence between Controls I and IV in Table Ia. The failure of selection tests also accounts for decrease in r between Controls I and IV when Absolute Score (Otis) or N.I.I.P. Score, is correlated with production and selection controlled association scores. (Tables II and IV).

Again, in selection tests, the correlation of intelligence with free association is consistently higher than the correlation of intelligence with controlled association (Control I), whereas in production tests, the correlation of intelligence with controlled association (Control I) is consistently higher than the correlation of intelligence with free association, - a result entirely in accordance with legitimate expectation.

Thus, if the correlation of I.B. with controlled association in selection tests is not only lower and more variable than in production tests but also fails to support the legitimate hypothesis (a) that controlled association must correlate more highly with intelligence than free association, and (b) that the correlation of controlled association with intelligence must increase in passing from one to four controls, it may be concluded that selection controlled association tests are inferior to production controlled association tests, both as a measure of controlled association and as a measure of intelligence.

This being so, support for the hypothesis must be looked for in the correlation of I.B. with production controlled association tests (see Table Ib). From these results, it can be concluded that the correlation of I.B. with controlled association increases between one and four controls.

Performance with four controls has a higher correlation with intelligence than performance with one control.

Correlation of Intelligence with Free Association.

The correlation of I.B. with free association is .31 for Group IV, .13 for Group V, and .11 for Group VI. In each case the correlation of I.B. with free association is/

is less than the correlation of I.B. with controlled association (one control).

(1) The fact that the correlation between I.B. and free association is higher than might have been expected, is to be explained by the fact that free association in the Continuous form is essentially a productive test. It was shown, in discussing the controls introduced into undirected thought when it is examined under laboratory conditions, that one additional non-accidental significant control is always involved in undirected thought (free association) under laboratory conditions, i.e. that the subject must respond in discrete words. Besides this control which is always present, other accidental significant controls are frequently introduced by the subjects themselves.

Thus, under laboratory conditions, free association is not only a productive process, but, in the case of many subjects, a productive process directed by self-imposed controls.

The findings of other investigators as to the relation between free association and intelligence are most frequently based on the Discrete free association method, which has not the same productive aspect as the Continuous free association method. The productive aspect of the Continuous method is thus sufficient to explain the comparative height of these correlations as compared with the lower correlations found to exist between intelligence and free association in other investigations.ϕ

(2)The fact that the correlation of I.B. with free association is higher in Group IV (K.H.S.) than in either of Groups V or VI may possibly be explicable on the hypothesis that a free association test correlates more highly with intelligence in younger subjects than in older subjects.

There are many reasons why this might be so. For example verbal facility and speed of writing must be factors influencing the number of items produced in a free association test of the Continuous form. Among subjects/

ϕ E.g. See Whipple. Manual p.53-71, 328 ff.

subjects over, for example, thirteen or fourteen years of age, whatever the I.Q. may be, (within limits of normality) a sufficient period of training will have elapsed to have levelled many initial differences in speed of writing or verbal facility. The initial advantage which the more intelligent child has, which will show itself in the earlier attainment of ability in these factors, and particularly in verbal facility, will have been compensated for in the less intelligent children by the practice and training afforded by further education and experience. Hence, at an earlier age where the effect of practice, experience and training in such factors has not yet levelled attainment in them, the factor of intelligence will play a larger part. In short, at an earlier age, attainment either in verbal facility or possibly in speed of writing, will be influenced by intelligence factors to a greater extent than will be the case in later years, since at this stage both the finding of words, and the task of writing, are conscious tasks requiring effort.

This hypothesis is further substantiated by the fact that in B. Table V and Fig.II, it is seen that Chronological age norms for free association are lower than Mental age norms for free association for ages ten to thirteen years, whereas, after fourteen, the Chronological age norms are consistently higher than the Mental age norms.

It may be concluded that free association correlates more highly with intelligence in younger subjects than older, and finally, that free association correlates less highly with intelligence than controlled association. The correlation of free association with intelligence is consistently lower than the correlation of controlled association with intelligence throughout the production tests.

Free Association and Controlled Association.

The correlation of free association with controlled association ranges between .25 and .56, and is higher than the correlation of I.B. with controlled association.

