

CREATIVE PROCESSES

IN

YOUNG CHILDREN

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- CHAPTER I -

INTRODUCTION.

"Making allowances for human imperfections, I do feel that
..... the most valuable thing in life is possible - the develop-
ment of the individual and his creative powers".

A. Einstein.

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Enthusiasm for developing creativity in the individual has been remarkably widespread - at least in America - over the past twenty-five years or so. The armed services, the arts and sciences, educational institutions, businesses and industries are recognising to a greater and greater extent, the urgent necessity of developing this relatively neglected aspect of people's personalities. Their reasons differ, of course, and usually the welfare of the individual himself is not the main concern. This is perhaps fortunate, as advances made on philanthropic grounds alone have never progressed very rapidly. In business and industry, new ideas are urgently needed for survival - this was especially evident after World War II which was, in the end, really a battle of ideas. The importance of this implication has not decreased with distance in time from that conflagration, indeed, individuals in the armed services are probably the people most deeply involved in and the most concerned with the problem of developing creative thought. "We are in a mortal struggle for the survival of our way of life", writes Guilford (53). "The need (for developing creativity) is a national crisis", says Anderson (1).*

* Words in parenthesis are the writer's own.

The power of creative thinking should never be underestimated. Just a few creative minds can change the world - and it must be pointed out that creative thought need not be good, it has no inherent morality - the nature of the change depending on the nature of those "few creative minds".

Often closely related to military interest in creative thinking, is the interest of the sciences. Technical ascendancy is required to ensure national and ideological supremacy. Although it is somewhat short-sighted to declare, "The twentieth century represents the zenith of scientific progress" (Shapiro, 108), this century certainly has seen and will still see tremendous technical and scientific advancement at all levels. Sir Charles Snow has pointed out ("Science and Government") that between 35% and 45% of Russia's top men have some technical and scientific training, whereas it is doubtful whether the proportion in the West is a quarter of this. As a result, the Russians have often made correct choices, e.g. developing the lithium bomb and giant rocket boosters, instead of wasting time and energy (as the U.S. did) on "technological dead-ends" such as tritium bombs and air-breathing missiles. Writing in 1961, Arthur C. Clarke (21) said, "If in November 1967, there are only Russians on the moon to drink a toast to the fiftieth anniversary of the Revolution, they will have won the solar system and theirs will be the voice of the future. As it will deserve to be". How much, then, does the U.S. owe their programmes for developing the creative capacities of individuals in schools, universities and scientific research institutions, for their "giant leap for mankind" in 1969?

The space age demands rapid readjustment in all people if individuals are to cope with such quickfire changes and "miniature" as well as "giant" leaps in progress. Of course, this means not only technological advances but, more important, the social implications and impact of such progress. We need to revise, change and adapt to alterations or our culture will perish, but if there is one thing most people resist with all their might, it is change and adaptation (Rogers, 104).

There is distrust, fear or antipathy towards new ideas and, therefore, towards creative thinking. Throughout history, there has been a time-lag between the creation of a new idea and its acceptance by society. One wonders, indeed, how much knowledge has been completely lost, perhaps never to be rediscovered, because people and their societies have felt threatened by unorthodox ideas.

It is never easy to live in an age of transition and constant change - an old Chinese curse says: "May you live in interesting times" - but we must learn to do so. The only place where this ability to tolerate and seek change can be taught on a large scale is in educational institutions, yet the attitude in many schools and other places of learning is in complete opposition to that needed to encourage creative thinking and its associated attitudes and values. Lowenfeld (76) states that the present educational system emphasises learned, factual information, but largely neglects to develop the ability to question, seek answers, think anew and discover for oneself. In schools, as in every other sphere, investigation, experimentation and free-wheeling thought, as well as discipline, laws and regulations are necessary.

Apart from the consideration of the applications of creative thinking in schools, industry, science, art and warfare, there is the vital consideration of the individual himself. Most people, as William James says (in Barron, 2), live in "a very restricted circle of their potential being". To neglect the problem of creativity is to neglect an integral and vital part of every individual. Creativity is an act in which not only a thought is born, but also "a moment which gives meaning to the act of appreciation" as Bronowski said at his M.I.T. address. A man cannot handle paints, or languages, or electronics, or the symbolic concepts of physics or mathematics, he cannot even stain a slide without instantly creating within himself a sense of pleasure, a sense of exploring his own activity - this lies at the heart of creativity (Styles, 118).

Only if the individual is aided in developing his abilities and his personality to the full at school, at home, at work and at leisure, can he approach the ultimate goal of self-fulfilment.

The phenomenon of creativity is being studied more and more extensively in the United States of America and research has covered quite a wide field - adults, children, adolescents, psychotics, business men, scientists and artists. In Minnesota, Torrance has concentrated on the development and expression of creativity in different cultures and on the construction of a special battery of creativity tests, while Guilford and his associates have attacked the problem from a psychometric angle to try to discover the basic, underlying traits in creative thinking. Still others, such as Barron, Cattell and Drevdahl have focussed attention on important personality variables, while others have been content with armchair model-building and theorising. In Southern Africa and throughout the rest of the world, the subject of creativity has been almost totally neglected and, therefore, there are numerous virtually untrodden paths of research waiting to be explored. Creative processes are of particular interest and importance in children because in children we have the purest processes, still relatively undistorted by years of formal, rote learning both at school and in the larger social environment. As Hillman says (62), the child is "inherently an image for the creative" - he grows, learns and creates language and perceptions. Children's eyes are not yet shut to everyday, "obvious" ideas and objects: they are capable of seeing things afresh with "new" eyes. Surely we can learn much from them! Does the young creator work in ways similar to those found in his elders? Are the same types of creative processes - established in adults and adolescents - present ten or more years before? As will be seen in Chapter II, it is highly likely that the crux of creativity lies in perception. What roles do perceptual processes play in creative processes in the child's early years?

The more we can discover about creative thinking, the better will we be able to aid its development at all age levels. How much is lost as the child grows up? What happens to the fresh, open-eyed curiosity many children possess? This particular study has concentrated on establishing some ideas of the intellectual aptitudes or processes important in creative thinking in young children and on investigating the role of some perceptual processes in creativity - this has been at the cost of ignoring other more global (and usually less experimental) approaches to creativity, especially the study of personality variables. In this, the writer is aware of the limitations of studying only some aspects of the field (which is inevitable) and of the value of concentrating on one particular approach at a time. Only when the phenomenon of creativity has been analysed in detail from all angles, can we hope to achieve anything approaching a true, integrated picture of creative behaviour. Possibly the most important aim is to interest at least some educators from all levels of education, and to encourage them to reconsider and, perhaps, to creatively reorganise their approaches to education.

"One of the heaviest responsibilities in education is to do justice to exceptional minds, remembering that they may emerge in any place, at any time and in any body". (G. Highet; "The Unpredictable Intellect").

- CHAPTER II -

THEORETICAL CONCEPTS.

CREATIVITY - THEORY AND RESEARCH.

"There is nothing more disenchanting to man than to be shown the springs and mechanisms of any art and yet, if we had the power to trace them to their springs, (we would find) indications of a delicacy of sense finer than we conceive and hints of ancient harmonies in nature".*
(Stevenson, in Spearman, 115).

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As highly valued as creativity is among human qualities, it has proved to be (quite expectedly) elusive to systematic inquiry. Just twenty years ago, J.P. Guilford in his Presidential Address to the American Psychological Association, complained about the appalling lack of literature on the subject of creativity: today the position has improved vastly, so that there now exist hundreds of books and articles on the subject by a growing number of authors. There is now an appalling amount of literature! The slow start the study of creative thinking received can be attributed to several sources, not the least of which in the antipathy with which most people consider anything new. Many erroneous ideas about creativity also contributed towards a sluggish beginning to serious study and although these ideas were put forward centuries ago, their influence can still be felt in the twentieth century. One ancient philosophical theory attributed creativity to divine inspiration. This view was expressed by Plato (99) who wrote: "God takes away the minds of men and uses them as his ministers, just as he does soothsayers and goodly seers in order that we who hear them may know that it is not they who utter these words of great price when they are out of their wits, but that it is god himself who speaks and addresses us through them". Even today, Sorokin (114) has stated that the greatest creative achievements are the results of a "super-

* Words in parenthesis are the writer's own.

sensory-supernatural power" - ultimately unknowable. This type of admirationist fallacy "erects a sanctuary around the venerable area of creativity" (Hacker, 57) so that it cannot be understood, criticised or evaluated.

From Aristotle to Freud, people have believed genius to be balanced by some affliction and have attributed creative thought to insanity or neurosis. "The lunatic, the lover and the poet are of imagination all compact", Shakespeare wrote in "A Midsummer Night's Dream". The idea that creativity has its roots in pathological processes has persisted. Kretschmer (73) was a firm subscriber to this belief and established his views on the basis of his postulated relationships between temperament and physique. Gifted people, he said, have over-sensitive nerves and are moody, "inconsiderate and haughty" with many odd personality traits. Even today, creative people are described as "touched" if their behaviour deviates from accepted norms. It is interesting, as well as amusing, to note that Afferbeck Lauder, in his lexicon of modern Australian language usage, defines "off his rocker" as "psychopathic, neurotic, psychotic, slow, quick, eccentric, imaginative, introspective, creative or in any way different".

Yet another philosophical theory sees creativity as intuitive genius which cannot be taught or developed. According to this theory, creative people are a rare and different breed - born, not made, and set on a pedestal way above the understanding of lesser mortals. These views tended to render any study of creative processes impossible: creativity just existed and was beyond investigation.

Apart from the limitations of theories, scientific study of creative thinking has been hampered by a misdirected sense of democracy and equality among men. These views have tended to blind people to the fact that men are not equal in ability but, in fact, differ vastly from one another. Consideration of creative abilities has, at times, been shut out and ignored completely: now it has been welcomed back with open arms.

After World War II, the sudden demand for knowledge about creativity caught psychologists unawares, but they have been rapidly attempting to catch up the backlog of work in this field.

No single, universally-accepted theory of creative thinking has come out of twenty years of sustained research on the subject, though this is hardly surprising. Consequently there is no one, universally-accepted definition of creativity either, since definition is linked closely with theory. However, even a brief review of the many available definitions shows several similarities amongst them. Most definitions mention some type of new or unusual product, e.g. Flieger (36) says the creative person "manipulates external symbols or objects to produce an unusual event uncommon to himself and/or his environment". Mednick's (86) associative definition says: "Creative thinking consists of forming new combinations of associated elements, which combinations meet specific requirements, or are in some way useful". Hacker's (57) definition follows similar lines. Although Ghiselin (46) sees creativity as a process rather than as a product, the element of newness is still present, as he says creativity is "the process of change, of development, of evolution, in the organisation of subjective life". Some people have developed definitions which surely can be intended only for one field of creative thinking. This is quite a wise choice in view of Guilford's findings on creative aptitudes which will be considered later, though it is not known whether the originators of such definitions had these in mind. For example, Shapiro's is essentially a definition for scientific work (108): "Creativity is a potential capacity by means of which an individual may produce something original that serves to fill a gap in a particular human endeavour. The degree of creativity expressed can be roughly gauged by the magnitude of the affect that the product has on the field, in the sense of the changes introduced into the traditional state of knowledge or modes of expression formerly characterising that field". The writer's main objection to this and similar definitions, is the insistence on a product that is entirely new to

society, that changes or re-structures knowledge and, moreover, that is useful in some way. Thus true creation must be creatio ex nihilo. This is reminiscent of the old "genius" idea which saw creative thinking as the prerogative of a chosen few, for few people can hope to make their products fit the stringent requirement mentioned above. Ghiselin's theory of two different levels of creativity is more cognisant of the real state of things: at one (low) level, an existing idea or product is improved or advanced; at another (high) level, something completely new occurs. Maslow (79) and Kuhn (75) have similar ideas. Other investigators are even less stringent in their demands for useful products as proof of creative thinking. Guilford (52) has stated that (a) "Creative productivity" does not mean socially useful products, for science is not interested in socially-oriented values, and further, (b) an individual may be creative and yet not be creatively productive, i.e. he can be potentially creative. One definition that certainly tries to meet the multi-dimensional view of creativity is that set forward by Torrance (129) who says creativity is a "process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies and so on: identifying the difficulty; searching for solutions, making guesses or formulating hypotheses about deficiencies; testing and re-testing the hypothesis and possibly modifying and re-testing them; and finally communicating the results". Intuitively, novelty and originality seem to be the crux of creative thinking, probably because they are the most obvious aspects, having the most implications for society and the most impact on the individual because the product (or process) is new and unexpected. The hallmark of creative enterprise, says Bruner, (10) is "an act that produces effective surprise". Ability to evaluate situations or put forward many ideas is not as socially valued nor does it have as many social implications as the introduction of something new - people have tended to forget the hours of work of Einstein, Poincaré, Picasso, Conrad, et al., in the blinding light of the startling originality of their products.

To clarify the position, it will be useful to consider what creativity is not. It is not unitary but complex and multi-variate; it is not synonymous with intelligence; it is not limited to a few outstanding people, nor to any one age group, sex, culture or field of endeavour - creativity belongs to all humanity; it is not to be equated with the arts or with genius and it is not just a collection of abilities, but includes personality, motivational and environmental constituents as well.

Investigators may fracture the picture of the creative individual and isolate aspects of him in order to concentrate on one thing at a time, but this^{is} artificial simplification, eventually he must be "put together again". The most popular approach to the study of creativity is through the study of the products of creative thought, partly because it is usually the easiest way, but also because it seems that for creative thinking to be recognised at all, some sort of auditory or visual evidence is required. A person may be creative "internally" as Barron (4) suggests, but if we have no evidence of such^a type of creativity, it is as if it had never been. As far as the evaluation of products is concerned, the statistical infrequency of a product has most often been used as an indication of its unusualness (Guilford (50); Torrance (129); Barron (45); etc.). This, however, is not enough, a response may be infrequent and also totally irrelevant to the situation (e.g., one could say $2 \times 2 = 5,980,752$) and, furthermore, two responses may be infrequent and relevant and yet one has involved "seeing the situation in a different way" to a greater extent than the other. (e.g. using a brick (a) to prevent a car rolling and (b) for practising karate on). A very important and surprisingly simple point to remember in recognising the truly novel response, is one's reaction of surprise or "shock of recognition" (Bruner, 10). Surprise requires unexpectedness and interest and takes one beyond common ways of experiencing the world. It must also be related to something that matters, i.e. it must be relevant. We probably do not notice the trivially unexpected and thus "surprise is only for privileged, prepared minds" (op. cit.).

This is one interesting reason why many innovations are not always accepted by society.

With these thoughts in mind, the writer offers her own definition of creativity. The many that already exist do not recognise all the points discussed above. It is realised that all definitions are in some way limiting, but at the same time, "creativity" means many different things to different people. It is well to set forward some sort of framework which can be amplified at will when necessary.

"Creativity is a process (exhibited by all individuals to some extent) involving several relatively independent thinking abilities and associated personality attributes, which results in products characterised by some degree of novelty as measured by statistical infrequency in the group of individuals concerned and by the degree of restructuring of and relevance to the situation under consideration".

A longer definition could detail the "thinking abilities" and "personality attributes" mentioned - these will be discussed throughout this chapter.

It has been said that when one person is not sure of what he is saying and his hearer is even less certain, then they are talking psychological theory. This rather harsh indictment is not, it is hoped, too relevant to creativity theory. In evaluating the worth of theories, it must be remembered that they are theories and not laws. A theory merely gives a frame of reference within which one can work and, therefore, must be expected to be changed, modified, re-interpreted or thrown out completely as new thinking and research progresses. An inadequate theory is better than no theory because it can at least be the source of hypotheses which can be proved or disproved. Theory formulation is, of course, also a creative activity. A phase of creative activity which is just as important as the birth of ideas, is the death of ideas (Henle, 59). An individual outgrows his ideas: a science may do the same. Here, too, it must again be noted that different theorists may choose to concentrate on one

particular aspect of creative thinking, e.g. personality, aptitudes, or the influence of the environment whereas the theory that attempts to integrate all approaches is probably the most worthwhile.

Most of the philosophical theories of creativity have already been mentioned, though two other ideas must be included here. The first is the conception of creativity as a life force which arose as a consequence of Darwin's evolutionary theory. Life is creative because it organizes itself and engenders novelty (Kneller, 69); man himself has the power to initiate novelty and impose structure and meaning on the apparently unrelated. The second is the theory that creativity is a cosmic force and is thus a manifestation of a universal creativeness that is present in everything: an eternal source of nourishment and regeneration (Hillman, 62). Creativity operates to (a) maintain what it is, i.e. it is continually renewing existing elements and (b) produce new, unprecedented forms. Note that none of the philosophical theories attempt (wisely, some might say) to explain how creativity functions.

In the nineteenth century, the dominant school in psychology was that of Associationism, a Newtonian-type psychology which reduced all mental contents to elements and combinations of elements. Its modified presence is still with us today. According to this view, creativity is reduced to a trial-and-error problem, with a person summoning one combination of ideas after another until the "right" combination occurs, or the person gives up. There are several objections to this approach, e.g. why does one person come up with one combination while another person does not? How is the correct solution chosen? Trial-and-error thinking is a long process, yet creative thought is often sudden and spontaneous and, furthermore, creativity does not rely only on old associations and knowledge: creative people do not "walk the paths of past associations" (Kneller, 69).

Mednick has attempted to bring associative theory up to date and make it more presentable. The main difference

between classical associationism and Mednick's associationism is that, in the latter, creative thinking is the ability to associate not just any concepts, but concepts that are remotely connected and "the more mutually remote the elements of the new combination, the more creative the process or solution"

(Mednick, 86). His definition of creativity has already been stated on page 8. Ideas are brought together by:

- (1) Serendipity, i.e. "the accidental, contiguous appearance of appropriate stimuli" (op. cit.).
- (2) Similarity of elements, e.g. similarity of form, sound or colour. Alliteration in writing would be an example of this type of combination.
- (3) Mediation of another element, i.e. an element Z may be closely related to two remotely associated ideas X and Y.