In all groups the correlation of free association with controlled association decreases between the first and fourth controls. Since the correlation of I.B. with controlled association increases between the first and fourth controls, and since the correlation of I.B. with free/

free association is lower than the correlation of I.B. with controlled association, it is to be expected that the correlation of free association with controlled association will decrease in passing from one to four controls.

The comparative size of the correlation of free association with controlled association (one control) is again to be explained by the fact that free association in this form is a production test.

Controlled Association.

The correlation of Control I with II is higher than the correlation of Control I with III which is in turn higher than the correlation of Control I with IV. Again the correlation of Control II with III is higher than the correlation of Control II with IV. The result is in accordance with expectation. It would be presumed that the correlation between an individual's performance with one control and his performance with two controls would be higher than the correlation of his performance with one control and his performance with either three or four controls. The closer in number the controls, the greater the resemblance between the operation involved in working with the controls.

Correlation of Age with Association.

The correlation of age with free association is .53. It is higher than the correlation of I.B. with free association, which is .31, .13, .11 (see Table Ia).

The correlation of Age with controlled association ranges between .39 and .59. It is averagely higher than the correlation of I.B. with controlled association.

The correlation of age with controlled association decreases between the first and fourth controls.

(a) Age and Controlled Association.

It is clear that both Age and Intelligence are correlated with controlled association. I.B. is a measure which eliminates the age factor from Absolute Score, which is a measure of (Age and Intelligence). That this factor, if allowed to remain increases the size of the correlation is evident from Tables II and III (Absolute Score - Association)

viz./

viz. Group IV. (Production + Selection)	I.B. with F.A.	.31	Absolute Score with F.A.	.32
	I	.39	I	.48
	II	.32	II	.41
	III	.27	III	.38
	IV	.26	IV	.33
Group V. (Production only)	I.B. with F.A.	.13	Absolute Score with F.A.	.29
	I	.36	I	.44
	II	.35	II	.34
	III	.34	III	.73
	IV	.36	IV	.54

Although it is clear from this that the presence of an age factor increases the size of the correlation of intelligence with controlled association, yet the correlation of age with association might have been expected to be smaller than it actually is, viz.

(Production + Selection) Complete Group.	Age with F.A.	.53
	I	.54
	II	.47
	III	.59
	IV	.39

The comparative size of this correlation however may be explained when it is seen that in this measure, intelligence has not actually been isolated from age.

Examination of the size of the groups and the distribution of age among the groups show that the groups for ages fifteen upwards are much smaller than the age groups for each year below 15 (see B. Table I Age norms).

The distribution of age among the three main groups of subjects IV (K.H.S.) V (W.A.) and VI (G.L.C.), is, as we know, uneven. Group IV contains all the youngest subjects, Group V subjects between fourteen and eighteen years, and Group VI subjects over eighteen. Thus in the computation of r (Age - Association) the upper ages are represented by subjects from Groups V and VI, and the lower ages by subjects from Group IV. It is known also that the mean I.B.s of the upper groups V and VI are 129.7, and 142.8 respectively, while the mean I.B. of Group IV is only 125.5. We saw that this difference in the group mean I.B.s was explicable on the ground that a process of self-selection of more from less intelligent subjects must be presumed in passing from lower to higher classes in the Secondary schools and finally to University standard (discussed Section IV). It might be concluded that Group VI would tend to be composed of averagely more intelligent/

intelligent subjects than Group V, which in turn would be composed of averagely more intelligent subjects than Group IV.

Thus, in this computation of Age-Controlled association, the older age groups will consist of averagely more intelligent subjects than the younger age groups. This fact will necessarily raise the size of the correlation of age with association, and hence it can be taken that Table VIII does not show the relation of age alone to association, but the relation of age and an unisolated intelligence factor to association.

It must be concluded that both age and intelligence are correlated with controlled association. The age factor remaining in the correlation of Absolute Score with controlled association raises the correlation higher than the correlation of I.B. with controlled association. It is clear that, in the second place, the comparatively high correlation of age with controlled association found in Table VIII is not to be explained wholly by the intervention of an intelligence factor, but must also represent the effect of increasing age in controlled association scores.

(b) Age and Free Association.