Individual differences are explained in terms of associative hierarchies which may be flat or steep. This is illustrated as follows:- an individual is asked to make associative responses to the word "table". The person who tends to restrict his answers to stereotyped responses (e.g. chair), has a steep-sloped associative hierarchy as shown in Fig. 1. He has high "associative strengths" to a few conventional responses, then his associative strengths for other words drop rapidly. Another individual has a flatter slope because, although the conventional response is his strongest, it is not very dominant and, in addition, he has relatively high associative strengths for less stereotyped responses - where the remote associations needed for creative solutions are most likely to be found. Thus the more creative individual will be characterised by less stereotypy. This prediction was supported in a study by Mednick, Gough and Woodworth (Mednick, 85). Other predictions are that (a) a high-creativity subject will respond relatively slowly and steadily, giving many responses, (b) a low-creativity subject will respond faster but will give fewer responses, (c) a high-creativity subject's dominant responses may be strong but quite different from the usual dominant responses, (d) the low-creativity person may create one unusual response and

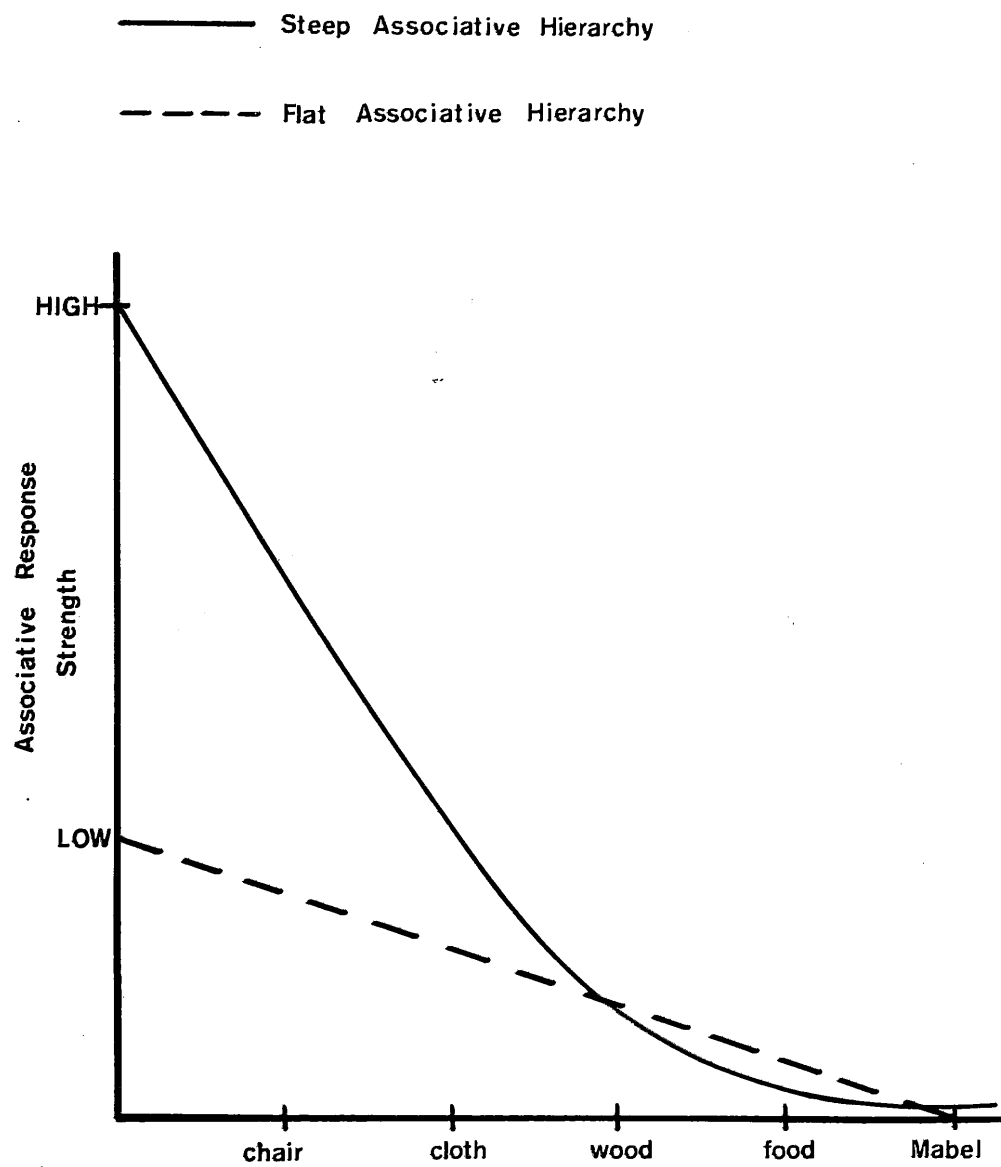


FIG.1 Associative hierarchies around
the word "table."

any other responses will resemble the first, whereas the high-creativity person will produce many different approaches to creative expression, (e) the greater the number of times an individual has attained solutions in a particular manner with particular materials, the less likely he is to attain a creative solution, i.e. he develops a steep hierarchy because he "knows" the meanings of the elements involved and the answers to the problems. Thus people should not work in one specific field for too long and a newcomer to a field is more likely to achieve a creative solution, as long as he possesses the necessary basic knowledge.

The notion of hierarchies still does not explain why there are individual differences. Mednick (85) maintains that "previously learned or innately predisposed methods of approaching problems will influence the probability of a creative solution", e.g. if associative elements and their combinations are concrete representations of aspects of a problem, a person with a "perceptual" approach will be more likely to attain a creative solution, whereas a person with a "conceptual" approach will achieve better creative solutions if the elements and combinations cannot be represented in a concrete way. Mednick admits that these factors of different cognitive styles are poorly defined. As far as the choice of a particular combination is concerned, Mednick says the combinations tried are limited by the problem, i.e. "the imposed requirements of the problem may be viewed as part of the requisite elements in the situation" and hence a person does not have an infinite number of elements to choose from (op. cit.). Mednick has suggested a measure of individual differences in creativity called the Remote Associations Test (PAT) in which groups of three remotely associated words are presented to the subject who then has to find one word which serves as a connecting link amongst the other three, e.g. rat/blue/cottage, for which the connecting word is "cheese". This test has proved fairly worthwhile in several studies, e.g. Mednick (84); Karp (67); Kowalski (71); Crutchfield (25); but not in others, e.g. Datta (26).

Mednick's theory has some basis in anecdotal reports from creative people, e.g. Poincaré (100) reports that in his discovery of Fuchsian functions, he combined two different kinds of mathematics which happened to have a similarity in methods of transposition. He writes, "Ideas rose in clouds: I felt them collide until pairs interlocked, so to speak, making a stable combination". In his letter to Hadamard, Einstein (33) wrote, "The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be voluntarily reproduced and combined this combinatory play seems to be the essential feature in productive thought".

Criticisms still remain. Firstly, often the problem is not even defined and one of the steps in creative thinking is to formulate the problem and ask the right questions. Secondly, intuitively, an associative theory appears shallow: that there is more involved than the mere association of remote elements has already been mentioned. Thirdly, the RAT seems to involve "convergent" thinking, i.e. there is only one correct response which the experimenter already knows - this is hardly creative thinking. And lastly, people with steep hierarchies may produce rapidly up to the end of any time limit a test may have, while the low-gradient person will lag, making the former type of person's results look better. (Wallach and Kogan, 134).

Traditional logic has proved barren as far as accounting for creative thinking is concerned, although some psychologists have tended to equate all types of thinking with the ability to carry out the operations of logic correctly and easily. Even inductive logic, with its emphasis on collecting facts and observing the relationships between them in order to set up general assumptions, is hopeless as a basis on which to explain creative thinking. Logic implies rationality and reasonableness, but creative thought does not proceed rationally in neat, interlocking, ordered steps. Even in science, which too often is seen as the ultimate in applied logic, this is not true: as Shapiro (108) says, "the popular image of the scientist as a cold logician, is misleading".

Taking a step forward from traditional logic, we can ask the question: is creative thinking a form of problem solving? Some psychologists (e.g. Newell, Shaw, Simon (95); Thurstone (124)) see it as a type of problem solving marked by novelty, persistence and difficulty in formulating the problem. Indeed, in one sense, every situation can be considered a problem and every decision a solution and certainly some problem solving is creative, but to say all creative thinking is a problem solving activity, is questionable. Hilgard (61) has pointed out that in much of creative thinking, there are no "correct" answers and the "solutions" are better viewed in the light of their originality rather than their correctness. Many creative productions of literature and art defy description according to ordinary formulae of problem solving. Newell, Shaw and Simon (95) say that problem solving is creative to the extent that one or more of the following conditions are satisfied:

- (1) The product of such thinking is novel and has value for the thinker or for his culture.
- (2) The thinking is unconscious and requires modification or rejection of accepted ideas. Hence, the importance of personality is realised here, e.g. persistence in following one line of thought will act unfavourably against creative problem solving. The ability to break direction of "set" is important and people who are unable to do this, "freeze" the meanings of objects and situations, displaying what Duncker (31) has called "functional fixedness".
- (3) The thinking requires high motivation and persistence.
- (4) The problem as initially posed, is vague and ill-defined so that part of the task is to formulate the problem.

In support of their theory, they point out that (a) these processes agree well with Wallas' (135) account of creative thinking, (b) there is a correlation between creativity and intelligence, especially when considering scientists and (c) computers (working according to the principles of problem solving) can discover proofs for theorems, play chess, design engines, compose music and recognise visual patterns. An objection here is that

such programs are not exact simulations of thinking, in fact, only the products from these programs and from human creative thought are similar: the processes are far from similar, e.g. a computer will eventually come up with the name "Brand X" for a product if it is programmed to take cognisance of spaces as well as letter combinations, but only as one of thousands of letter combinations, i.e. it would go through a kind of trial-and-error problem solving and again lack the spontaneous, irrational element in creativity.

The Gestalt theorists - of whom Wertheimer is the most notable - formulated a thought-provoking theory of creativity within the framework of their well-known perceptual theory. Wertheimer (who accuses associative theorists and traditional logicians of cutting thinking processes to pieces) sees the creative situation as a transitional process of structuring "Gestalten" or wholes (138). S (the situation) is seen as structurally incomplete or deficient and the forces and tensions inherent in the situation set up similar stresses in the individual's mind so that he tries to complete the situation and find structural harmony. The essential features in creative thinking are: (1) realising the structural features and requirements in a situation and (2) changing the situation in the direction of structural improvements by (a) viewing the gaps and disturbances, (b) seeking the inner structural relations among those gaps and the situation as a whole and (c) indulging in structural grouping, centring and transposing, again considering the whole situation and looking for structural harmony and truth. We need to know the laws governing "grouping" and "transposing" activities and governing the relations between the parts and the whole of the situation, i.e. what constitutes the "good" Gestalten? There is a desire in a person to proceed from an unclear, inadequate relation to a "clear, transparent, direct confrontation" (Wertheimer, 138). This is interesting when we consider Poincaré's (100) ideas on the basis on which solutions are accepted as the best ones. They are, he says, "those which

affect most profoundly our emotional sensibility". He continues, "only certain ones are harmonious and consequently at once useful and beautiful". This seems similar to Gordon's (47) "hedonic response" to solutions, which is a feeling of "being right" and taking pleasure in the elegance of solutions to problems.

One criticism of Wertheimer's theory is that often the situation or problem does not exist before the individual formulates it, but Wertheimer says the person has an "envisaged Gestalt" and that goals are always present even though they may be vague. If this is the case, the individual proceeds to crystallise the central idea as well as its parts, at the same time.

Many psychologists have maintained that **psychoanalytic** theory contributes the most useful and acceptable explanation of creativity. The basis of the **psychoanalytic** theory of creativity, as put forward by Freud (37), is as follows:- creativity has its genesis in conflict in the unconscious and this is resolved by unconscious forces. If the resolution reinforces an activity intended by the ego, it emerges as creative behaviour, otherwise it is repressed or results in some type of neurosis. The role of the unconscious was considered to be of prime importance, as indicated by Sinnott (111) who wrote, "here (in the unconscious) the organising power of life fashions into orderly patterns the floating fantasies of the unconscious mind. Here, if anywhere, new patterns may be created".* Behaviour without the influence of unconscious forces is rigid and habitual, i.e. there is too much control over the unconscious contents: on the other hand, if there is too little control, bizarre responses and behaviour can result. The function and effect of creativity, then, is the discharge of emotion resulting from internal conflict and thus creativity can prevent neurosis and psychosis and vice versa. At the same time, creative behaviour is seen as "a continuation and substitute for the play of childhood" (Freud, 37) and so derives from the elaboration of fantasies and ideas related to day-dreaming and play which are, of course, part of the contents of the unconscious. Jung (66) saw the

*Words in parenthesis are the writer's own.

unconscious as the source of imagination, pointing out that the "unconscious images" found in psychotics are also the raw material used in imagination. "Though such imagination is present everywhere, it is both tabooed and dreaded, so that it even appears to be a risky experiment or a questionable adventure to entrust oneself to the uncertain path that leads to the depth of the unconscious Unpopular, ambiguous, and dangerous, it is a voyage of discovery to the other pole of the world". (op. cit.) In 1936, Jung described what he considered to be the five basic, instinctual groups: hunger, sexuality, the drive to activity, reflection and - a creative instinct. His viewpoint is actually vastly different from Freud's, for, although these instincts are subject to interrelations with each other, they are not responsible for each other - thus sexuality does not cause creativity, etc. For Jung, creativity is the whole essence of man (see Hillman, 63) and thus, in therapy, "we must follow nature as a guide, and what the doctor then does is less a question of treatment than of developing the creative possibilities latent in the patient himself" (Jung: Collected Works 17).

The neo-Freudians have altered Freud's original views, the main alteration being the shifting of the origin of creative behaviour to the pre-conscious. Ernst Kris (74), the leading exponent of ego psychology, has put forward his theory of "regression in the service of the ego" which many psychologists have used, notably Barron (2,4) in his studies of the creative personality. In Freud's theory, the pre-conscious decided what material should or should not pass from the unconscious to the conscious. Kris however, assumes that unconscious material can become pre-conscious and vice versa, i.e. a pre-conscious process can assume id energy and be drawn into primary process which is an "energy system of a free and mobile nature" consisting of unneutralised drive striving towards immediate discharge (Shapiro, 108). Primary process is marked by spontaneous, uninhibited, uncontrolled behaviour. Quoting from Kris (74) "ego regression (primitivisation of ego functions) occurs not only when the ego is weak - in sleep, in

fantasy, in intoxication and in the psychoses - but also during many types of creative processes. This suggested to me years ago that the ego may use the primary process and not be overwhelmed by it". The ego must be secure and flexible enough to venture into the unconscious and return safely: the creative person is not dominated by the unconscious, he uses it.

The preconscious is preferable to the unconscious as a source of creative activity because the preconscious can gather, compare and re-arrange information (essential aspects of creativity, which is not as haphazard as many believe) and, furthermore, unconscious processes may actually inhibit flexibility because they are linked to repressed conflicts.

Quite a substantial amount of research has been done in efforts to find empirical support for psychoanalytic theories of creativity. Investigators have tried to assess the roles of primary and secondary processes in creative thinking, i.e. the amount of fantasy and lack of reality as opposed to the amount of realistic, rational, logical responses in people's behaviour. Barron (2), using the MMPI, Early Anal and Late Anal Scales of the Personal Preference Scale, the Impulsivity Scale of the California Psychological Inventory and Guilford-type creativity tests, found that his more creative subjects

- (1) had more contact with unconscious material and so exhibited fantasy, imagination and reverie,
- (2) had strong egos and hence, as the distinction between the self and not-self was secure, the distinction could be allowed to disappear for a time, i.e. the ego could allow regression and the expression of impulses, secure in the knowledge that it could correct itself,
- (3) were more complex psychodynamically, their insight and awareness was great, their life experiences broad and deep,
- (4) rejected suppression as a mechanism for the control of impulses and expressed themselves in a "sort of indiscipline" (Barron, 2).

Originality, Barron says, will be greatest where suppression is at a minimum and where a degree of disintegration and disorientation can be tolerated while a higher level of integration is reached. Barron's other findings will be discussed later in the section on personality. If the creative person can allow the ego to "detour through regression toward adaptation" (Schafer 106) and, far from walling off unconscious contents, actually exhibits them, we would expect, for instance, the non-creative male to repress any characteristics which might be considered feminine and the creative male to do the reverse. Mackinnon's (77) finding supported this prediction. Using MMPI, he found all his male highly-creative groups obtained their highest scores on the Mf (feminine) scale and on this basis he says "the greater femininity of the creative male suggests that in him there is greater openness to and acceptance of feeling and emotion, a more sensitive intellect and more far-ranging interests, including many which in the U.S., would be thought to be feminine". He also found evidence of greater psychic turbulence in the highly-creative groups which suggested, again, a lack of defensiveness, a complex personality and an openness to experience. Cattell's (18) and Guilford's (53) research showed many similarities to the above findings. Myden's (94) study using the Rorschach projective test, showed creative subjects (twenty artists) and non-creative subjects could be distinguished by (a) greater use of primary processes, (b) more integration of primary and secondary processes and (c) less repression.

Although there seems to be a lot of support for predictions made on the basis of psychoanalytic theory, we can, of course, question the explanations the theory puts forward to account for creative behaviour. Are unconscious, preconscious and ego processes and the notion of the sublimation of unconscious impulses and conflicts into creative and other types of behaviour necessary? As with problem solving theory, the resultant products may ^{be} present, but the explanations of how they occur may be incorrect. Psychoanalytic theories have tended to oversimplify the picture and to

reduce creativity to an expression of something else, e.g. neurosis, defence, sadism, aggression, erotic wishes or ambition, but creativity is an end in itself, and, furthermore, people do not wish just to avoid tension, they seek it, too, right from the first explorations and experiments of childhood. Rogers (104), for one, sees creativity as more than a tension-reducing mechanism. For him, creativity is the "tendency to express and activate all capacities of the organism to the extent that such activation enhances the organism or the self" (op. cit.). He uses the word "creativity" in two senses: (1) as a kind of behaviour characterised by spontaneity, intuition, etc. and the products of such behaviour and (2) as self-realisation. "The main spring of creativity is man's tendency to actualise himself, to become his potentialities" (op. cit.). Thus a person is creative to the extent that he fulfils his potentialities as a human being.