The same facts explain the height of the correlation of Age with free association, .53

In Group IV (K.H.S.)	r (I.B.-F.Assoc.) - .31 (Intelligence)
" " " "	r (Abs.Sc.-F.Assoc.)-.32(Intelligence+Age)
In Group V (W.A.)	r (I.B.-F.Assoc.) - .13 (Intelligence)
" " " "	r(Abs.Sc.-F.Assoc.)- .29 (Intelligence+Age)
In total group	r (Age-F.Assoc.) - .53 (Age+Intelligence)

Since from B. Table V (Mental v Chronological Age norms) it is evident that older groups produce a greater average number of items in the free association test, and since, as has been shown, a considerable intelligence factor intervenes in the calculation of the correlation of age with free association, the height of the correlation of age with free association is understandable. The fact that the age factor present in Absolute Score raises the correlation of Absolute Score with free association above the correlation of I.B. with free association, shows the joint effect of age and intelligence on free association scores, and clearly in the calculation of the correlation of age with free association, the age factor is paramount.

It may be concluded that age and intelligence both affect free association scores. As was seen, it is most probable that intelligence has a greater effect on the free/

free association score than age in the younger age groups. Further since from Table Ia, it would seem that the correlation of I.B. with free association is smaller in the more intelligent groups than in the less intelligent, and in view of the fact that the correlation of age with free association is high, it may be the case that age correlates more highly with free association than intelligence in the older age groups.

Factors Determining the Correlation of Age with Association.

Only hypothetical reasons can be advanced as to why age should correlate comparatively highly with association, both free and controlled, in this investigation. Reasons why age should correlate with free association are easier to discover. As has been considered, it is an empirical fact that speed of writing and verbal facility tend to increase with training and education. In free association tests of the Continuous form, both of these factors must be implicated.

In controlled association tests of the productive type, they will also be at work, but although they may influence the amount of relevant produced, they cannot account for the quality of relevance. Some other factors may explain the influence of age on controlled association.

In theoretical analysis, Chapter VI, the relation of facility in the use of controls to ability to employ controls was discussed. It was agreed that facility in employing controls must be partially dependent upon ability to employ controls, but that facility in employing controls was not the same thing as ability to employ controls. It also seemed to be the case that facility in employing controls could be acquired with practice. If this is so, and if we suppose that ability to employ controls is measured by the correlation of I.B. with controlled association, then it is possible that the facility with which controls are employed is measured by the correlation of age with controlled association.

Under the term facility in the employment of controls would be meant purely the speed with which controls are employed, and this, as has been seen, does not a priori, involve anything as to the success with which controls are employed, which is the ability to employ controls.

If the speed with which controls are employed

increases/

increases with extensive practice in the use of controls, i.e. in solving problems, such practice will obviously be given in the course of education, and it could be presumed that the older classes in the schools and particularly the University group, would have had considerably more practice in solving problems and employing controls than the younger classes. Increase in the facility with which controls are employed, is therefore to be expected in passing from the younger to the older groups of subjects used.

It is possible that the facility factor may only extend to a certain number of controls. In this connection it is interesting that the correlation of I.B. with controlled association increases in passing from one to four controls, while the correlation of age with controlled association decreases between one and four controls. The advantage gained by age, and hence facility may fall away with the addition of controls, where the intelligence factor, i.e. ability to employ controls, comes to play its proper part.

It is to be remembered, however, that the advance of age means growth in experience factors and verbal facility. It cannot be decided from the evidence in hand whether increase in performance with the advance of age is due
(a) to growth in the "reservoir" i.e. enlargment of vocabulary and verbal facility
or (b) growth in the facility with which controls are employed.

Section VII.

The Support Given to the Hypothesis by the Results of Experimental Investigation.

The most important facts which emerge from the consideration of the results of the investigation are (1) that free association has a positive but low correlation with intelligence. It has a higher correlation with controlled association, and a higher correlation with age.

(2) Controlled association has a positive correlation both with age and intelligence. The correlation of controlled association with intelligence is lower than might have been expected but (a) it is consistently higher than the correlation of free association with intelligence, and (b) it increases in passing from one to four controls.

(3) Production controlled association tests have a higher correlation with intelligence than selection controlled association tests.

How far do these results support the hypothesis arrived at by the theoretical analysis of the relation of association and intelligence? The hypothesis as stated was "If one essential factor in intelligence is the ability to solve problems, and if success in solving problems depends upon the extent to which a subject can manage a complex group of controls, the higher the intelligence of the subject, the greater the number of controls with which he can work successfully." Hence an increasing coefficient of correlation in passing from few controls to many controls is to be expected.