The inner conditions necessary (according to Rogers) for creativity are:

- (1) Openness to experience. This is the opposite of psychological defensiveness where, to protect the organisation of the self, certain experiences are prevented from entering awareness or, if they do, they are distorted in order to make them more palatable. A person who exhibits openness to experience lacks rigidity, tolerates ambiguity and does not perceive things only in pre-determined ways (c.f. Duncker's "functional fixedness", 31), he can deal with conflicting information and does not ignore it in order to avoid uncertainty. This is similar to Hacker's idea that the creative person forfeits all the safeguards of certainty in favour of doubt (57).
- (2) An internal locus of evaluation. The individual himself establishes the value of his product, though he is not oblivious to the judgements of others.
- (3) Ability to toy with elements. The creative individual plays spontaneously with ideas and relationships, translating them from one form to another and juxtaposing them in order to view a situation in a new and significant way.

He puts "reality" aside to some extent and perceives it in his own way. Thus there is an element of rebellion, a lack of trust in customary schemes and a determination to explore new ways. However, too much rebellion and diffusion can be dangerous because it may always remain undisciplined and uncontrolled: the importance of the organising, structuring principle in creativity is again evident. This is analogous to the same balance that must exist between disintegration and return to reality in ego regression.

Other concomitants of creative thinking are: (1) a "Eureka" feeling. (Compare this with the discussion of structural harmony in Gestalt theory), (2) an anxiety of separateness, i.e. a feeling of exploring untrodden ways and (3) a desire to communicate a creative product to others in some way.

Since it is evident that creative behaviour cannot be coerced or produced by force, Rogers sees the external conditions of creativity as:

- (1) Psychological safety. This means the individual must be accepted as of unconditional worth so that he can "discover" himself. It also means external (i.e., subjectively-biased) evaluation must be absent so that the individual can recognise his own likes and dislikes.
- (2) Psychological freedom. This means freedom for the individual to express himself and be responsible for himself: it does not mean freedom from all societal restraints. The views of other psychologists on the conditions for creative activity overlap a great deal with Rogers' ideas, i.e. Fromm (39) lists his conditions as:

- (1) A capacity to be puzzled and surprised.
- (2) An ability to concentrate and to be fully committed to the task in hand.
- (3) The ability to accept conflict and tension rather than avoid them. This can be compared with Rogers' "tolerance of ambiguity" (104), Murray's "certain just for temporary chaos" (93) and Hacker's "suspense of ambiguity" (57).

- (4) A willingness to let go of certainties and illusions and to stand in isolation. This seems similar to Rogers' "openness to experience".

Schachtel's (105) approach to creativity is a perceptual one in which he attempts to evaluate the importance of the outer environment in creativity. He says creative thought is the result of being open to the world and receptive to experience: its motive is man's need to relate to the world around him. As a child develops, he progresses through a predominantly autocentric (subjective) mode of perception, to a predominantly allocentric (object-centred) mode. During this process, as a person learns his society's conventional responses to situations, a secondary autocentricity develops, which can block the person's view of reality and can lead to a tendency to see only the usefulness of an object and to avoid anything new and strange. To be creative, a person must avoid this closed, autocentric world and see the world afresh. Quoting from Schachtel, creativity is "the art of seeing the familiar fully in its inexhaustible being without using it autocentrically for purposes of remaining embedded in it and reassured by it" (op. cit.). Secondary autocentricity becomes predominant in the uncreative person, so that his closed world holds no wonder and everything has a pre-determined label.

The psychometric approach to creative thinking has been headed by Guilford, whose work in this field is still continuing. Measurement is "the application of numbers to events, conditions or attributes according to accepted rules" (Guilford, 52): one may then take advantage of the properties of the number system in order to discover the relationships amongst such events, conditions or attributes. The experimental psychologist has a choice between two approaches to the analysis of a set of data:

- (1) Traditional bivariate method where treatments in the form of varying stimuli, time, etc. are applied while many conditions (or variables) are held constant so the experimenter knows which variables are affecting responses. Here, S - R, (stimulus - response) dependencies are studied.

- (2) Multivariate methods, which include intercorrelation and factor analysis. In the latter, R - R dependencies are studied, the experimenter being relatively less concerned with how his subjects go the way they are than he would be in (1). Multivariate methods have been used in attempts to discover trait concepts, or basic psychological functions, in many fields including clinical and developmental psychology, personality theory and psychopathology. The most popular and most defensible multivariate method of discovering trait concepts is that of factor analysis which starts with information regarding concomitant variations of performance of individuals and "classifies" tests with respect to the underlying traits they measure. By varying the quantity and quality of the tests, more and more accurate interpretations of factors (roughly, traits) and their properties are possible. "If this 'loses' the individual, then very often we have to 'lose' him to find him". (Guilford, 52).

Guilford has carried out extensive factor-analytical studies in the realm of intellectual functioning, with the aim of discovering basic intellectual factors or "primary abilities". The advantages of factor analysis in this type of research as well as in other fields, are as follows: (1) Economy in the number of variables. The main aim of factor analysis is to "account for the major variance of a large battery of tests in terms of a minimal number of primary abilities or factors" (Wechsler, 137). Any scorable variable which we think may be important in personality can be represented by a dimension of the mathematical model Cattell has called the "personality sphere", which is a hypersphere of n dimensions. Basic traits (found by factor analysis) are sets of different dimensions, limited in number, which can account for all other variables, i.e. economy of description is achieved by this method. (2) Increased amounts of information. Finer and finer discriminations complicate descriptions of phenomena, but information cannot be ignored on

these grounds - factor analysis can help replace loose concepts and terms with defined and delimited dimensions. (3) Factors provide a frame of reference, for the psychologist can obtain an idea of what psychological variable is represented by the mathematical factor. A psychological variable is "an underlying latent variable along which individuals differ" (Guilford, 50). Factor scores can indicate how much of a certain attribute an individual has. A further step in this direction is to consider factors as psychological functions - and the taxonomy of functions has always been the business of the theoretical psychologist.

(4) The evidence that intelligence is not a unitary concept is so widespread, that it is incredible that some psychologists and many other people still support a monolithic view of intelligence. Intra-individual differences, patterns of growth and decline, low intercorrelations of some I.Q. test scores with others, differential intellectual symptoms associated with brain injuries and other pathological conditions, all supply persuasive arguments against a delightfully simple, narrow view of intelligence. I.Q. tests contain a variety of tests of intellectual functioning, but still not enough to account for all the intellectual abilities we know. We must not equate intelligence with "what I.Q. tests measure": the I.Q. tests are inadequate. Guilford's inspection of the latest Stanford-Binet test showed 28 intellectual factors represented, whereas at least 80 are known to exist at present. At the same time, I.Q. tests can only sample the abilities considered important in intellectual functioning, because of the large number of abilities and the complexity involved. There is evidence that the multi-dimensional view of intelligence is at last affecting tests and testing methods, in the development (under the auspices of the British Psychological Society) of a new intelligence test which contains sections on reasoning ability, verbal ability, spatial ability, number ability, memory and ideational fluency and gives a profile of cognitive abilities - not one pervasive "I.Q." (Watson, 136). Thus a start has been made, though this start, too, may be in-

adequate and narrow compared, at least, with Guilford's view.

By 1956, almost 40 intellectual factors had been found by the Guilford group and the problem of organising them into some system arose. A hierarchical model was considered not applicable: in spite of many efforts to hang on to it (Eurt, 13: Vernon, 133), the well-known *g* factor of intelligence does not stand up in the face of increasing experimental evidence such as the occurrence of zero correlations between some pairs of intellectual tests and changes in the *g* factor with different batteries. Further, if a *g* factor really exists, rotation methods will not lose it, contrary to the opinion of some staunch *g* factor supporters. Even if (as Thurstone himself eventually maintained) a *g* factor exists as a second-order factor, which of the second-order factors can be recognised as the *g* factor? First order factors can be difficult to interpret, but second-order ones are even more so. There has been little evidence to support the existence of a few broad group factors (with many variables) and many narrow group factors (with few variables). These objections and the finding of different factors which, though similar in psychological function, differed in content (e.g. verbal and non-verbal content), led to Guilford's conception of his Structure-of-Intellect model. This is a morphological model, i.e. it deals with "cross-classification of phenomena in intersecting categories" (Guilford, 50) and appears suitable in many areas of psychology. Eysenck regards Guilford's model as a reductio ad absurdum of the use and interpretation of factor-analytical methods, for there might be an endless division of abilities and, further, Guilford has not taken cognisance of personality differences between his subjects (35) (see section on personality attributes later in this chapter). Eysenck, instead, recommends an approach used by himself and Dr. Furneaux, in which results for different items on one test are analysed (which certainly is praiseworthy) and in which creativity is analysed according to personality differences. However, if Guilford has ignored some variables, so, too, has Eysenck in his method of separating introverts and extroverts. What about other personality differences? In view

of the complexity of the study of intelligence (and creativity), it is inevitable that some possibly important variables are ignored. Most experimenters have to concentrate on one particular aspect and so leave some variables out intentionally (and, perhaps, sorrowfully). There are also bound to be hitherto unconsidered variables which have been omitted because ~~no~~-one has recognised their importance. In the final analysis, a combination of approaches will probably yield the most worthwhile and the most complex picture on intellectual functioning. To neglect any one of them must result, to a greater or lesser extent, in oversimplification.

The Structure-of-Intellect (SI) model appears pictorially in Fig. 2. Note that it is a three dimensional model, the three dimensions being:

- (1) Content categories. There are four such categories - figural (concrete non-verbal pictures, etc.), semantic (information in the form of meanings), symbolic (signs that can stand for something else) and behaviour (non-verbal human interaction) - instead of the usual two verbal and non-verbal categories as recognised, for instance, in Wechsler's Verbal and Performance Scales of his intelligence test and by Thorndike's use of "concrete" and "abstract" intelligence. The inclusion of the behavioural category involving the kinds of information used in interaction with other people, is interesting in view of Thorndike's proposal of a kind of social intelligence in addition to the usual kind (in Guilford, 50).
- (2) Operation Categories. Before the existence of content categories became evident, intellectual factors were classified according to the operations involved, e.g. memory, perception and reasoning. From 1950, Guilford suggested the use of the terms "convergent" and "divergent" thinking for the two basic cognitive modes of thinking which he found underlay his initial 47 modes of intellectual functioning. The former type of thinking is described as

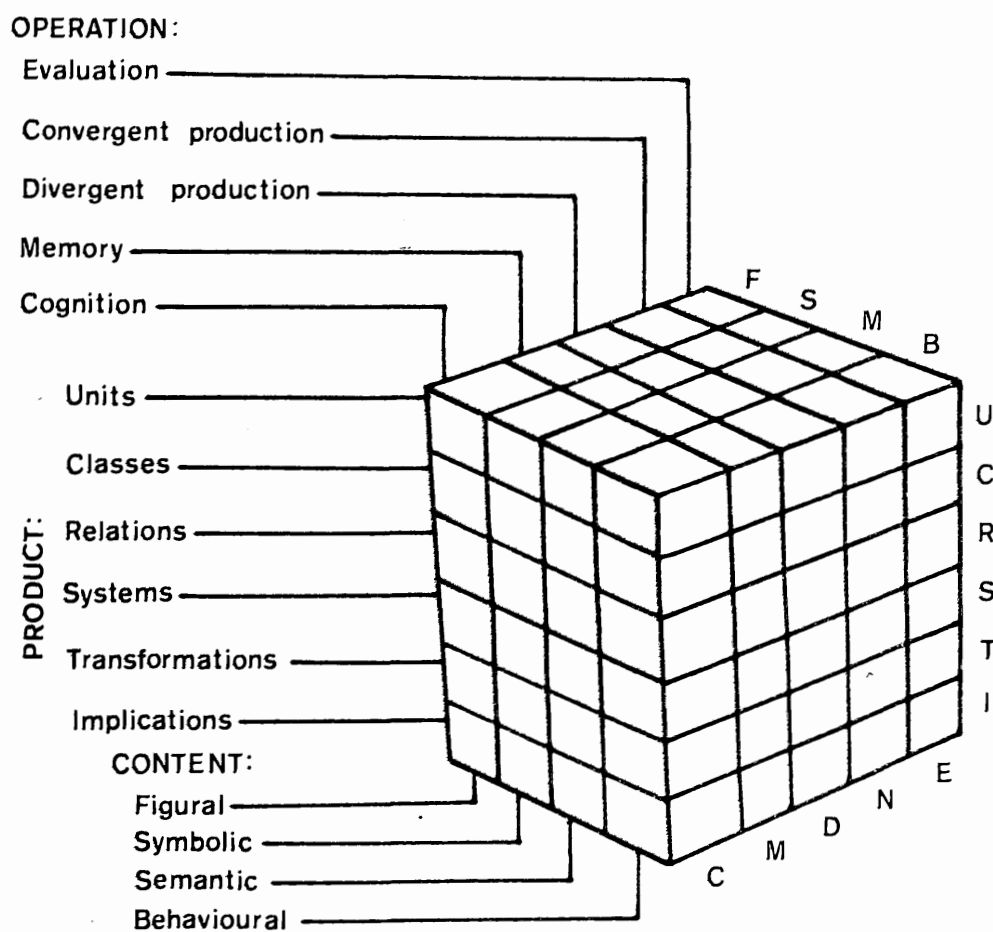


FIG.2: The Structure-of-Intellect Model

"retaining the known, learning the pre-determined and conserving what is" (Getzels and Jackson, 44), i.e. producing the usual and the expected. Present standard tests of intelligence measure this mode. The latter type of thinking entails "revising the known, exploring the unknown" (Getzels and Jackson, 44), i.e. producing the novel and speculative.

Eventually, Guilford postulated five categories of operations, these being divergent production, convergent production, memory, cognition and evaluation. Cognition, here, is not exactly equivalent to the usual "cognitive abilities" which are often used to cover all intellectual abilities, but simply means "comprehension" and determines how much knowledge an individual possesses.

- (3) Product Categories. These were slower to evolve and came about because it was recognised that there were parallels cutting across both the content and operation categories. "Product" refers to the way in which information can be handled or conceived of, the six types of products being units, classes, relations, systems, transformations and implications. Thus units are "things" (e.g. nouns, letters); classes are sets of units with common properties; relations are connections between ideas or things; systems are organisations or patterns of interacting parts (e.g. a mathematical equation); transformations are changes or redefinitions of objects or ideas and implications are predictions or expectations derived from given information.

The interesting and important fact about this model is that it can account for factors found in other studies, e.g. Spearman's "fundamentals" are SI units, his "relations" are SI relations, his "education of relations" are the equivalent of SI "cognition of relations" and his "education of correlates" the equivalent of SI "convergent-production of relations". Another important point about the model is that many hypotheses about

abilities can be (and have been) set up and tested, i.e. the model has guided and is guiding research as well as providing a remarkably far-reaching and unified description of intellectual functioning. Guilford sees his model as an informational approach to psychological theory, providing a basic working design which may be altered as research progresses, e.g. there may be more than the three present parameters. In the SI, the dimensions are discrete and thus there is no necessary linkage between them. As yet there is no empirical basis for the order of the categories and no intercorrelation of factors has yet been done, though Guilford does suggest there may be a complex factor linking as many as twenty or thirty cells of the model. This the writer considers to be the major shortcoming of Guilford's theory; it will be interesting to await his findings on this problem.

Guilford has concentrated on the aptitude traits he considers important in creative thinking, most (but not all) of these being located amongst the divergent-production abilities, but he has also carried out factor-analytical studies on non-aptitude (motivation and temperament) traits. Some critics have found it useful to forget that Guilford does not consider the divergent-production abilities to be the only important dimensions of creativity, e.g. Wallach and Kogan (134) say of Guilford that "he means to denote "creative" with "divergent" thinking". The study of abilities, says Guilford, determines ways in which individuals can be expected to show creative productivity and also aids our understanding of creative processes. There is not one important ability (c.f. Mednick's concept of association), but many, and, in addition, almost all intellectual abilities may contribute to creative output, e.g. vocabulary size would aid creative writing and numerical ability would aid some scientists. Thus creative abilities must be seen for what they are- a segment of a range of many intellectual abilities. It seems probable that divergent and convergent thinking intermingle in creative production, e.g. considering Wallas' stages of creativity,

"preparation" involves cognition of information, "incubation" involves (possibly) the production of divergent and convergent systems as well as evaluation, etc. Perhaps there is some ability involved in the integration of all these activities (51). The best predictor of creativity would probably be a conglomeration of suitably weighted aptitude and non-aptitude traits as it is unlikely that any one factor will be highly valid. Before proceeding further, it must be noted that the writer is concerned with creativity and not with the larger area of the more traditionally studied modes of intellectual functioning. Hence other theorists dealing specifically with these aspects (e.g. Burt, Vernon, Guttman, Piaget, Spearman) will not be discussed. The main consideration is not the Structure-of-Intellect model in its entirety, but the elucidation of the divergent-production abilities and other abilities important in creative thinking.

To obtain a clearer idea of the function of the SI model as related to creativity, the more important factors concerned should be viewed briefly. To do this, the SI cube is sliced along the divergent-production line to give a cross-sectional picture as shown in Fig. 3, so that the attributes of each cell can be studied. Not every cell (factor) has been empirically studied and supported as yet, in particular the behavioural category. Not all relevant tests and analyses of tests are included here, but merely examples to show the meanings of the factors. Full details can be found in Guilford's "The Nature of Human Intelligence" (50).

- (1) Figural Units. The best and most univocal test for DFU has been found to be Sketches (Gershon et al., 43; Guilford and Hoepfner, 55). The subject (S) is given a simple basic figure and told to add just enough to it to make it a recognisable object, e.g. a circle can be made into a ball, face, orange, etc. The score is the number of objects made. Other tests are Make-a-Figure (given two or three line elements such as a straight line and a curved one to make into figures) and Monograms (arranging combinations

figural(F)	symbolic(S)	semantic(M)	behavioural(B)	
DFU	DSU	DMU	DBU	Units (U)
DFC	DSC	DMC	DBC	Classes (C)
DFR	DSR	DMR	DBR	Relations (R)
DFS	DSS	DMS	DBS	Systems (S)
DFT	DST	DMT	DBT	Transformations(T)
DFI	DSI	DMI	DBI	Implications (I)

Fig. 3: Matrix of divergent-production factors (D) represented in the Structure-of-Intellect.

of letters to make a variety of monograms), although the two letter tests allow DFS variance to creep in, possibly because a unit can be easily treated as a system in the visual-figural area.

- (2) Symbolic Units (DSU). This is identified as Thurstone's "word fluency" factor where the S has to generate words of letter patterns to fulfil certain requirements - the meanings of the words do not matter. Tests for this factor are: Suffixes (S lists words ending in "tion") and Rhymes (for a specified word, e.g. roam). Word fluency is actually a misnomer as the name "symbolic" content here implies. In a study by Canisio (14), a Number Fluency test in which the S had to generate numbers to fill specifications, went with Word Fluency tests.
- (3) Semantic units (DMU). The S has to generate word meanings to fill requirements - sheer quantity of output is important, e.g. Consequences (S lists consequences of a given event, such as people no longer needing sleep); Plot Titles (list possible titles for a short story); Utility Test (list uses for a brick, pencil, etc.)
- (4) Figural classes (DFC). The S has to list members of different classes of figural properties, e.g. in Alternate Letter Groups, he has to find all letters with horizontal lines, straight lines, etc., the subject himself choosing the class properties. Another test is Figural Similarities where six figures are presented to the S who has to re-classify the figures in groups on the basis of different properties, e.g. black figures, straight line figures.
- (5) Symbolic classes (DSC). Two tests here are faithful, but not strong markers of this factor. They are Varied Symbols (S has to match sets of letters on the basis of common properties, e.g. vowels) and Name Grouping (classifying names according to properties they possess such as having two syllables, double consonants, etc.).
- (6) Semantic classes (DMC). This has been identified as the

factor of spontaneous flexibility which is defined as "the ability to produce a diversity of ideas in a relatively unstructured situation" (Frick et al., 33). Marker tests include the Utility Test (number of shifts in uses of an object, e.g. a pencil) and Multiple Grouping (making subclasses of given objects, e.g. those found in the air, in water, etc.) (Guilford and Hoepfner, 55).

- (7) Symbolic Relations (DSR). Marker tests are Alternate Additions (combining given numbers in different ways to obtain a total of 7) (Guilford and Hoepfner, 55) and Number Rules (e.g. start with 2 and reach 6 by applying different operations). Appropriate letter tests for this factor have not yet been constructed.
- (8) Semantic Relations (DSR). This is identified as "associational fluency" found initially by Thurstone (Fruchter, 40). Tests here are Controlled Associations (production of synonyms for words is required) and Inventive Opposites where words opposite in meaning are required.
- (9) Figural Systems (DFS). This entails organising visual-figural elements into wholes as in the test Making Objects where, using two or three simple geometric figures, S has to construct a named object (Gershon et al., 43).
- (10) Symbolic Systems (DSS). This has so far been poorly supported. It was originally thought to be the factor "expressional fluency" involving the organisation of words into sentences, but this was found to be too "semantic". The two tests Make a Code (making many different code systems from letters and numbers) and Number Combinations (production of simple equations required) just managed to separate DSS from expressional fluency tests (Guilford et al., 56).
- (11) Semantic Systems (DMS). This is the expressional fluency factor. Sentence-construction tests involving the organisation of meanings (the syntactical problem being of minimal importance) have been strong markers for this factor, e.g. Four-Word Combination (W - C - E - N -) a

response for which might be "we can eat nuts" and Story writing where ^{the} number of words written on a theme is important.

- (12) Figural Transformations (DFT). This is the factor "adaptive flexibility" initially found by Wilson et al (139), using the test Match Problems where, say, six squares are constructed from matches and the S is required to remove four matches to leave three squares. The rationale of the test is that to succeed, the S must continually revise his tactics and not be too firmly set in one approach. Adaptive flexibility is defined as "the ability to change set in order to meet requirements imposed by changing problems" (Frick et al., 38). Another good marker test has been Planning Air Manoeuvres (planning sky-writing with the initial and final positions of the plane and the sharpness of the turns specified).
- (13) Semantic transformations (DET). This is commonly known as the originality factor, tests for which involve either (1) ability to produce responses that are statistically rare in the population concerned, (2) the ability to produce remote related responses, or (3) the ability to produce clever responses. Tests that have proved worthwhile here are: Remote Consequences (Guilford et al., 56) Associations (remote), Plot Titles (clever), (Guilford et al., 56). Guilford has postulated that there could be three, parallel adaptive flexibility factors, depending on the three kinds of content - figural, structural and conceptual. The present adaptive flexibility factor may be a confounding of figural and structural (symbolic) adaptive flexibility. On the other hand, adaptive flexibility could be an originality dimension pertaining to figural and structural material, with the present originality factor dealing with conceptual material (as most contemporary originality tests do). Results from investigations into these hypotheses have been far from decisive (Frick et al., 38).

- (14) Figural Implications (DFI). The first elaboration-ability factor which represented both semantic and figural tests was found in a study of planning in 1957 (Berger et al., 6). A later analysis in 1961, (Guilford et. al., 56) supported the separation of two elaboration tests, one figural and one semantic. Such a figural test is Decorations (drawing decorative additions of pictures of common objects).
- (15) Symbolic Implications (DSI). This has been poorly supported. Only Symbol Elaboration (where the S had to deduce different equations from two simple equations) has been consistently representative of the factor.
- (16) Semantic Implications (DMI). This is the semantic counterpart of figural elaboration and has been represented by Planning Skills (S has to set forward plans to improve a given problem situation and his answers are scored for the number of steps involved). Another test designed for DMI is Possible Jobs, in which a design (e.g. a light bulb) is given to the S who has to suggest occupations the picture might represent. It has come out on factor DMI in four out of five analyses (Guilford 50).

Two non-divergent-production factors considered to be important in creative thinking, are CMI (cognition of semantic implications, or "sensitivity to problems") and NFT (convergent production of figural transformations, or "figural redefinition"). At first the factor interpreted as "sensitivity to problems" was assigned to EMI (Guilford et al., 56), but a more recent analysis (Nihira et al., 1964, in Guilford, 50) led to its being shifted to CMI: it was realised that the factor involves cognising implications and evaluating them. Tests of CMI include Seeing Problems (what difficulties arise in using a common object, e.g. a candle) and Seeing Deficiencies (what is wrong with described plans). NFT is a perceptual factor, roughly analogous to Thurstone's "Gestalt flexibility" (123), which was marked by

Gottschaldt-figures tests. Tests of this type (e.g. Guilford's Hidden Figures Test) involve transformations in the form of revising the definition of lines, e.g. in order to find a simple geometric figure hidden in a more complex one. The factor is thus an ability to change the function or significance of figural elements of an object in order to use them in a new way. In the study by Frick et al., (38), figural and structural redefinition were confounded. It is possible that NMT (semantic redefinition) is also an important factor because it involves redefining an object for some unusual use.

The main criticism of Guilford's work has concerned the question of validity, i.e. do his tests measure creative processes and can they predict who is, or will be, the creative person? Guilford (50, 51) and others have maintained that factor analysis itself provides the best kind of construct validity, but this is not enough. Validation studies have not been extensive: Barron (2) obtained a correlation of +.55 between originality ratings and total scores on originality tests using Air Force officers as subjects, while Drevdahl (30) found scores on originality correlated to the extent of +.33 with instructor ratings of the originality of arts and science students. Adaptive flexibility has consistently shown positive relationships with performance in mathematics (reported in Guilford, 53) and also in physics (Hills, 63). Sprecher's study of graduate engineers (reported in Guilford, 53) resulted in multiple correlations of between +.30 and +.50 for inventiveness ratings, performance on original problems and a few tests of creativity factors. A study of public relations personnel, showed significant positive correlations between scores on some Guilford tests and supervisor ratings on creativity (Elliot, 34). Validation studies of Torrance's tests are also relevant here because many of his tests are based on Guilford-type tests and factors. In a study by Weisberg and Springer (1961) on 32 children, the more creative ones (criterion tests included Circles, Unusual Uses and the Ask and Guess tests) were found to give more unconventional Rorschach responses and movement and colour responses and to exhibit greater self-awareness

(reported in Torrance, 129). Fleming and Weintraub (1962) found measures of rigidity and a composite score on the Torrance tests, correlated to an extent of $-.41$ (significant beyond the $.01$ level).

Yamamoto (1960, 1964, op. cit.) found the relationships between scores on selected Torrance tests and peer nominations on questions such as, "Who thinks of the most unusual, wild or fantastic ideas?", to be significant in the 8th., 9th. and 10th. grades. Nelson (1963) used the personality characteristics of creative people (Q-sorted by teachers) to differentiate the upper and lower 27% of 5th. and 6th. grade pupils and found that the Torrance verbal measures all differentiated the same groups at better than the $.01$ level of significance for fluency, originality and elaboration variables. The non-verbal (figural) elaboration and originality variables, differentiated the groups at greater than the $.05$ level of significance. Many other validity studies are reported in Torrance, 129. Long-range predictive validity studies are being conducted by Torrance, but complete results are not yet available.

It is extremely likely that different spheres of creative endeavour involve different aptitudes, e.g. writers and scientists probably operate largely with semantic content, artists with the visual-figural and mathematicians with symbolic content. In other words, it must be stated again that creative potential is not a single variable, hence it is extremely unlikely that any one of Guilford's factor tests will have high validity - as MacKinnon (77) and Taylor and Holland (120) have found. It will be necessary to factor-analyse the structure of the criteria as well as the predictors before proper predictive validation studies can be done (Guilford, 52).

A perennial problem in studies of creativity, is that of the establishment of criteria. This is important because the development of a predictor-battery of variables depends on the establishment of criteria of creative behaviour. Since creativity is not a simple, single ability, it is impossible to use a simple, single criterion, and yet investigators have been guilty of just this.

How can we possibly be justified in assuming we can predict the behaviour of an Einstein from a measure of one aptitude, attribute or ability? Another difficulty is that, most often, ultimate criteria (e.g. a scientist's total productivity) cannot be used because these would only be known in retrospect: often, no contemporary person can evaluate a product properly. Indeed, as history has shown, it frequently happens that the more original a product, the more likely it is to be considered with suspicion, regarded as evil, or ignored altogether - think only of Galileo, Copernicus and Stravinsky. Thus we have to use intermediate criteria which are more predictor-type measures than they are criteria (Shapiro, 108).

There are three types of variables which have been considered as criteria, viz., products, processes and people.

Rogers (104) and others have stated that there must be some type of observable product of creative behaviour which can be evaluated in some way. Barron denies the need for products. He sees creativity as a central nervous system activity which is continually in action, but not always observable. Millions of internal events occur which form the basis of associative patterns which become part of a "reservoir of thought" from which visible creative products can be drawn. Be that as it may, until methods of measuring internal activity improve vastly we have no way of studying "internal" creative processes. Of course, this type of view reflects again the psychologists' favourite trick of separating aspects of a problem and forgetting to put them together again, for, whether a product was produced by trial and error, or by chance, or by a reorganisation of the individual's perceptual world, is a question associated with the other side of the same coin - process. Product and process are inseparable. Hacker (57) describes products as "interruptions, congealed moments and alienations of the creative process" which is constantly in action. Anderson (1) is aiming at the same idea when he says products exist only in the past: the process is in the moment of now. One can only guess at the process behind a product, in fact, one quality of greatness in a product is its apparant simplicity, e.g. think of

the ballet dancer about whom one says "she makes it seem so effortless".

Despite the dangers of evaluating products, one has to start somewhere and trust to human judgment, hence several investigators have used McPherson's (82) "inventivlevel" criteria in assessing products. These criteria include "creative strength", usefulness, newness, amount of experimentation and achievement in a field marked by previous failure. Unfortunately, most of these criteria are hopeless in fields other than the sciences (it has already been pointed out that different criteria will be needed for different types of products) and even more hopeless if one wishes to begin the predicting game at the childhood level. Products also involve many different creativity factors and, therefore, it should be important to assess these as well. This is essentially the method Torrance has used (129).

Considering people's characteristics as criteria, evaluations have usually been obtained from peer, supervisor, teacher or self ratings on variables such as work habits and personality traits and from personality inventories. Teacher ratings and peer ratings appear to be of little value in predicting creative performance (Torrance and Holland, 1959, in Yamamoto, 141), but supervisor ratings have some value (Shapiro, 108). The validities of personality inventories such as the 16PF and the CPI, are usually low--typical correlations for personality scales being in the range $+0.10$ to $+0.30$, though higher correlations have been found in some studies (Taylor and Holland, 120). Self-ratings have shown better validity. Terman found self-confidence, persistence and integration towards goals were good predictors (122); several self-ratings on other non-intellectual characteristics have proved to be fairly good predictors (C.W. Taylor et al., 121). Motivation and interest inventories have been poor predictors (op. cit.). Strangely enough, biographical information on background, interests, goals, etc., have proved to be predictors of quite high validity (correlations being in the range $+0.30$ to $+0.55$) (Taylor et al., 121; Smith et al., 112). Once again, from Shapiro's (108) study (he used a Work Habits Inventory, a Personality Questionnaire, a

Products Questionnaire and Biographical Questionnaire, supervisor and self-ratings on 74 scientists) and C.W. Taylor, Smith and Chisslin's (121) work with a range of 56 criterion variables on 166 research scientists (they used aspects of products, ratings and organisational status), it is obvious that no single criterion is sufficient: many criteria are needed to give a good evaluation of an individual's creative potential.

No discussion of criteria would be complete without mentioning the intelligence quotient - once the sole criterion used in identifying gifted people. This raises the whole creativity/intelligence question - a question one cannot help feeling has caused reactions bordering on the hysterical in some quarters.

As early as 1898, Dearborn (27) (using inkblots and I.Q. tests with Harvard students) concluded that high I.Q. and creativity were not highly correlated. During the next few years, several other studies supported this finding (Colvin and Meyer, 23; Chassel, 19). In 1922, Simpson (113) wrote, "Tests devised to ascertain either native intelligence or acquired knowledge are certainly valuable to an employer (however) there are no elements in them to extract from the mind of the individual his powers of creative productivity and his tendencies toward originality". By 1924, Terman (122) had reported his findings on the characteristics of gifted children (the top 2% in I.Q.), but thirty years later, the field had stagnated - nothing new had been added to the picture (Getzels and Jackson, 44). The stumbling block was the equating of "giftedness" with "high I.Q.". Of all types of psychological tests, the intelligence test has proved the most immune to advances in theory, despite the fact that it samples a narrow field of cognitive abilities and accounts for only a quarter of the variance in factors of school achievement. Perseverance along this one line of thought blinded people to "other forms of excellence" (Getzels and Jackson, 44). In one of Torrance's studies, 7 out of 10 of his gifted children would have been excluded if selection had been I.Q. alone. The definition of the gifted child as "one who shows consistently remarkable performance in any worthwhile endeavour" is much fairer (Terman

- in Henry, 60). Still, old ideas die very slowly, indeed, as Cattell (17) has said, (rather cynically), "Today it has become a truism to say that a major scientific theory triumphs, not by converting its opponents, but by their deaths". It is to be hoped that this has not been the case in the issue of giftedness, but it is true that more than fifty years after Dearborn's tentative statement, Guilford, in his Presidential Address to the American Psychological Association (1953), had to restate: "I believe that creativity and creative productivity extend well beyond the domain of intelligence". He followed this address with a 16-year factor-analytical study of thinking which is still progressing and the results of which have been listed.

Investigations into the relationship between intelligence and creativity have mostly showed very similar results. Getzels and Jackson (44), using high creativity/low I.Q. and low creativity/high I.Q. groups with two intelligence and five creativity measures, found relatively low correlations (+.11 to +.52) between them. Torrance obtained similar results in 6 out of 8 different studies using subjects from elementary schools to college graduates (126). Holland (64) and Styles (117) came to the same conclusion. Wallach and Kogan (134) maintained that studies previous to theirs showed no evidence for considering creativity as distinct from intelligence and, in fact, what creativity measures have in common, is the variance they share with measures of intelligence. However, their own study (in which fluency and originality (uniqueness) scoring was used), showed creativity variables correlating highly with one another even across the visual/verbal distinction and correlating to only a small extent with standard intelligence variables. However, using scientists as subjects, Meier and Stein (37) found significantly high positive correlations between creative performance and I.Q. for non-Ph.D. but not for Ph.D. students and concluded that I.Q. as an indication of creative performance (not potential), may lose its usefulness at high levels, i.e. above a certain level, I.Q. is no longer important for high creative performance - at least in science. MacKinnon (77) also thinks that the "certain level" of I.Q. will differ in art,

music, science, etc. It must be pointed out that although Pearson r 's (with their assumption of linear relationships between variables) have been used, the relationship between I.Q.'s and creativity test scores is often a curvilinear one. Guilford's (50) general, hypothetical plot of any DP (divergent-production) score as a function of I.Q., is shown in Fig. 4.

From this graph, it can be seen that people with high I.Q. could fall almost anywhere along the DP range and people with low DP could fall almost anywhere along the I.Q. range, but those people with high DP have a high probability of falling above the average I.Q. Dunn (32) has actually found such a relationship between DP test scores and scientific achievement tests. It seems, then, that "although high I.Q. is not a sufficient condition for DP ability, it is almost a necessary condition" (Guilford, 50), but it is still possible for a person with relatively low I.Q. to distinguish himself in some creative endeavour. In studies with children, few have been found with high DP and low I.Q. status. The most likely explanation for this is that I.Q. tests emphasise a person's stock of information (cognitive abilities) and if the information is not there, it cannot be used, for example, in DP tests. Furthermore, Kneller (69) has pointed out that the low I.Q. person lacks the capacity for prolonged abstract thought - this is necessary in the production of many types of responses.

Barron (2) has found that originality measures and I.Q. correlated +.33 with each other, but that the variables associated with each were different, e.g. originality was associated with the integration of diverse stimuli, response to emotion and impulsivity, whereas intelligence represented the "operation of the reality principle and caused delay in impulsive expression" (op. cit.) and so allowed the effective organisation of experience. Thus a mixture of ^ahigh degree of creativity and intelligence would seem to be the most worthwhile and productive combination.