The results of the experimental investigation support this hypothesis. It has been found that controlled association in its productive form has a consistently higher correlation with intelligence than free association, and shows a consistent increase in the size of the correlation between one and four controls.

The main points on which the results of the investigation fail to support the hypothesis can be accounted for by a reconsideration of the test series. The points are these:-
(1) The decrease of some coefficients of correlation of controlled association and intelligence between one and four/

four controls.
(2) The lowness of the correlation of intelligence and controlled association.
(3) The fact that the correlation of age with association is higher than the correlation of intelligence with association. This fact does not invalidate the hypothesis in any sense, but it must be explained in relation to the hypothesis.

These points may be dealt with in order.

(1) The Decrease of the Correlation of Intelligence with Controlled Association in some cases.

We have to account for the decrease of the correlation of I.B. with Controlled Association between one and four controls for Group IV (K.H.S.) in Table Ia, and for the same group, the decrease of the correlation of Absolute Score with controlled association in Table II, and in Table IV, the decrease of the correlation of N.I.I.P. score with controlled association. In all of these correlations, the measure of intelligence is correlated with production and selection controlled association tests taken together.

These points have already been dealt with in the last section. Whatever the reasons for the failure of selection controlled association tests, it is clear that they do fail, since (a) the correlation of intelligence with selection controlled association tests is lower than the correlation of intelligence with production controlled association tests. (b) It is more variable (see particularly the correlation of I.B. with selection controlled association tests in Group VI. (Table Ic) (c) Contrary to all legitimate expectation the correlation of any measure of intelligence with selection controlled association tests decreases consistently and steadily between one and four controls in Group IV (the largest and most uniform group). (d) The correlation of any measure of intelligence with selection controlled association tests is smaller than that of intelligence with free association tests.

Since the failure of the selection tests is most marked in Group IV (K.H.S.), it accounts for the decrease of the correlation of any measure of intelligence with controlled association taking both production and selection tests together, throughout this group. Further, since Group IV is the largest group, the failure of selection tests doubtless accounts for the decrease of the/

the correlation between one and four controls when all groups are taken together. (Table IV)

Where the correlation of intelligence with controlled association decreases between one and four controls, then, the decrease is accountable for by the inclusion of selection controlled association tests, since when the calculation of the correlation of intelligence with controlled association is confined to production tests, the correlation increases between one and four controls for all groups.

The failure of the selection tests is significant. Not only are selection tests less satisfactory as a means for measuring performance with controls, but most importantly, they correlate less highly with intelligence, and must be less reliable as a measure of intelligence.ϕ When it is considered that Selection is a principle on which numerous intelligence tests are based, the probable importance of this finding is clear. It may be that all tests where subjects are asked to select items which are relevant to certain requirements are less reliable as measures of intelligence than tests where subjects are instructed to produce items relevant to requirements. Such a findingvindicates the older form of examination questions as against newer forms where candidates are asked either to underline the correct answer, or to answer yes or no to the questions.

The superiority of production tests is understandable when we consider that what an intelligent thought process does is to produce something which is relevant to the gap in the consciousness of a problem, to produce, in short, something which answers requirements. The fact is perhaps clearer when we consider the solving of a problem by the production of a new idea, as, for example/

ϕ Since selection tests used on a simple level as in the present investigation are an adaptation of Cancellation tests, it is interesting that Whipple, reporting the findings of past investigators as to the relation between cancellation and intelligence, says "Earlier investigators did not reveal consistent relationship between cancellation and intelligence. Later investigators, working with more refined correlation formulas, have usually discovered a very small positive correlation." (Manual.)

example the solving of an economic, a literary or an aesthetic problem by the creation of something new, than when we consider a simple practical situation where the problem consists in the adjustment or adaptation of some already existing elements within the situation. Neverthe: less, both cases are the same. What is demanded by each is the production of a new synthesis of elements in experience. Items are released from their former contexts and welded into novel contexts.