The aforementioned use of personality variables as criteria of creativity, leads to another view of creative people and the final section of this chapter.

Barron (4) has stated that originality is habitual with

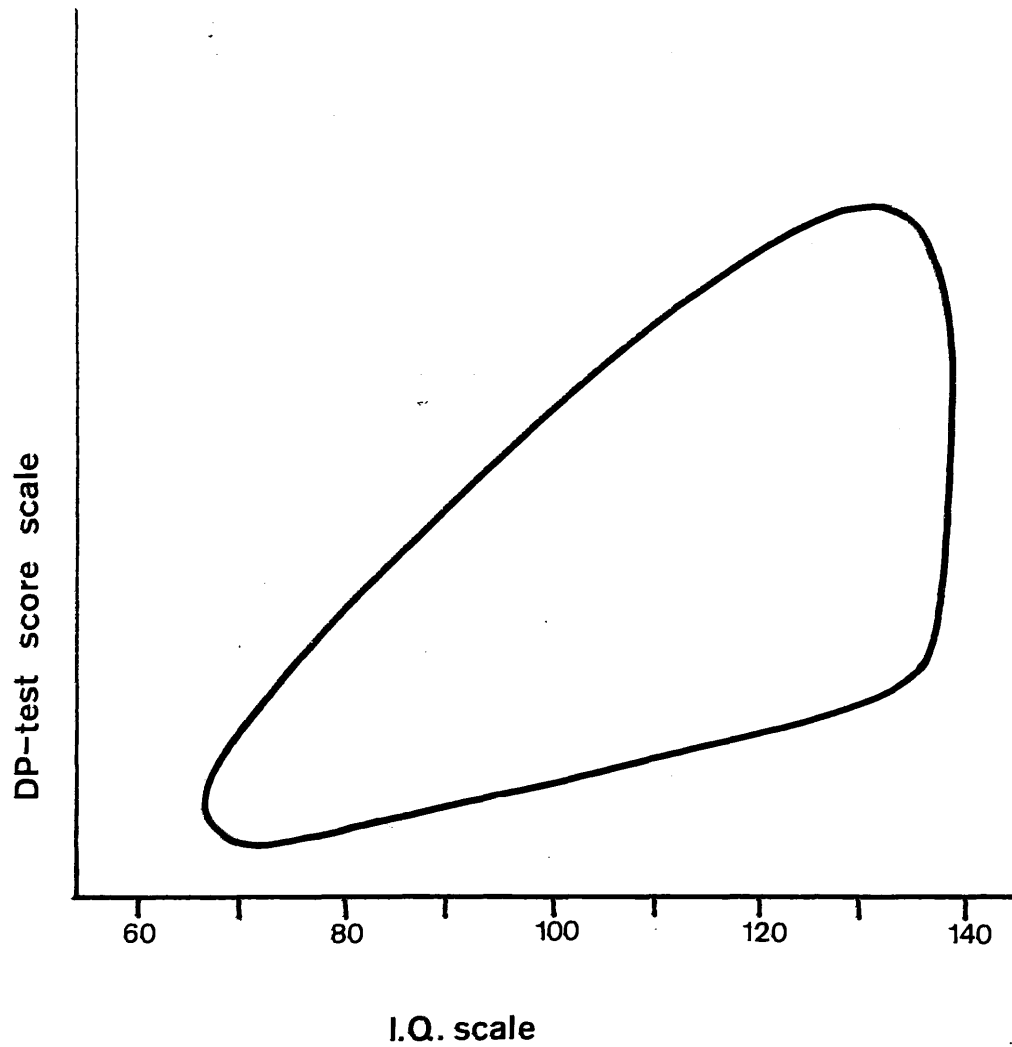


FIG.4: Illustration of a typical scatter of individuals when scores for divergent-production tests are considered in relation to I.Q.

creative persons and high productivity is the rule and, therefore, certain personality trait patterns must facilitate or impede the production of original ideas. This "disposition toward originality" may be defined as the ability to produce "unusual, adaptive responses" (i.e. unusual, relevant responses), which is a function of the range of possible responses the person has available, or the "objective freedom" (Barron, 4) of the person. Freedom is greatest where complexity is greatest because complexity allows a greater repertoire of responses. However, increasing complexity strains a person's ability to integrate phenomena, so that one solution is to prevent the development of complexity - and so inhibit the possibility of original thought. Bruner (10) seems to have a similar notion in his "deferral of completion of a task", i.e. the individual guards against premature closure to seek something beyond the ordinary and expected.

Gordon's (17) ideas on these lines are worth noting. In the normal course of a day, the individual is bombarded by an enormous amount of data, most of which is irrelevant to what he is doing. The nervous system acts as a primary filter to screen out much of the irrelevancy - for to try to attend to all stimuli would be to court madness - but the mind continues this selective, editing process to prevent distractions from disrupting purposive activity. If this filter is too efficient, the kind of activity essential to creativity is inhibited. Therefore, the creative person has the ability to entertain, or at least be prepared for a range of irrelevant data and this allows him to re-examine the "existing order of things". A balance is necessary to prevent "psychological dispersion", where the individual's attention is focused on nothing, because it is trying to focus on everything.

Barron's five hypotheses about creative personalities deserve a closer look. They are :

- (1) Original persons prefer complexity and some imbalance in phenomena. They are willing to attend to vague feelings and intuitions and to do without a sense of reality and the "established perceptual schemata". (Thus Barron sees the disposition toward originality as a highly organised mode

of responding to experience). Ordinary structures of experience are broken down, resulting in an extension of perceptual boundaries so that the creative person can attend to the usually unobserved and see things "as others do and as others do not" (Barren, 2).

- (2) Original persons are more complex psychodynamically and have greater personal scope. They tend to admit new experiences even if this results in contradiction.
- (3) Original persons are more independent in their judgements (c.f. Rogers' "internal locus of evaluation", 194). To establish this, Barren analysed self-ratings on Gough's Adjective Check List of Independents and Yielders as obtained from the well-known Asch experiments on independence of judgement. He found the Independents could deal comfortably with contradictory phenomena, were receptive to new ideas, valued creative work, did not like taking orders, did not value strict discipline and liked some uncertainty which served as a challenge to their understanding and imagination.
- (4) Original people are more self-assertive and dominant: they reject regulation by others, but possess a high degree of self-regulation.
- (5) Original people reject suppression as a mechanism for the control of impulses. This has been discussed under the section on psychoanalytic theory.
- (6) Original people prefer complexity and asymmetry and are averse to simple, symmetrical figures. Barren established this using responses to the Barren-Welch form of the Welch Figures Preference Scale which contains complex, asymmetrical and simple, symmetrical figures.
- (7) Original people display femininity of interests (Barren was studying male military officers).

From results on his 16 PF test, Cattell (18) describes creative scientists as withdrawn, precise, intelligent, assertive, dominant, adventurous and resourceful, with great emotional stability and ego

strength. Drevdahl (30) has studied creative scientists in even greater detail. He divided his subjects into three groups: (1) creative, productive, (2) non-creative, non-productive, (3) non-creative, productive. The first group, compared with the other two groups, were: (a) more self-oriented, (b) superior in personal, social and emotional adjustment, though far from perfect, (c) given responsibility and independence relatively early in life, (d) relatively unconcerned with people, authority and rules. This is supported by McClelland's (30) theory that creative people avoid interpersonal contact and are less gregarious and more autonomous. Furthermore, they are disturbed by (and therefore avoid) complex human emotions, not only in their professions but in other areas of their lives, (e) from families where achievement was valued for itself, but pressure to achieve was not frantic or emotional, (f) reared with a more loose-knit, free, independent type of training and also had ^a more laissez-faire type of graduate training.

Guilford's (53) factor analysis of the "thinking interests" of creative people, using Self-Inventory scores, resulted in the following factors:

- (1) Willingness to work long and hard: a high level of motivation. This trait is also mentioned by Roe (103), Terman (122), McClelland (30) and others.
- (2) Freedom from rigidity (c.f. Barron's "complexity of personality").
- (3) A liking for divergent thinking.
- (4) A tolerance for ambiguity - this provides experimental evidence for Rogers' theory.
- (5) Interest in creativity and originality.

Guilford also tried correlating these factors scores with his creative aptitude scores and found (a) individuals scoring high on ideational fluency were impulsive, confident, ascendant, and appreciative of creative thinking, (b) high associational fluency scorers were adventurous and tolerant of ambiguity and (c) high originality scorers were tolerant of ambiguity, liked divergent thinking and appreciated aesthetic expression. Thus different

personality traits are likely to go with different ways of being creative. Guilford's hypothesis that originality rests on "an attitude of unconventionality" was not supported. Kneller (60) says that too much non-conformity can side-track creative energy into rebellion for its own sake. The individual has to maintain a balance between group-centredness (conformity) and self-centredness (non-conformity).

In support of the previous findings, Cough (42) discovered five factors in his studies of motivational and personality factors in original thought. These were, (1) intellectual competence, (2) inquiringness a habit of mind, (3) cognitive flexibility (roughly analogous to Guilford's fluency and flexibility factors), (4) aesthetic sensitivity, i.e. "a preference for elegance of form and harmony wrought from complexity" and (5) a sense of destiny, self-worth and resoluteness: an ultimate faith in the ability of the individual himself.

Other interesting personality traits have been mentioned by several investigators. Firstly, Bruner (10) has said that the creative individual is detached from his work so he can consider it objectively and yet is also deeply committed to it. Henle's (59) "detached devotion" refers to a similar phenomenon of objective, and yet intense interest in work so that the individual can examine and criticise his work and still believe in its worth. The creative individual must also be immersed in his work and although he must know a lot about his subject, he needs to maintain a balance so that knowledge of existing ideas does not blind him to the consideration of new ones.

Quite a number of studies, on somewhat different lines, have been done on children and have been remarkably consistent in their findings. In Texman's (122) monumental study, he found gifted (in this case, high I.Q.) children had high character ratings, were curious, concerned for others, humorous, imaginative and highly motivated to excel. Teachers described them as unruly, dominant, ambitious, independent, friendly and hard-working. In Getzels and Jackson's (44) comparison of highly intelligent and highly creative children, they found the latter group superior to the

former in the production of original ideas and of humour, incongruities, playfulness, violence and unexpected endings in their stories. They tended to choose more "eccentric" careers for themselves instead of conventional ones. (This was supported in a study by Styles (117).) No difference was found between the two groups in school achievement and achievement motivation. The high I.Q. children were considered more desirable pupils by their teachers and came from higher educational-status families. The mothers of high I.Q. children tended to set conventional standards and there was greater implicit familial pressure on the children to do well (c.f. Drevdahl's findings, 30). The mothers of the high I.Q. children observed more objectionable qualities in their children, but were more satisfied with their child-rearing techniques than were the mothers of the highly creative children whose mothers tended to be dissatisfied with their children, but let them go their own way, in the expectation that they would learn for themselves.

Wallach and Kogan (134) studied four groups of children: (a) highly creative and highly intelligent, (b) highly creative, low intelligence, (c) low creative, highly intelligent and (d) low creative, low intelligence and found differences amongst the four groups in personality characteristics, e.g. children in group (a) showed high self-confidence, were popular, interested in academic work and eager to propose novel possibilities. They could also exercise, within themselves, both control and freedom, both adult and child-like behaviour (i.e. they possessed high ego strength), whereas children in group (b) were cautious, hesitant, unmotivated, unpopular and not confident. They were "in angry conflict with themselves and their school environment" (op. cit.), being beset by feelings of inadequacy and yet they performed well in stress-free situations.

Torrance's (126) developmental studies on creativity in children have resulted in some interesting findings: his testing procedures will be discussed in the next chapter.

Grippen (49) has stated that no creative imagination exists in children below five years of age except in rare instances.

This is totally incorrect and is based on the incorrect use of tests. Obviously the level of a child's understanding will influence his responses and, therefore, not all tasks or tests of creativity will be valid at all ages. A great deal remains to be done with children below five years, where investigators will probably have to look for creative thinking in children's ways of handling objects (e.g. blocks) and playing games. Factors which could inhibit the development of creative thinking in early childhood are: (1) attempts to eliminate fantasy. Children have to learn the difference between fact and fancy, but the latter is too often extinguished altogether, (2) holding a child back when he is ready to learn, (3) strict insistence on adherence to appropriate sex roles, especially after five years, (4) over-supervised, adult-directed, activities.

Torrance has found a drop in performance on creativity tests at five years (probably because of the reasons given above). Performance increases ^{through} the years 6, 7 and 8, but drops severely at about 8 - 9 years, probably for the following reasons: (1) success-orientation. The child is urged to succeed - failure and frustration must be avoided, (2) peer-orientation - there is great pressure on the child to conform with others, (3) attempts to prevent questioning and exploration - there are many devices for putting the curious child in his place, (4) over-emphasis on sex roles. The child has to learn to shut out certain areas of awareness, e.g. creative thinking requires sensitivity and independence, but the former trait is not considered socially desirable in boys and the latter is undesirable in girls, (5) the typical 9 year-old is supposed to enjoy play and dislike work and find no play in work, or vice versa.

Increases in fluency scores occur at 10 years and by 11 years, performance on originality tests has recovered, but the years 12 and 13 see yet another decrease in creativity due this time to (1) the child having to take on more adult roles with more responsibility - wild ideas and childishness are frowned upon, (2) the onset of puberty with its accompanying anxieties and necessity for

adjustment. At 14, creative performance once more starts to increase till the end of high school when there is a levelling-off of performance.

It is evident that this uneven development of creativity can be blamed largely on cultural discontinuities in child-rearing practices and social expectations. Torrance's (125) research with different cultures has provided empirical support for this theory. Three non-verbal and six verbal creativity tasks translated into the appropriate vernacular and scored separately for each culture, were administered to children in U.S.A., Australia, Western Samoa, Germany, India and to American negroes. The Western Samoan sample showed no drops in performance, though the level of originality was always low; the Negro group showed a slight drop between 8 and 9 years; German and Australian samples were similar to one another up to 8 years, but German children improved rapidly from 8 to 10 years, while Australian children remained at a steady level; the Indian sample was similar to the U.S.A. sample, but at a lower level. Margaret Mead (23) and others, have commented on the continuity of child-rearing practices and the suppression of creativity and independence in Western Samoan culture - this fits the creative developmental picture Torrance found. If Torrance is able to establish more firmly that cultural discontinuities are associated with personality disorganisation and decreased intellectual functioning in particular areas, then perhaps steps can be taken to eliminate the unnecessary discontinuities.

It is obvious that a great deal of the theory and research findings discussed in this chapter hold many implications for education, child-rearing, industry and research institutions. These implications are discussed in Chapter VI.

FACTOR ANALYSIS:

The aim of factor analysis is to obtain a description of a set of data. Cattell states the aim as, "to represent or explain observed co-variational relations among many experimental variables in terms of linear dependencies on, and relations among, a much reduced number of "ideal", "intervening" or "abstract" conceptual variables. (16). These "abstract" conceptual variables need not be fundamental categories or influences because not all possibly important variables can be included in the data to be analysed, but they do represent a fundamental description of the variables analysed for one particular group. Thus new concepts can be created by this method and, therefore, new light can be thrown on a particular field of study because one is not limited to using traditional concepts which may or may not be worthwhile. This unique quality possessed by factor analytic methods is just one of the reasons why they are useful not only in psychology, but in many other fields such as zoology, medicine and sociology where a multitude of complex variables has to be considered. Other advantages have been listed earlier on in this chapter. However, in making use of these methods, one should not allow oneself to be carried away by the implications - or supposed implications - of the results, but should remember that factor analysis is a tool, a statistical instrument to be used with as much care and the results treated with as many reservations as any other procedure. Factor analysis allows for the preliminary structuring of a field to obtain a rough picture of the influences or concepts at work and to avoid experimenting with trivial problems.

If a variable z is to be represented in terms of hypothetical, "abstract" constructs (or factors) the simplest mathematical model for doing this is a linear one, but even within this limitation there are several possibilities:

Model 1: the variance of the variables is accounted for by common factors which are as numerous as the variables themselves. This was first proposed by Karl Pearson and developed by Hotelling and is known as "component analysis". However, it is unlikely that n variables would contain in themselves, all the causes of their variances.

This model can be represented mathematically by the equation

$$z_j = a_{j1}F_1 + a_{j2}F_2 + \dots + a_{jn}F_n. \quad (j = 1 \text{ to } n) \quad (1)$$

Model 2: The variance is accounted for by n (correlated) common factors and n (uncorrelated) specific factors. Cattell (15) calls this the "free, general factor analysis" model. If some of the n common factors are negligible, then this leads to

Model 3: The variance is accounted for by m (correlated) common factors ($m < n$) and n specific factors. Cattell calls this the "approximating factor analysis" model because some approximation is needed whenever it is applied in practice.

The typical, basic, factor analytical regression equation for describing a variable in terms of a set of common and unique (specific) factors, is

$$z_j = a_{j1}F_1 + a_{j2}F_2 + \dots + a_{jm}F_m + d_jU_j \quad (j=1,2,\dots,n) \quad (2)$$

where the F 's are the common factors and U_j is the factor unique to the particular variables z_j . The common factors account for the correlations among the variables and the unique factor for the remaining variance of the variable. The coefficients, a_{jp} , of the factors (F 's) indicate the weight of the factors F and U in the variable z_j or the degree to which the variable z_j is related to F or U and are usually known as "loadings".

The unique factor contains uncorrelated specific and error factors and may also contain as yet undiscovered common factors.

The mathematical model's symbols refer to population parameters and can only be inferred from observed data.

For one person, i , m

$$z_{ji} = \sum_{p=1}^m a_{jp}F_{pi} + d_jU_{ji} \quad (i=1,2,\dots,N; j=1,2,\dots,n) \quad (3)$$

which means that a person's (i) obtained score is "a linear combination of weighted contributions from his status on common factors, a specific factor and an error component" (Guilford, 52).

The methods of factor analysis aim at obtaining the values of the nm coefficients, a , (factor loadings) which have to be estimated indirectly. Various methods are available for doing this - some are better than others.

Equation (2), written out for each variable ($j = 1$ to $j = n$), forms a set of equations known as a factor pattern which is usually written out as the loadings. In a pattern, the common factors F_p ($p = 1, 2, \dots, m$) may be correlated or uncorrelated, but the unique factors U_j ($j = 1, 2, \dots, n$) are always uncorrelated.

A table of correlations between variables and factors is called a factor structure and can be written

$$\begin{aligned} r_{z_i F_1} &= a_{j1} + a_{j2}r_{F_1 F_2} + \dots + a_{jp}r_{F_1 F_p} + \dots + a_{jm}r_{F_1 F_m}, \\ r_{z_j F_p} &= a_{j1}r_{F_p F_1} + a_{j2}r_{F_p F_2} + \dots + a_{jp} + \dots + a_{jm}r_{F_p F_m}, \\ r_{z_j F_m} &= a_{j1}r_{F_m F_1} + a_{j2}r_{F_m F_2} + \dots + a_{jp}r_{F_m F_p} + \dots + a_{jm}, \\ \text{and } r_{z_j U_j} &= d_j. \end{aligned} \quad (4)$$

The correlations with the unique factors are always identical with the coefficients of the unique factors in the pattern - the rest of the elements r_{pF_p} of a structure are usually different from the a_{jp} pattern coefficients. However, when the F_p common factors are uncorrelated, then the structure reduces to

$$r_{z_j F_p} = a_{jp} \quad (j=1,2,\dots,n; p=1,2,\dots,m) \quad (5)$$

i.e. when the factors are uncorrelated, the structure elements are identical with the corresponding pattern coefficients.

Most often, the structure equations are used to obtain the required pattern coefficients since (4) can be considered as n sets of m linear equations for the coefficients a_{jp} .

The a_{jp} coefficients bear a relationship to the correlation coefficients between the n variables and hence can be estimated from them. For the correlation between 2 variables j and k , the relationship is given by

$$r_{jk} = a_{j1}a_{k1} + a_{j2}a_{k2} + \dots + a_{jm}a_{km} \quad (6)$$

From the pattern,

$$r_{jk}' = a_{j1}a_{k1} + a_{j2}a_{k2} + \dots + a_{jm}a_{km} + (a_{j1}a_{k2} + a_{k1}a_{j2})r_{F_1F_2} + \dots + (a_{j1}a_{km} + a_{k1}a_{jm})r_{F_1F_m} + (a_{j2}a_{k2} + a_{k2}a_{j2})r_{F_2F_2} + \dots + (a_{j2}a_{km} + a_{k2}a_{jm})r_{F_2F_m} + \dots + (a_{jm}a_{k2} + a_{k1}a_{jm})r_{F_mF_2} + \dots + (a_{jm}a_{km} + a_{km}a_{jm})r_{F_mF_m} \quad (7)$$

where r_{jk}' = correlation coefficient reproduced from the pattern.

Now all correlations between unique factors are zero and if, further, the correlations $r_{F_pF_q}$ ($p, q = 1, 2, \dots, m$) are zero (i.e. the factors are orthogonal), then the correlation between the variables, reproduced from the factor pattern, is given by

$$r_{jk}' = a_{j1}a_{k1} + a_{j2}a_{k2} + \dots + a_{jm}a_{km} \quad (j \neq k; j, k = 1, 2, \dots, n) \quad (8)$$

If a factor pattern is an adequate description of the variables, then the residual correlations (when the reproduced correlations are subtracted from the obtained correlations) should not be significantly different from zero, i.e.

$$\bar{r}_{jk} = r_{jk} - r_{jk}' \quad \text{should be } 0. \quad (9)$$

If this is not so, the hypothesis that the model (pattern) can describe the data in a worthwhile manner, has to be altered. To digress slightly in order to fill in the picture more clearly before progressing, a few definitions are necessary. The variance of a variable may be written

$$S_j^2 = \sum_{i=1}^n \frac{z_{ij}^2}{n} = 1 = \sum_{p=1}^m a_{jp}^2 + d_j^2 + 2 \sum_{p < q=1}^m a_{jp}a_{jq}r_{F_pF_q} = 2 \sum_{p=1}^m a_{jp}r_{F_pF_p} \quad (10)$$

For uncorrelated factors,

$$S_j^2 = 1 = a_{j1}^2 + a_{j2}^2 + \dots + a_{jm}^2 + d_j^2 \quad (11)$$

The total contribution of factor F_p to the variances of all the variables, is

$$V_p = \sum_{j=1}^n a_{jp}^2 \quad (p = 1, 2, \dots, m) \quad (12)$$

and the total contribution of all the common factors to the total

variance of all the variables, is

$$V = \sum_{p=1}^m V_p \quad (13)$$

The communality of a variable z_j is the sum of the squares of the common-factor coefficients, viz.

$$h_j^2 = a_{j1}^2 + a_{j2}^2 + \dots + a_{jm}^2 \quad (j = 1, 2, \dots, n) \quad (14)$$

and the uniqueness of z_j is the contribution of the unique factor - an indication of the extent to which the common factors fail to account for the total unit variance of a variable.

The uniqueness can be divided up thus:

$$d_j^2 = b_j^2 + e_j^2 \quad (15)$$

where b_j^2 is the specificity (b_j = coefficient of the specific factor) and

e_j^2 is the error variance.

Thus,

$$s_j^2 = 1 = h_j^2 + d_j^2 = h_j^2 + b_j^2 + e_j^2 \quad (16)$$

and

$$e_j^2 = 1 - r_{jJ} \quad (17)$$

where r_{jJ} is the reliability of the variable.

There are several ways of conducting a factor analysis of a set of data. These can be divided into two groups according to whether they require estimates of communalities or estimates of the number of factors.

The first group includes

- (1) The principal-factor solution
- (2) The centroid solution which was developed by Thurstone and which he himself described as "a computational compromise (involving) much less labour than the principal-axes solution" (in Harman, 58). With high-speed computers now available, there is no excuse for compromising.
- (3) Triangular decomposition (Harman, 58).

The second group includes

- (1) Maximum-likelihood solution
- (2) Minres solution
- (3) Multiple-group solution

For the first group, one of the most defensible methods of estimating communalities (i.e. the diagonal elements of the matrix R) is that of finding squared multiple correlations (SMC's). (Harman, 53; Browne, 9; Guttman, in Harman, 58).

They are obtained from the inverse of the correlation matrix R (with unities in the diagonals), thus,

$$SMC_j = 1 - \frac{1}{d_{ffj}} \quad (13)$$

where SMC_j = communality estimate of variable z_j and d_{ffj} = diagonal element of R^{-1} corresponding to z_j .

The SMC is also the lower bound for the communality, i.e.
 $R^2_{j(n-1)} \leq h_j^2$,
 where $(n-1)$ is the set of variables excluding z_j and hence the SMC's tend to approach the h^2 's if the ratio of n to n tends to zero as n tends to infinity.

Doctor M. Browne has conducted studies on the comparison of different factor analytical techniques (Browne, 9), viz., maximum-likelihood, Thomson, principal factor (with SMC's), weighted principal factor (with SMC's) and centroid solutions. He concluded that the maximum-likelihood estimates of factor loadings were slightly superior to those estimated by other methods, but that this method requires a great deal of computation. Thomson's method requires even more computation and gives less satisfactory estimates. Solutions obtained from using principal factor methods and squared multiple correlations as communality estimates, were only slightly inferior to the maximum-likelihood solutions (unless the sample size was very large) and involved far less computation.

It appears that the Minres solution may be even better than the maximum-likelihood one, but not enough is known about it yet (Harman, 53; Browne - personal communication).

Since the writer employed the principal-factor (SMC's) method of attaining a solution, this is the only method that will be considered in detail. This method is widely used since the advent of the computer and has been adapted for use with these machines.

As the initial set of data, we have an $n \times n$ square, symmetric correlation matrix R , containing $n(n-1)$ correlation coefficients. Remembering that the sum of the squares of the factor coefficients gives the communality of a variable, while any term a_{jp} indicates the contribution of the factor F_p to the communality of z_j , the first step is to select the first-factor coefficients a_{j1} so as to make the sum of the contributions of factor 1 to the total communality a maximum, i.e.

$$V_1 = a_{11}^2 + a_{21}^2 + \dots + a_{n1}^2 \quad (19)$$

and the a_{j1} 's must be chosen to make V_1 a maximum under the condition

$$r_{jk} = \sum_{p=1}^m a_{jp} a_{kp} \quad (20)$$

where r_{jk} = communality of a variable. Thus observed correlation coefficients are replaced by reproduced ones, implying zero residuals.

Reproduced correlation coefficients can be obtained from the latent roots and vectors (i.e. eigenvalues and eigenvectors) of the correlation matrix. It is not intended to give the full mathematical justification for this. (see Harman, 58, pp 130-143).

$$Rq = \lambda q \quad (21)$$

where any number λ_p satisfying this equation is an eigenvalue of R (the matrix) and its associated vector $q_p = \{\alpha_{1p}, \alpha_{2p}, \dots, \alpha_{np}\}$ is an eigenvector of R and

$$\alpha_{jp} = \alpha_{jp} \sqrt{\lambda_p} / \sqrt{(\alpha_{1p}^2 + \alpha_{2p}^2 + \dots + \alpha_{np}^2)} \quad (22)$$

Thus the problem is reduced to the determination of the eigenvalues and eigenvectors of the reduced correlation matrix R' (i.e. the matrix with estimates of the communalities in the diagonals). One method of achieving this is the Jacobi method. This involves the diagonalisation of R by reducing every off-diagonal element to zero in turn. An element reduced to zero does not usually remain so during other transformations on other elements, but with a sufficient number of iterations, the off-diagonal elements of R will converge to zero (to a specified number of decimal places).

The matrix R is reduced to a diagonal matrix D, and after a number of iterations,

$$D = BRB' \quad (23)$$

where $B = B_1 B_2 \dots B_n$

The diagonal elements, λ_p , of D are the eigenvalues of R and rows of the final orthogonal transformation matrix B, contain the corresponding eigenvectors $\alpha_p = (\alpha_{1p}, \alpha_{2p}, \dots, \alpha_{np})$.

The coefficients of each factor F_p are then obtained from

$$a_p = \alpha_p \sqrt{\lambda_p} \quad (24)$$

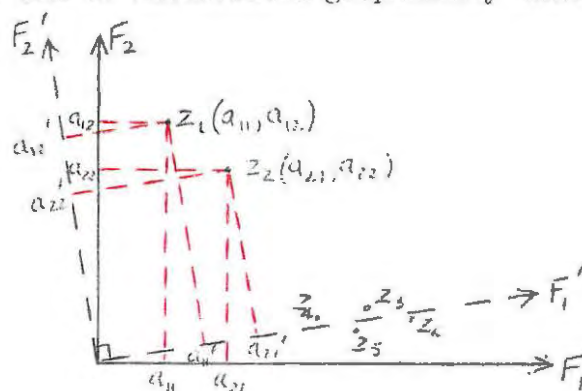
i.e. $A = B'D^{1/2}$

where A is the factor matrix.

Any solution obtained by factorising a matrix R is an arbitrary one. In order to render the solution more meaningful and thus usually easier to interpret, the original solution is often rotated either orthogonally or obliquely to a new set of axes. This is in line with the laws of parsimony inherent in every scientific field of study. There are rules governing this rotation, i.e. general criteria have to be adhered to - one can't rotate to any position one chooses. In practice, there is a choice between rotating according to (a) statistical significance or (b) psychological meaning: some investigators prefer a combination of both approaches (Cattell, 15). To stick to the ^{one} purely statistical approach, ^{one} rotates to obtain simple structure. Thurstone has set forward 5 criteria of simple structure:

- (1) Each row of ^{the} factor matrix should have at least one zero
- (2) For m common factors, each column of the factor matrix should have at least m zeros.
- (3) For every pair of columns of the factor matrix, there should be several variables whose loadings vanish in one column but not in the other.
- (4) For every pair of columns of the factor matrix, most of the variables should have zero loadings in both columns when $m \geq 4$.
- (5) For every pair of columns of the factor matrix there should be a small number of variables with loadings significantly different from zero in both columns. (Thurstone, in Harman, 58).

Thus it is necessary to find a rotational position for each factor in which the majority of variables have zero projections upon it. This can be illustrated graphically thus:



Consider just 2 dimensions F_1 and F_2 of the m -dimensional factor-space (i.e. each factor is represented by a different dimension). A variable z_j may be represented by the vector (a_1, a_2) in 2 dimensions, or by the vector $(a_1, a_2, \dots, a_m)$ in m dimensions.

The reproduced correlations of the 2 variables z_1 and z_2 , is the scalar product of their vectors in the common-factor space and their loadings (a 's) on the 2 factors F_1 and F_2 are the projections of the variables on the axes F_1 and F_2 . The a 's are the initial loadings and the a' 's are the final loadings after rotation of the axes.

Programs aimed at providing good simple structure have been devised and can be restricted to orthogonal solutions (i.e. keeping each pair of factors at right-angles to one another) or can be open to oblique solutions as well (i.e. allowing the axes to intersect at an angle of $<$ or $> 90^\circ$). Obviously, as far as simple structure is concerned, oblique rotation would be better, but in practise the results are often very difficult to interpret and add little to a clearer picture of the field being studied.

One main method of orthogonal rotation is the Varimax procedure which is a modification of the quartimax method (Harman, 58). The criterion for rotation requires that the final factor loadings b_{jp} maximise the function

$$V = n \sum_{p=1}^m \sum_{j=1}^n (b_{jp}^2 / h_j^2)^4 - \sum_{p=1}^m \left(\sum_{j=1}^n b_{jp}^2 / h_j^2 \right)^2 \quad (25)$$

where the symbols have the usual significance.

Factors are rotated 2 at a time and the cycle of $m(m-1)/2$ pairs of factors repeated until the value of V no longer increases to a specified number of decimal places. This contains the mathematical equivalent of the notion of simple structure and, furthermore, a varimax solution is invariant over changes in the test battery composition, i.e. varimax factors obtained from a sample will be more likely to represent the universe varimax factors.

As far as oblique rotational solutions are concerned, there are again many to choose from, including quartimin, covarimin, biquartimin, promax and oblimin. An interesting method called the direct oblimin has been developed by Jennrich and Sampson. In this method, a solution is obtained by minimising a function of the primary-factor pattern coefficients, viz.,

$$F(P) = \sum_{p < q}^m \left(\sum_{j=1}^n b_{jp}^2 b_{jq}^2 - \frac{\delta}{n} \sum_{j=1}^n b_{jp}^2 \sum_{j=1}^n b_{jq}^2 \right) \quad (26)$$

where P = primary-factor pattern matrix with elements b_{jp} and where δ can take different values, the most satisfactory solution being obtained when $\delta = 0$, but other values may be better for different numbers of variables and factors, etc. (Harman, 53; Jennrich and Sampson, 65).

One of the problems that arises before rotation is that of the number of factors to be selected. One cannot speak of the exact or "right" number of factors to extract. Mathematically speaking, the number of factors to be extracted is the same as the number of variables, n . Now, both common and specific factors consist of what Cattell calls "substantive" ("real", i.e. found in more than one study) factors and error factors (which are due to errors of measurement and are not repeated in any two studies). If one extracts only permanent substantive factors, then some of the error variance which should have gone into "error" common factors not extracted, will tend to get rotated into the substantive factors. The number of factors extracted should take out as many substantive factors as possible while leaving as many of the error factors as possible behind.

One method of selecting factors is to take the "comprehensive, non-trivial common variance", i.e. an arbitrary but exact value (say 99%) of the common factor variance (Cattell, 15).

One can also consider the number of factors at which the onset of "forless" or "skree" factors begins, i.e. the point at which the decreasing exponential graph of all the eigenvalues flattens off, though this should be used only when the matrix R , is unreduced (Cattell, 15). This same drawback applies to the method of selecting all latent roots ≥ 1 or ≥ 0 as this over-estimates the number of factors. Browne (9) found that the likelihood-ratio test of the number of factors to extract, tends to under-estimate the number and, further, it can be used only with maximum-likelihood solutions. Another possible method is to rotate to simple structure using different m 's (number of factors) until the most "meaningful" number of factors is found. It must be noted that significant factors may or may not indicate meaningful factors.

In order to ascertain which loadings are significantly different from zero, most investigators have been content to select all those loadings $\geq \pm 0.30$, since, for orthogonal rotations, a loading may be considered as the correlation of a variable with a factor and, for a sample of 100 individuals, an ordinary correlation of ± 0.30 would be considered significant (Guilford, 56). Other writers have set up other, still fairly arbitrary values in order to select factor loadings (in Harman, 58). Some writers have suggested different statistical methods of testing the significance of factor loadings, e.g. Saunders, Henrysson and Lawley (in Cattell, 15). Cattell himself favours the direct method put forward by Harris. This test is formulated as follows:

Any loading a_{jp} such that

$$|a_{jp}| \sqrt{\frac{n-m-1}{(1-h_j^2) \text{diff}_p}} > t_x \quad (27)$$

is significantly different from zero, where

a_{jp} = loading of variable j on factor p

diff_p = diagonal element in the p th row and column of R^{-1} (the inverse correlation matrix)

t_x = the critical value of t at a chosen level of significance for $n - m - 1$ degrees of freedom.
(n and m have the usual significance).

Several factor analysts have set forward "hygiene" rules for good, sound factor analytical results (Guilford, 54; Cattell, 15; Harman, 58). Some of these are listed below:

- (1) The number of subjects is important. A rather arbitrary rule of thumb is that the ratio of persons to variables should be at least $2\frac{1}{2}: 1$, because as n (the number of variables approaches N (the number of subjects), there is insufficient information to define the correlations (Cattell, 15). More important than any ratio, is the difference $(N - n - 1)$ which should be large - of the order of 100.
- (2) Factor analysis does not assume normality of distribution of the sample being studied, but simple structure is clearer when scores have normal rather than skewed distributions.

If distributions are fairly normal there is a good chance of regressions between variables being linear.