Moreover, as we have seen, the essence of an intelligent problem-solving process lies in the fact of the initial production of relevant ideas. What comes to mind has always a comparative degree of relevance. The relevant is not selected from a chaotic mass of the primarily irrelevant. Yet this is exactly the process which series of intelligent tests frequently stress
For example:-
Underline in each line the word which should go in the parenthesis in place of the question-mark
foot; man - hoof: (?).....leg, dog, horse, boy, shoe
book; author - statue:(?).....sculptor, model, marble, man

The Opposites, Similarities, Directions, Narrative completion tests which are included in most series of intelligence tests are frequently constructed in this selection form.ϕ It seems that the principle of selection of the relevant from the irrelevant upon which such tests are based, is a principle which is involved only in a secondary way in an intelligent thought process, and has little connection with the essential principle in such a process, which is the production of the relevant.

It is at least clear that in the present investigation, the principle of selection in accordance with stated requirements has failed to answer its purpose./

ϕ It is probable that such tests could be improved if the items from which the selection is to be made are such that all are partially relevant to the gap. Even this adjustment would not affect the principle involved.

purpose. If performance in controlled association is to be measured it can best be measured if the tests are restricted to production controlled association tests.

(2) The Size of the Correlation of Intelligence and Controlled Association.

Before discussing further reasons for the size of the correlation of intelligence and controlled association, it may be remarked that the failure of the selection tests to produce other than a very low and variable correlation with intelligence must naturally affect the height of the correlation when production and selection tests are considered together. If the selection tests had been replaced by further production tests, the size of the correlation would doubtless have been increased.

As matters stand, however, if production tests alone are considered (Table Ia) it is clear that the average correlation with intelligence is not much greater than .4. This fact alone would not give the results much weight; what is important is the height of the correlation of intelligence with controlled association, even with only one control, as compared with the correlation of intelligence with free association.

In normal thought, as was seen, problems are of a very complex nature. Not only does a normal problem tend to be an inter-relational whole of problems, but the unit problems within that whole may also be complex, either in the sense that they themselves contain sub-gaps or because (a) they may contain many controls, thus presenting difficulty in the organisation of the controls to specify the gap, or (b) they may present 'experience' difficulties, as e.g. that appropriate experience is difficult to revive, or, should it be revived, it may yet be difficult to organise in such a way as to exactly fit the gap.

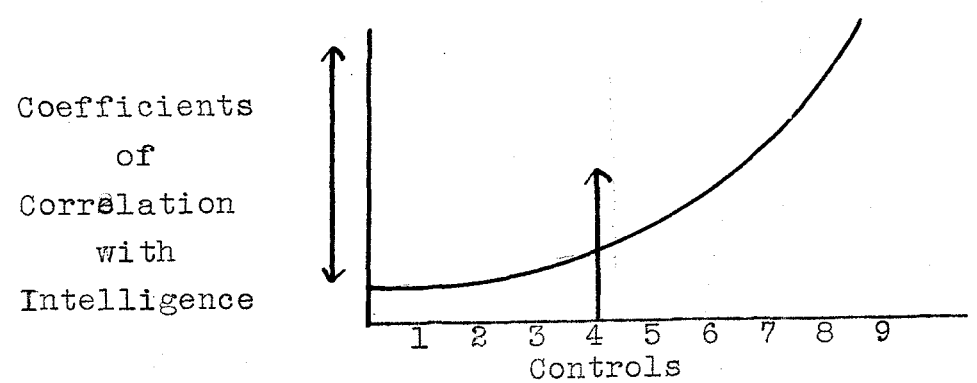
Such problems are very different in complexity from the kind of problem which is presented in controlled association tests, such as have been used in this investigation. Controlled association, as we saw, is a schematised form of problem-solving process, which is simpler even than processes of the kind frequently involved in the answering of intelligence test problems, where experience factors are eliminated in so far as possible. But in controlled association problems, both experienae and organising factors, i.e. control factors, are simplified. These tests embody fewer and generally speaking, simpler controls than would normally be found in what are commonly styled 'problems'.

To/

controlled association, since the difference between the two is measurable, whereas the difference between directed and undirected thought is not measurable.

If then, it is the case that free association even in the Continuous form has not, and cannot be expected to have, more than a low correlation with intelligence, there is no reason why controlled association in its quantitatively simplest form, and the form which is the nearest possible to free association, should have a very much higher correlation with intelligence. It is sufficient if the height of the correlation of intelligence with free association is clearly demarcated from the height of the correlation of intelligence with controlled association. In the results of the present investigation the line of demarcation is clearly drawn.