- (3) Adequate marker variables should be included in the test battery. These are variables that are known (from previous factor analytical studies) to be loaded on a particular factor and help to "nail" the new results down within previously acquired knowledge and help to ascertain whether or not something new has been found. 2 or 3 markers should be included for every expected factor.
- (4) An adequate number of variables should be used in the test battery. At least 3 variables are required for every factor expected in order to indicate the generality of a factor and to define it satisfactorily. Don't extract too many factors for the number of variables. A common factor may not emerge because it is represented by only one variable and therefore cannot be interpreted. Thus a wide range of variables should be used as well.
- (5) Variables should not be factorially complex, i.e. variables should not load significantly on many factors. This simplifies rotation and interpretation of results.
- (6) Variables should be linearly independent - the whole basis of using Pearson r 's rests on this assumption and, therefore, all the factor analytical methods do too. If variables are linearly independent, covariation will be due to the influence of common factors. This is a very thorny problem because if the common factors are found to correlate, it may be because (a) the variables are factorially complex (and hence cause correlations between factors), (b) factors could genuinely correlate with one another, (c) factors may, in fact, be orthogonal but the variables representing them have not been properly constructed so they do not separate properly (thus correlated factors would be artifacts of testing methods), (d) in addition, specific and error variances may serve to confuse the picture. All these reasons make the interpretation of obliquely-rotated factors very difficult. Assumptions of linearity and additivity in psychological measurement ~~are~~ are employed, not because it is assumed that they can give the whole picture, but because they can give first approximations of relationships between variables. Any errors arising from these assumptions are conservative, i.e. they simplify the picture and do not result in odd relationships - they are part of the true story (Digman, 23).
- (7) Data should be in continuous ranked form (though Thurstone says non-continuous scores can be used; (in Kerlinger, 63). Ipsative scores cannot be used for R-technique (for inter-individual studies) but only for Q-technique (for intra-individual trait studies). Only normative scores can be used. Tests do not have to be very long.

- (8) The sample population should not be very heterogeneous, e.g. the subjects should be very much alike as regards age, sex and education, especially if it is possible that the experimental variables are related to such attributes.
- (9) Don't extract too few factors - no harm appears to be done if too many are selected - some will just emerge as residual factors during rotation. Most criteria for selecting the number of factors are too severe. (Guilford, 54).
- (10) Rotation must be carried out blind, i.e. by automatic rotation programs, so that the investigator does not just select the positions he finds most convenient.
- (11) Apply a test of simple structure, though these (e.g. Bargmann's) tend to be too harsh (Cattell, 15).

Criticisms of the factor analytical method include:

- 1. Factor analysis is statistically inadequate. The position here is improving all the time. The statistical basis of the method has and is receiving more attention. (Cattell, 14; Digman, 26).
- 2. Rotation of axes is too subjective. This need not be so, as mentioned above.
- 3. The method is too complex - hardly an adequate criticism.
- 4. Factors obtained are merely artifacts of the method used and have no psychological reality. This is irrelevant. All scientific constructs are averages and inventions of the scientist. They are invented or created to aid descriptions and understanding of a phenomenon. For a scientist, the basic criterion of reality is its empirical reality. If we can use factors to understand a psychological phenomenon and predict behaviour (in its widest sense) from them, then they are "real".

The pointers and theory given above serve as a guide to good factor analysis. It is obvious that it is important that careful planning must precede and accompany the use of the statistical tool of factor analysis.

- CHAPTER III -

FORMULATION OF HYPOTHESES.

The field and scope of this study has had to be circumscribed - as must every study conducted by a single individual. The approach is, therefore, a somewhat "blinkered" one, shutting out some aspects of the problem of creative thinking. At this point in time, it is virtually impossible to take cognisance of all theories and even if one could, there would still remain the problem of variables no-one has yet thought important or, perhaps, even thought of. Presented here is one way of attempting to produce a picture of creative processes in children of one age range (5-7 years), with at least some of the probably important variables represented. A great deal can be learnt from this rather austere approach, but it must be remembered that this is by no means the full story - it is doubtful whether anyone will ever recount it.

The major hypothesis of this study is:

HYPOTHESIS H₁: a test battery containing representatives of different semantic-content, divergent-production aptitudes and other aptitudes considered important in creative thinking, when administered to a sample of boys in the age range 5-7 years, will exhibit a factor structure similar to that found in adolescents and adults. The factors will not be as clearly differentiated as in the older age groups, i.e. clearly distinguishable factors will not be completely developed at this early stage.

The two sub-hypotheses linked to this hypothesis are:

HYPOTHESIS H₁ (a) The positions of the sub-tests of the Torrance Tests of Creative Thinking in the overall factor structure will be as shown in the factors hypothesised below.

Some factors may be equated with Guilford's divergent-production factors: others are newly-hypothesised factors.

HYPOTHESIS H_1 (b) Guilford's "semantic content area" can be divided into two parallel content groups, one being semantic concrete content (analogous to Torrance's "non-verbal" or "figural" category, but not synonymous with Guilford's "figural" category) and the other being semantic, conceptual content (analogous to Torrance's "verbal" category). The two types of content areas are defined below.

Semantic, concrete content: this type of material is meaningful and can be represented pictorially. Information is given in concrete form to which meaningful labels can be attached. It is distinct from the figural content area, which has its meaning in the structure of the figures, e.g. $\bigcirc$ would represent figural information, but $\odot$ would represent semantic, concrete information.

Semantic, conceptual content: this type of material is meaningful and wholly verbal. Information is given in conceptual or abstract form (and thus is already labelled) and cannot be represented in concrete form (e.g. story themes) or at least, is not handled pictorially in a particular test, e.g. verbally-stated instances of the category "things that are round".

Shapiro (108) maintains that the creative individual tends to use an abstract mode of thought and the non-creative individual a concrete style of thought. The latter is thus stimulus-bound and insensitive to the objectively unobservable. The writer disagrees strongly with this - an individual can be creative using either mode of thinking.

The factors in Guilford's SI model in the semantic content area are listed below for easy reference since some of the writer's hypothesised factors are based on Guilford's factors. Only the semantic content area was studied. The product categories "Relations" and "Systems" were not studied because marker tests for these categories seemed too difficult for the children tested for the purpose of this study. Thus the writer was not concerned

with all the Guilford factors.

- (a) DMU (divergent production of semantic units) - ideational fluency, which is "the ability to produce many ideas to fulfill certain requirements in a limited time". (Guilford, 53). Marker tests are Consequences, Plot Titles and Topics, all of which can be considered to involve semantic, conceptual material, and the Utility Test and Rorschach R score which seem to involve semantic concrete material.
- (b) DMC (divergent production of semantic classes) - spontaneous flexibility which is "the ability to produce a diversity of ideas in a relatively unstructured situation" (Frick et al., 33). Marker tests are Unusual Uses, Object Naming and Multiple Grouping. The latter definitely employs semantic, concrete information, but the first two may be considered to involve conceptual material which could be concretely represented.
- (c) DMR (divergent production of semantic relations) - associational fluency which is the production of relations, e.g. thinking up synonyms or opposites of words. Tests of this factor are Controlled Associations, Inventive Opposites and Multiple Analogies, all of which appear to have semantic, conceptual content.
- (d) DMS (divergent production of semantic systems) - expressional fluency which is fluency in producing phrases or sentences. Tests for DMS are Unfinished Stories, Word Arrangement and Sentence Fluency which again have semantic, conceptual content.
- (e) DMT (divergent production of semantic transformations) - originality which requires (i) unusual or rare responses, (ii) remote associations, or (iii) "clever" responses. Marker tests are Consequences (remote), Quick Responses (remote word associations) and Plot Titles (clever). All appear to involve only semantic, conceptual information.
- (f) DMI (divergent production of semantic implications) - elaboration such as planning and taking steps to solve problems. Tests are Planning Skills, Unusual Methods and

Possible Jobs. The two former tests seem to use semantic, conceptual material and the latter uses semantic, concrete material.

Guilford's DFI or figural elaboration, presents a problem. In theory, it should involve non-semantic additions to pictorial material, e.g. adding detailed decorations to objects and building up objects from simple lines, but the elaborations themselves may be meaningful and hence would fall in the DFI category.

Guilford seems to recognise the difficulty with his semantic content area when he says (Frick et al., 55) it is possible that what he called "originality" is actually adaptive flexibility when dealing with verbally meaningful material since his originality tests are all conceptual-type tests. However, he just mentions this possibility in passing and its implications are not followed through.

In the Torrance Tests of Creative Thinking, figural or non-verbal tests denote those which require drawing in the form of completing pictures or adding lines to make meaningful objects, whereas the verbal tests require the subject to think up ideas when faced with different kinds of situations. The figural and the verbal tests are quite a sharp departure from Guilford-type tests in that they are much more complex. Torrance has attempted to construct tests that are models of the creative process, "each involving different kinds of thinking and each contributing something unique to the (test) batteries". The products of the tests are evaluated in terms of Guilford's factors of fluency, flexibility, originality and elaboration. These types of tests are likely to provide a much more "true-to-life" picture of creative processes than Guilford's very pure, stringent and restricted marker tests because they are more complex and involve many different kinds of thinking. For this reason also, a clear factor structure cannot be expected. This complexity is hinted at even in Guilford's studies where Brick Uses (fluency), Consequences (remote) and Unusual Uses (fluency) are all loaded together with Brick Uses (flexibility) on the factor spontaneous flexibility. Unusual Uses (fluency) is also found loaded on the

factor originality (Frick et al. 38). Possible reasons for these occurrences are discussed at different points in this chapter and in Chapter V.

The factors hypothesised under H_1 are as follows:

1 - FLUENCY

- 1a. the ability to produce many appropriate ideas when dealing with semantic, concrete stimuli. Quality of response is not important.
- 1b. as above, but dealing with semantic, conceptual stimuli.

In the SI model, both (a) and (b) would be called DMU. In terms of the Torrance Tests, (a) is figural fluency and (b) is verbal fluency. In both cases, fluency means sheer quantity of relevant output when quality of response is ignored and unusual responses are not counted. Guilford, Merrifield and Cox's (56) marker variables for DMU were Consequences, Utility test (fl.), Ideational fluency and Plot Titles. Frick et al. (38) found Plot Titles and Brick Uses (fl.) loaded on the same factor - ideational fluency. Guilford (50) sees the essence of a measure of this factor as "thing listing" - the best results being obtained with a particular class defined by two adjectives, e.g. things that are square and white. Other possible tests are Topics or Theme (when the score is the number of words written on a subject) and the R score (total productivity) of the Rorschach test (Guilford, 50). The fluency tests hypothesised to be loaded on these two factors are listed below. The starred tests are Guilford-type marker tests.

(a) Line Meanings	(b) Just Suppose*
Rorschach R score*	Unusual Uses*
Make-a-Figure	Stories*
Circles	Ask and Guess
Incomplete Figures	Product Improvement
	Instances

In considering the Torrance Tests' methods of scoring flexibility, it seemed that there are actually two types of flexibility.

One is the ability to diversify ideas to fit different classes or at least to produce responses that can be separated into different categories, the other type is the ability to shift or change one's approach in interpreting a situation. This^{is} especially evident in Torrance's Just Suppose test where he actually uses the word "shift" instead of "flexibility". He says "instead of using static categories as in the other tasks, flexibility is defined in the Just Suppose test as a change or shift in attitude or focus. Thus two types of flexibility factors are hypothesised.

FACTOR 2 - FLEXIBILITY

- 2a. the ability to produce diverse ideas fulfilling certain class or category requirements when dealing with semantic, concrete information. The ability to avoid rigidity, overcome sets and to be free from inertia is important.
- 2b. as above, but for semantic, conceptual material.

Guilford's DMC or spontaneous flexibility factor would cover both (a) and (b). This was first discovered by Wilson et al. and is named "spontaneous" because there is nothing in the tasks set that tells the subject or suggests to him that he should be flexible. He alone decides to produce varied class responses. Guilford points out that sometimes some DMT variance is introduced into this factor because in diversifying his responses, the individual is almost bound to use transformations in dealing with the stimulus. Frick et al. (39) found this to occur in their study. The variables on their factor were: Brick Uses (flex.), Object Naming, Unusual Uses, Brick Uses (fl.) and Consequences (remote). In their 1966 study, Guilford and Hospfner found the test Multiple Grouping went with their Unusual Uses and Alternate Uses tests on this same factor. Again, class flexibility is involved because in Multiple Grouping the subject is required to group several objects together in different ways according to different common properties they might possess.

Tests hypothesised to load on these factors are:

- | | |
|---------------------|---------------------|
| (a) Circles* | (b) Instances* |
| Incomplete Figures* | Unusual Uses* |
| Structured Drawings | Product Improvement |
| Animal Sorting* | |

FACTOR 3 - FLEXIBILITY

3a. the ability to shift or change one's approach to a situation involving semantic, concrete material.

3b. as above, for semantic, conceptual material

This factor would seem to involve Guilford's adaptive flexibility ability first found in 1954 (Wilson et al.), but dealing with semantic content and yet it is not, as Frick et al. thought, synonymous with originality. They thought that their adaptive flexibility factor might be an originality dimension pertaining to figural and structural material. Since tests of originality have been almost exclusively conceptual, they then thought that their originality factor might be "conceptual, adaptive flexibility". Restructuring is important in flexibility and could also be important in originality. Frick et al. (38) say, "More obvious, possible structures have to be replaced by less familiar ones. Interpretations must be reached that are out of the ordinary". The writer does not agree. Originality involves unusual responses, but this factor involves adapting, shifting, redefining and transforming. Thus, if this factor belongs in the DMT cell, originality is crowded out of its position there. This could be the true position, i.e. the product category "transformations" is concerned with revisions, redefinitions and adaptations, all of which can occur in flexibility. Perhaps there is yet another product category which would hold the "originality" ability: it is possible that Guilford has been wrong in placing it in the DMT cell. The essence of originality is unusualness. Originality may belong in a cell DMT(u) - production of unusual transformations, not merely a transformation which may or may not be original. Of course, some transformations will be unusual ones, hence low loadings for some originality variables are to be expected.

Tests for these factors are:

- | | |
|-------------------|---------------------|
| (a) Line Meanings | (b) Just Suppose |
| Make-a-Figure | Ask and Guess |
| Rorschach | Product Improvement |

The test Make-a-Figure presents something of a problem because, unlike the other concrete tests, the elements of the stimulus do not have roles in any previous composite. Guilford states that transformations involve redefinition of elements that are already playing a role in some other composite, whereas in his Making Objects test (similar to Make-a-Figure), each element is separate and presented apart from any organised whole. This is incorrect to some extent because once one object is made with the separate elements, a new object can be made only by transferring or changing the roles of the elements already used. Guilford places his Making Objects test in the cell DFS, but many other tests may be considered to involve systems, e.g. Product Improvement, Stories, Unusual Uses. It is much more likely that transformations are the important products involved in Make-a-Figure and in the other tests listed here.

FACTOR 4 - ORIGINALITY

- 4a. the ability to produce rare, unusual, but appropriate ideas when dealing with semantic, concrete material. This involves seeing a situation in a novel, unusual way, playing with ideas, entertaining possibilities and impossibilities, making "mental leaps" and transforming or redefining a situation to arrive at an unusual response.
- 4b. as above, but for semantic conceptual information. Both (a) and (b) would fall under Guilford's DMT (originality) factor, but it is likely that originality belongs in another category - DMT(u).

Guilford (50) has discussed the role of transformations in originality tests. The writer considers that to be original, the subject must shift his view of the situation but he must shift it to a new, unusual angle, not just a different one as Guilford mentions. In the tests used here, no tests scored for "cleverness" of response were included: most were assessed according to infrequency of response and what some investigators have called "creative strength", i.e. a response involving a large and surprising transformation. One test (Quick Responses) was assessed on the remote-association principle championed by Mednick as the

basis of creative thought (34). The Just Suppose test may also be conceived of as a remote-associations type of test (Guilford has done this) and has been found useful as an originality test in several analyses (Guilford, Merrifield and Cox, 56; Merrifield et al., 88). It is interesting to note that in three out of four ninth-grade samples, the Consequences (remote) test became a weak flexibility factor (DMC) test instead of a DMT test. The influence of transformations appears to be strong in both flexibility and originality abilities. This lends support to the writer's hypothesis of two separate factors DMT (flexibility) and DMT(u) (originality).

Tests for the above factors are:

(a) Line Meanings	(b) Just Suppose*
Circles	Unusual Uses
Incomplete Figures	Stories
Rorschach	Instances
Make-a-Figure	
Picture Construction	
Structured Drawings	

FACTOR 5 - ELABORATION

The first elaboration-ability factor was found in Berger's 1957 study (6) and was represented by both figural and semantic tests. In 1961, Guilford, Merrifield and Cox (56) found that the two types of content could be separated to give two distinct elaboration factors. However, in DFI, the tests used involved merely adding decorative details to named objects, not adding any lines that would be meaningful in themselves (tests were: Production of Figural Effects and Decorations). Thus the semantic, concrete elaboration hypothesised here would not be the equivalent of DFI. The DMI cell has been characterised by tests of planning and seeing the implications involved in different situations. The abilities involved must be defined in a slightly different way for semantic, concrete (a) and semantic, conceptual (b) content.

- 5a. the ability to add details to and to embroider semantic, concrete material. The embellishments themselves would be largely meaningful and not merely decorations. Hence this would not be Guilford's DFI factor, but rather part of his DMI; it is equivalent to Torrance's "figural elaboration".
- 5b. the ability to see the implications in semantic, conceptual material. This would involve being able to set up hypotheses and predict from, or improve on a given situation. Shapiro's "sensitivity to implications" probably belongs here.

Certainly creative thinking can include being sensitive to problems, disturbances and possibilities. This was recognised in the Gestalt concept of creativity where a structure is perceived as incomplete and an individual takes steps to achieve structural harmony. Sensitivity to implications is not mere problem-detecting, but the sensing of disturbances not recognised by others. The importance of the "prepared", privileged mind was noted in Chapter II. Personality influences must play a role here, for the person must be willing to entertain many possibilities and what other people may consider impossibilities. He must not just accept situations as they are; he must be curious, even though such behaviour may lead to uncertainty and many unanswered questions.

Tests:

- (a) Circles elaboration
- Incomplete Figures elaboration
- Pictures Construction elaboration
- Structured Drawings elaboration
- Painting (detail)
- Drawing (detail)
- (b) Product Improvement fluency
- Ask and Guess fluency
- Just Suppose fluency
- Unusual Uses fluency

The first two variables here are similar to those used by Shapiro to measure his "sensitivity to implications".