Further, it must be realised that when the numbers of the controls do not exceed four, only the lower reaches of the control of associative processes by the conditions of a problem are being examined, and the process is, as has been shown, very far distant in complexity from the process involved in dealing with the controls of most normal problems. It is probable that a high correlation between controlled association and intelligence could only be reached where a quantitative complexity of controls, reproducing the degree of difficulty involved in the organising of the controls of ordinary problems, is employed. Theoretically, it should be possible to construct a series of controlled association tests ranging from one control to several, from simple controlled association problems to intricate problems. The curve of coefficients of correlation with intelligence would then probably be of this nature:-



If this should be the case, it is clear that in this investigation, only a small section of the curve has been examined.

It may be concluded that a high correlation between intelligence and controlled association should not have been expected from the results of the present investigation. It is more important that the distinction between the correlation of free association with intelligence, and that of controlled association with intelligence, should have been marked. If a higher correlation of controlled association with intelligence is to be found, the number of controls embodied in the controlled association tests must be raised above the number used in the present investigation.

One further consideration of the quantitative aspect of the controls is indicated by examination of the introspective reports given by one group of subjects. (See Appendix) Although each additional control is objectively equal to each other control, it is clear that from the subjective point of view, the addition of each further control does not mean a corresponding equal increase in difficulty. Subjects report that working with four controls is more difficult than working with one control, but not four times more difficult. Thus, when equally graded controls are added to specify the gap, it is evident that, as subjectively apprehended, the difficulty of specifying the gap is not increased to a corresponding degree. In five out of six cases in the present results, the coefficients of correlation with intelligence are lower for the second control than the first. It may be the case that where there are not yet sufficient controls to render their organisation to specify the gap difficult, or to render the task of holding the controls before the mind difficult, the addition of a further control may only serve to "individualise" what is being looked for in such a way as to make it no more difficult to find than if the additional control were not present.

The fact that difficulty is only markedly increased from the subjective point of view with the addition of two or three further controls, provides another reason why it would prove advisable to employ a greater number of controls than that used in this investigation.

(3) Age and Controlled Association.

In discussing the relation of age to free association/

association, it was seen that such factors as verbal facility and speed of writing must help to explain the increase in free association performance with age. In controlled association, speed of writing will not play so large a part. In free association, speed of thinking runs ahead of speed of writing, but in controlled association, more particularly when more controls are in use, this would not be true to the same extent. Several subjects report that they "wrote down everything they thought of" in the controlled association tests.

Verbal facility, however, is a factor which must play a considerable part in controlled association. If it is remembered that the production of words containing certain letters must depend upon the size of what is called "explicit vocabulary",ø it is clear that the part played by verbal facility in such a test as this, must be carefully considered.

In older groups, and particularly in the groups of subjects used in this investigation, which are all composed of school children or students, it may be presumed that verbal facility has been inculcated by training as apart from initial advantages given by intelligence or particular aptitude. It is, of course, clear that intelligence does not imply corresponding verbal facility, and further, that only training of a certain kind will tend to increase verbal facility. In the older groups tested in this investigation, training has meant training in academic subjects such as languages and literature, and it would only be reasonable to suppose hence, that the further education undergone by the older groups will have meant (a) that they must have a larger explicit vocabulary (b) that they have had considerable practice in the handling of words. Such a conclusion would not affect the perceptual test to the same degree as the words test, but a similar factor enters the perceptual test.

It/

ø Explicit vocabulary means the number of words which an individual actually uses, or can use; implicit vocabulary the number of words which he recognises. For all practical purposes, the "potentially revivable" will be identical with explicit vocabulary.

It was suggested that the increase in performance in controlled association might either be attributed (a) to further practice in the employment of controls or (b) to increase in the 'reservoir' of experience. It was agreed that it was difficult to decide how far either or both of these factors might be responsible. In the perceptual test, for example, it is conceivable that the amount of experience possessed by older, as in comparison with younger subjects, should play a considerable part in increasing the correlation of age and controlled association.

Ultimately both verbal facility as employing the existence within the 'reservoir' of appropriate experience of words, and experience factors of the kind appropriate to the perceptual test, are the same kind of factor. They depend upon the amount of experience having certain appropriate qualities existing within the 'reservoir'.

Thus, in explaining the size of the correlation of age with controlled association, the two alternative hypotheses stand; either (1) in older years, a certain facility in employing controls may be attained or (2) in older years, the 'reservoir' of experience will be larger and will favour success from the side of experience factors.

On the strength of the conclusions drawn from theoretical analysis, it is probable that both of these factors are implicated, but direct evidence cannot be obtained from the results of the present investigation. It is clear that if increase in the facility with which controls are employed is to be investigated, some way must be found to discount experience factors. In the present investigation, although every attempt was made to keep the material content of the tests uniform, and to attempt to guarantee its independence of special knowledge or training, it has been shown that, even with such material, it is impossible to guarantee that the amount of potentially revivable experience appropriate to requirements can be reasonably supposed to be approximately similar in every case. The reason why this is impossible is to be attributed to the fact that the range of ages is too great.

There is no material suitable for a series of productive controlled association tests of this nature where no increase in the amount of experience appropriate to requirements can be guaranteed with advancing/

advancing age. Any specialised materials, such as geographical or literary names, have already been discarded on these grounds. Numbers cannot be used in the form of controlled association tests with graded controls. Words and percepts must also be influenced by growth of experience.

Thus, if tests embodying the principle of graded controls are to be used, and if the experience factors involved in such tests are to be discounted, there is no other way out of the difficulty than to restrict the test to ages where it may be presumed that the amount of potentially revivable experience is approximately the same for every subject. In a group of subjects of a restricted range of ages, and of similar training, it would be possible to discount factors of experience and to take the correlation of age with controlled association as measuring more nearly a possible increase in the facility with which controls are employed. Further, the restriction of the test to certain ages would render the coefficient of correlation with intelligence more reliable, for the intervention of an accidental age factor would be far less liable to occur. Any age factor accidentally intervening in the calculation of the correlation of intelligence with controlled association will invalidate the correlation to a certain extent, because it will either introduce (a) a measure of the facility with which controls are employed (which is, as was seen, something other than the ability to employ controls) or (b) experience factors. Both of these must be eliminated in a reliable measure of the ability to employ controls.

In conclusion, then, since it seems impossible to find material for the construction of controlled association tests which will not introduce experience factors into the calculation of the correlation of either age or intelligence with association, it will be necessary to restrict controlled association tests as a measure of intelligence to certain ages where
(a) the amount of potentially revivable experience may be supposed similar in quantity and quality in all subjects tested, and
(b) where speed of writing does not affect performance.

Suggested Lines of Development of Test Series for further investigation of the Hypothesis.

Since the points on which the present investigation has failed to give entirely satisfactory results/

results are to be explained by the inclusion of the selection tests, in the first place, the insufficient number of controls embodied, in the second place, and the large range in the ages of the subjects to which the tests were applied, in the third place, the test series could be emended and developed along each of these lines.

The hypothesis could be further tested by a test series which
(a) is restricted to production tests
(b) embodies further and more complex controls
(c) is restricted to certain ages (1) excluding younger subjects where speed of writing is an important factor (2) excluding older subjects where the existence of more experience influences performance.

A series of tests on such lines should prove a reliable measure of intelligence for certain ages of subjects. It may be suggested, from scrutiny of the Mental and Chronological age norms, that the most suitable age for the application of such a series of tests would be between twelve and fourteen years of age. In view of the fact that measurement of intelligence is often desired for these ages, the tests might prove of value and utility as a possible standard measure of intelligence (or of problem-solving ability) for these intensive ages.

Even if intelligence is not identical with problem-solving ability, the latter is worth testing for its own sake, for it is obvious that one reason why individuals are subjected to intelligence tests is the practical one that it is desirable to know what reasonable expectation exists that they will prove able to solve the problems they are called upon to solve.

Appendix A.

Introspective Reports.

A questionnaire of the following nature was presented to each of the subjects who were individually tested and retested (3rd Preliminary Experiment)

(1) Did you find the performance of the tests easier on this occasion than on the former occasion? What factors accounted for the difference (if any)?

(2) Did you find the tests with four conditions in every case four times more difficult than the tests with one condition? Did you notice any differences in individual tests with regard to this point?

(3) State your method of selecting each example which fulfilled the conditions. For example, did you recall each one of the set of conditions to mind before cancelling each item?

(4) In the first Words test (Monosyllables) - and in the Perceptual test, did what came to mind in answer to the requirements fulfil all the necessary conditions, - or did you find it necessary to examine the ideas which came into your mind to find out whether they really did satisfy the given conditions? Had you any feeling of searching about among irrelevant items for what was relevant to the conditions?

(5) How often had you mental images of the things you wrote down? - e.g. in the Perceptual test as compared to any other test?

Some Typical answers to Question (1).

The majority of subjects replied that the tests seemed easier on the second occasion, because of their familiarity with the procedure, or because they remembered something of what they had written before. No subject suggested that the actual performance was easier. For example (1) "slightly easier. There was no greater ease in actual performance. It was rather because of a certain familiarity with the procedure".

(2) "Easier because I remembered the kind of thing I had to do."

(3) "Much easier because (a) I knew what to expect/

expect and was subconsciously thinking about the test before I came for it (b) I had the last list of words I gave to fall back on."

(4) "Some tests were easier because I had thought about them in between. Writing down lists of words was more difficult."

(5) "Much the same. Numbers tests were easier owing to recollection of conditions. I also remembered some words I gave in the Words test before."

(6) "Everything seemed perfectly fresh almost as though I had never done it before, but later I began to remember what I had put down before. I felt I almost knew what they were but couldn't quite remember them."

(7) "I really don't think I found the tests any easier this time."

(8) "I did not find the tests easier in any way."

Question II.

95% of the subjects declared it was not four times more difficult to work with four conditions than to work with one condition. It is interesting that several subjects stated explicitly that the four conditions seemed to become one complex condition.

For example (1) "The four conditions fell into one main condition in my mind."

(2) "As soon as I had understood each set of conditions I never thought of them separately."

(3) "Tests with four conditions were certainly more difficult than tests with one condition, but I did no find them four times more difficult."

(4) "Tests with four conditions may have taken more time, but it wasn't a matter of difficulty."

(5) "Tests with four conditions were not more difficult in every case. In the numbers tests, the more conditions there were, the easier it seemed to be to tell at a glance what examples fulfilled them. The Letters test was the exact opposite."

(6) "Tests with four conditions were not four

times/

times more difficult than tests with one condition, except in the case of the Numbers Tests where the difficulty was in proportion to the number of conditions."

Question III.

The answers to this question give evidence of the organisation of all conditions into one complex condition. For example (1) "I did not remember each set of conditions one by one, but all together and as a whole."

(2) "I kept a notion of the conditions before my mind. It was not necessary to remember each one explicitly."

(3) "I remembered the rules in a pattern and applied that to each case."

As to the method of selecting items, the following two answers are representative.

(4) "The method of selecting examples fulfilling one condition is obvious. For two conditions I looked to see if one was observed; similarly in the case of three or four conditions, although here the selection seemed much more intuitive."

(5) "I got a picture of what the thing would look like, and so did not have to think of each condition separately.

These last answers seem to demonstrate very well what was referred to as the apprehension of the gap as specified meaning implicit knowledge of the kind of thing required.

Question IV.

Although many subjects failed to give an answer to the point on which I was most anxious for information, among those who did, there seemed a general agreement that what came to mind was characterised by relevance.

For example (1) "In the Words test, what came to mind first fulfilled the conditions."

(2) "I believe I wrote down all the ideas I thought of - probably because I seemed to have very few ideas/

ideas at all. I was never conscious of searching about for words. They all seemed to be connected either by sound or by eye."

(3) "In doing the Words test at first there was no feeling of searching about among words for the right ones. Analogy played an important part in this test and sometimes when analogy failed, a wrong word would come to mind, but the rejection was immediate."

(4) "There was no searching about among a lot of things for the right ones. There was no irrelevant matter, and little relevant."

Question V.

This question was not put so much with the idea of investigating imagery, as to discover whether any subjects would suggest by what means they did consider that ideas entered their minds in answer to the consciousness of a problem. There was considerable disagreement.

For example (1) "I found all the white objects by imagery, but in the other tests I had no images."

(2) "I always had images of nouns and adjectives in the Words tests, and in the Perceptual test."

(3) "I had very vague images but I didn't know whether they were images or memory. I wondered at the time."

(4) "Images were vague. I think I found everything by mental association of ideas."

(5) "I definitely found the items in the Perceptual Test by mental imagery. Some clear images of things fulfilling the conditions came to mind at once, but after the first few again, I found it necessary to call up images separately, for my mind was more or less blank."

Appendix B.

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