FACTOR 6 - ORIGINALITY (free).

Both Lowenfeld (76) and Guilford (50) have commented that divergent thinking in art will not be exactly equivalent to any one divergent-thinking factor. Hence, although it is expected that the free painting and construction activities will have low loadings on some of the hypothesised factors mentioned above (especially the originality and elaboration factors), they will also represent a separate factor on their own. Therefore, the ability involved here is production of unusual, novel responses when the subject is given a completely free rein. Restraint is imposed by the actual tools and materials with which he has to work, e.g. paints, charcoal, coloured squares. Again, there are two factors here, one dealing with semantic, concrete material (constructing objects, painting pictures) and one with semantic, conceptual material.

Tests:

- | | |
|----------------------|-----------------|
| (a) Painting | (b) Odd Animals |
| Drawing | Stories |
| Mosaics | |
| Toy Construction | |
| Picture Construction | |

Possibly some of the Torrance verbal tests will have small loadings on this factor, e.g. Ask and Guess and Just Suppose, though they are more restrictive about what the subject is required to do.

FACTOR 7 - FLUENCY IN THE USE OF MATERIALS:

This is the ability to make the most of the materials available and exploit them fully. This would seem to be related to openness of perception and also, perhaps, to the elaboration factors because a person who is aware of the possibilities existing in his environment is likely to use them to their fullest advantage. He will explore materials and try to find what they can be used to achieve. As one of five factors distinguishing gifted children from the average in artistic productions, Lowenfeld (76) lists "highly developed sensibility" to different areas of experience, e.g. colour, spatial relations, content, movement, i.e.

they can use materials to obtain maximum effects.

Tests:

- Mosaics (number of squares used).
- Make-a-Figure (average number of pieces used).
- Toy Construction (number of articles used).
- Painting (use of colour).

Secondary, or minor hypotheses of the study were:

HYPOTHESIS H₂: A test battery containing representatives of perceptual abilities will exhibit the following factors which are important in creative processes:

FACTOR 1 - PERCEPTUAL FLEXIBILITY.

The ability to isolate parts of a larger organisation and produce new wholes by reorganisation and transformation of the roles of the elements of a figure. A better name perhaps, is "figural redefinition".

This is Guilford's "convergent production of figural transformations" (PFT) and also, partly, Thurstone's "Gestalt flexibility" or second closure factor (123). The ability involves a revision of the interpretation, definition, or use of lines so that new forms are made out of old ones. Only one revision or redefinition is acceptable (i.e. there is only one correct answer in these tests - except for Enclosed Areas) and hence it is a convergent-production and not a divergent-production factor. (Guilford, 50).

One could also postulate a semantic counterpart of this factor - as Guilford has done (Frick et al., 38). Conceptual redefinition (NMT) is measured by Gestalt Transformations in which an object or a part of it must be used in some new and totally different way from its common usage. This factor has not been hypothesised in this study.

Tests:

- Hidden Figures*
- Embedded Figures*
- Enclosed Areas*
- Scribble Colour Spaces

FACTOR 2 - OPENNESS OF PERCEPTION.

The ability to alter one's perception concurrently with significant changes in stimuli. A person with this ability perceives changes in stimuli readily and is willing to admit new experiences, and to be aware of changes. Schnechtel (105) has said that openness of perception is an approach to the world used by creative individuals who view the world from many different angles in a playful manner. The less open individual's approach is "merely a quick registration of its familiar features according to ready labels" (op. cit.). Schulman thinks openness of perception should be involved in flexibility, though the former is a receptive process, whereas the latter is an expressive process (Schulman, 10).

Tests: Changing Figures
 Enclosed Areas

FACTOR 3 - FORM:

Proficiency in perceptual organisation: an ability to produce or perceive good, recognisable organisations. (This would be indicated by a high F+ percentage on the Rorschach test). Rickers-Ovsiankina (101) says that (in the Rorschach test, at least), structural Gestalt principles such as symmetry, contour and closure operate to produce the figural quality which is perceived as an object. The "more accurately these organisational principles are applied in bringing about the particular interpretation, i.e. the greater the figural "goodness" or the *Ergebnis* of the percept, the higher the form of the subject's functioning" (op. cit.). In attaining good form level, the individual has to evaluate and select and delay gratification while he is doing this. If he cannot do this and, instead, forces closure by giving any response which may be suggested by just part of the stimulus, the form of the response will suffer. Korchin, (70) points out that perception can range from "the one extreme of complete autism, to the other in which stimulus determination prevails", i.e. at one extreme, the perceiver takes little or no cognisance of the structure of the stimulus and at the other, he is completely "stimulus-bound" and cannot go beyond what is given.

Tests:

Torrance form
 Make-a-Figure form
 Line Meanings form
 Toy Construction form
 Structured Drawings form

Other tests probably loaded to some extent on this factor, may be Drawing ability and Painting ability and also some of the concrete elaboration tests because form is likely to improve as details are added.

FACTOR 4- PERCEPTUAL ELABORATION:

The ability to introduce other dimensions when perceiving stimuli. It is possible that different factors are involved here, these being:

- 4a. Movement - the introduction of movement, either human, animal or object, when giving a response to a static picture. The perceived configuration is not static, but is seen in motion or in suspended motion (e.g. "balancing" or "about to explode") so that a kind of tension is set up. Mickers-Ovsiankina (101) says the person who gives movement or kinesthetic responses is "less stimulus-bound and less closely dependent on the objectively given than in the case of a form response" (op. cit.). Rorschach, himself, saw movement responses as implying mental productivity or creative potential (in Burchard, 12). In Gestalt theory, too, structuring a stimulus beyond the actual elements given is equated with creativity and not with mere comprehension of the stimuli. In practice, there has been a lot of trouble in trying to find a relationship between M responses and creativity, e.g. studies by Roe (103), Schachtel (105). Other studies have been more successful, e.g. Prados, Steiner, Vles and Pedigo (reported in Burchard, 12). Piotrowski (98) has put forward the hypothesis that "the creativeness indicated by the M reveals itself primarily in inter-personal relationships" (op. cit.) because individuals interested in psycho-social relationships (novelists, psychologists, artists)

produce more M than others (engineers, physicists). It seems likely that M scores may play a part in Guilford's behavioural divergent-production factors which have not, as yet, been studied empirically.

- 4b. Three-dimensional effects - introducing depth or a three-dimensional effect into a two-dimensional, static picture. This is another way in which Rorschach responses have been scored. The picture, again, has a third dimension added - this time a spatial dimension so that the picture assumes depth and perspective. Often this was subsumed under the chiaroscuro (shading) responses, but it can surely occur in simple line drawings as well, where no shading is involved.

Tests:

- (a). Rorschach Movement Score (P.Q.12)
- Make-a-Figure Movement Score (P.Q.12)
- Line Meanings Movement Score (P.Q.12)
- (b) Line Meanings 3-D Score (P.Q. 1)
- Line Meanings Vista Responses (P.Q. 1)
- Rorschach Vista Responses (P.Q. 1)

FACTOR 5 - PREFERENCE FOR DIFFERENT TYPES OF FIGURES:

Using his Barron-Welsh Art Scale, Barron (3) found more original thinkers (both painters and scientists) preferred complex, asymmetrical, dynamic drawings and were averse to figures that were simple and symmetrical. His subjects also preferred paintings belonging to the Cubism, Impressionism and Abstract Schools of Art, i.e. paintings representing attempts at radical reconstruction of the common-sense world of reality. However, Moyles, Tuddenham and Block (92) have criticised this conclusion on the grounds that his figures involved two different dimensions: (i) asymmetry/symmetry and (ii) simplicity/complexity figures. From their study, they concluded that both dimensions seemed of equal and small importance in determining liking for figures, but results were inconclusive.

The complexity/simplicity dimension seems to involve several sub-dimensions. Thus asymmetrical figures could be considered

more complex than symmetrical ones, open figures more complex than closed ones and figures with lots of elements more complex than ones with few elements.

Thus two factors are hypothesised here and both should be bipolar:

5a. preference for asymmetrical figures/dislike for symmetrical figures.

Tests:

Good Figures category 2	
Good Figures category 4	
Good Figures category 6	
Picture Preference	
Good Figures category 1	} negative loadings
Good Figures category 3	
Good Figures category 5	

5b. preference for open figures/dislike of closed figures.

Tests:

Good Figures category 3	
Good Figures category 4	
Picture Preference	
Good Figures category 1	} negative loadings
Good Figures category 2	

FACTOR 6 - PREFERENCE FOR UNUSUAL ANGLES OF PERCEPTION:

This is the ability to interpret line drawings from unusual angles. It is postulated that the most common type of view is sideways on to an object or scene. Front, or head-on views and views from the top or from underneath, will be much more rare. Thus the variables P.Q. 7, 8, 9 and 10 will be positively loaded on this bipolar factor, whereas the variable P.Q. 11 will be negatively loaded. The perceiver organises selectively, his percept bearing "the imprint of individual modes of organisation" (Korchin, 70). Thus some individuals will habitually perceive and interpret objects from less obvious angles.

Tests:

Torrance P.Q. 7 (view from above) Torrance P.Q. 8 (view from back)
 Torrance P.Q. 9 (view from underneath)
 Torrance P.Q.10 (view from front) Line Meanings P.Q. 3 (back)
 Line Meanings P.Q. 7 (above) Line Meanings P.Q. 9 (underneath)
 Line Meanings P.Q.10 (front)
 Structured Drawings P.Q. 7 (above)
 Structured Drawings P.Q. 8 (back)
 Structured Drawings P.Q. 9 (underneath)
 Structured Drawings P.Q.10 (front)
 Torrance P.Q.11
 Structured Drawings P.Q.11 } negative loadings (view from the side)
 Line Meanings P.Q.11

HYPOTHESIS H₂: Creative and non-creative children - as defined by good or poor performances on the Torrance Tests of Creative Thinking - can be distinguished by differences on several creativity and perceptual variables. These are listed below:

Firstly, apart from the angle a person views a scene from, there are other ways of considering how the individual is interpreting a stimulus - these may be called "perceptual qualities" and have been numbered accordingly, P.Q. 1, P.Q. 2, etc. It is hypothesised that the more creative children will show more of the following types of unusual responses than will less creative children:

- (a) Depth, or three-dimensional effects (P.Q. 1) e.g. interpreting a stimulus as a "hole", "a tunnel" etc.
- (b) Panoramic, or vista responses (P.Q. 4) e.g. interpreting a stimulus as "fields stretched out below me".
- (c) Movement responses (P.Q.12) e.g. interpreting a stimulus as "two men fighting".
- (d) Unusual viewing-angles (P.Q.'s 7,8,9,10 e.g. interpreting a stimulus as a view from above, from the back, from underneath or from the front.

It is hypothesised that the more creative children will show fewer of the following types of "errors of perception" than will the less creative children:

- (e) Incongruous responses (P.Q. 2). This type of response occurs when the subject is unable to interpret the whole of a stimulus and thus interprets one part as one object and another part as another, totally unrelated object so that the two objects are randomly juxtaposed and not meaningfully related to one another, e.g. interpreting a picture as "a snowball and a snake".
- (f) Omission of parts of stimuli (P.Q. 3). In this type of response, one or more parts of a stimulus are omitted or ignored - possibly because the whole stimulus is found to be too difficult to interpret.
- (g) Rearrangement of stimuli lines (P.Q. 5). Another way of reacting to a stimulus which is difficult to interpret, is to rearrange (at least mentally) the elements of the stimulus. The subject says, for instance, "it could be a house if this bit was moved over here".
- (h) Repetition of response (P.Q. 6). A subject may give one or more identical (or virtual identical) responses to the same stimulus, e.g. making figures of people in the Make-a-Figure test. This would also appear to be due to difficulty in thinking up different ideas. The subject has to make more responses, and so finds safety and satisfaction in repeating responses already given.

It is hypothesised that the more creative children will give more responses in the following Stories Categories than will less creative children:

- (i) Category A - Destruction. Stories with this element include descriptions of earthquakes, burials, killings, etc. One of Shapiro's main hypotheses was that creative people express more primary process in fantasy than non-creative people do (108), because they allow normally taboo primary process content into their conscious thinking and play with it in order to accomplish some task. This concept has been discussed in detail in Chapter II under the section on psychoanalytic theories. Destruction, disaster and death, with

their connotations of aggression, may legitimately be considered related to primary process material.

- (l) Category B - Irrelevancy. This type of story does not follow the picture content: it is not so much an elaboration on a theme or picture as it is a type of defence against not knowing how to interpret the picture. The child, rather than being restricted by the given picture, chooses to ignore it and wander off - usually into the more familiar ground of a known story. This may, perhaps, be considered as the verbal counterpart of the non-verbal Form scoring, i.e. does the story more or less recognisably fit the given picture?
- (m) Category C - Incoherence. In this type of story, the child seem to be unable to integrate all the objects and situations in the picture he is interpreting, so that the theme or action in his story does not "follow on". Vernon (131) mentions this type of story in his study of the development of imagination in children.
- (k) Category D - Humour. Humour is often an attribute of creative people because it, like creative thought, often involves unusual juxtapositions of ideas and an element of surprise. Getzels and Jackson (44), Vernon (131) and Shapiro (103) have found that creative people employ more humour in fantasy than do non-creative people.
The more creative children will exhibit fewer of the following types of responses in their stories than will the less creative children.
- (n) Category E - T.V.-type stories. The writer has so named the category because this is the main type of theme occurring in this category, e.g. cowboys and Indians or detective stories, but it also includes the well-known fairy tales such as Goldilocks and the Three Bears. The child is faced with uncertainty and rather than venture into the world of creating for himself, he falls back onto the safer, well-known paths of story-telling.

- (o) Category F - Failure. To obtain a score on this category the child would have to fail altogether in giving any kind of story, even in one-word sentences. It would mean that the child is absolutely unable to produce any ideas at all and so is at a complete loss.
- (p) Category G - Description. Such stories consist only of descriptions of the stimulus-picture and are nothing more than an inventories of objects in the picture.
- (j) Category H - Violence. This is similar to Category A and what has been said about Category A also applies here. Vernon (131) and Getzels and Jackson (14) found creative children used more violence, either direct or indirect, in their stories. This could support Barron's hypothesis that creative people do not reject usually socially-taboo ideas, and Shapiro's hypothesis about primary process material, as mentioned above. "Violence" is used here to denote direct aggression, e.g. fighting, and indirect aggression, e.g. hate, dislike or expressed desire to hurt or kill.
- (q) Category J - Discontinuous sentences. These types of stories are collections of one or two-word statements which are usually incoherent, e.g. "fighting.....man dead".

HYPOTHESIS H₄: the degree of structure existing in a concrete stimulus, i.e. the amount of information given in a line drawing which has to be interpreted, will affect both verbal and non-verbal creative processes. The concept of "information" is the number of different line elements or items which are given in a line drawing. The amount of information given will determine the object perceived. As more information is supplied, the probability of obtaining different responses decreases. Thus creative processes will be affected by differing degrees of structure (or information) in the following ways:

- (a) originality scores will decrease as the amount of structure (or information) increases. This trend will be more pronounced in creative than in non-creative children because the former dislike being restrained in their responses, whereas the latter will feel "safer" and happier when dealing

with easily-recognisable stimuli.

- (b) flexibility will: (1) increase with increase in structure for non-creative children, because when faced with ambiguous stimuli they will tend to be non-flexible, whereas the inherent differences in the stimuli as ambiguity is reduced, force the individual to be flexible.
(a) remain static or increase slightly for creative children because they are likely to be flexible even when dealing with ambiguous stimuli.
- (c) form will increase with increasing structure for both groups simply because good form means little or no ambiguity. As structure increases, more information about the object is given and thus form improves through the test: it is inherent in the test material.

Considering the Structured Drawings test, most "changes" to the unoriginal response inherent in the test material, will occur in structure categories 1 and 2 because subjects cannot resist the implications of the stimuli for long.

Creative subjects will delay falling into this trap for as long as possible. Thus their "change number" means will be lower, i.e. they will change their responses to the unoriginal ones only in categories 3 or 4, if at all. The significance of these variables and categories are explained in detail in Chapter IV.

The above relationships will hold for concrete information (as represented by the test, Structured Drawings) and for conceptual information (as represented by the test, Stories).

The hypothesis that structure affects creative processes has some basis in theory. For instance, Garner (41) says that uncertainty implies the idea of choice or discrimination, and creative thinking, surely, is a process which involves complete freedom of choice. In creative activities, a person is free to respond as he wishes and the more uncertainty or ambiguity existing in a stimulus, the more freedom of choice of response he has. Furthermore, the less "set" concerning, or knowledge of, the stimuli the person has the more possible responses he has at his disposal.

Garner uses "structure" to mean the "totality of relations between events" (41), i.e. a set of random dots is meaningless - it has no structure - but the dots could be rearranged or structured to make a meaningful picture. If structure is increased, the pattern eventually becomes redundant, i.e. eventually there is no choice in the interpretation of the meaning of the structure and more cues are given than are necessary for discrimination or recognition. Garner also maintains that increasing structure increases uncertainty because there is more variability. In the case of increasing the structure of simple line drawings and pictures, this certainly is not the case: here, increasing structure increases structural complexity, but also decreases uncertainty or ambiguity of interpretation because the amount of information available is increased.

HYPOTHESIS H₅: The following variables will be related to performance on the fluency and flexibility variables in creativity, but not to the originality variables:

A. e

Father's Occupation

As a child grows older, he is bound to gather more and more information and therefore have a greater repertoire of responses which must affect fluency and flexibility scores.

Father's occupation is an indication of the child's social background. The higher levels of social status are more likely to provide a wide range of stimulating information which again affects the child's "response repertoire". The ability to produce unusual responses should not be affected by these external influences e.g. Getzels and Jackson (44), Styles (117). Altus (1966) found that the eldest child in two, three and four children families he studied, had a higher level of intelligence than that child's siblings. Further, 60% of a group of gifted students he studied were first-born. Perhaps, then, creative thinking ability will vary with a child's sibling position or birth order. It would be interesting to find out if the same relationship

found between birth order and intelligence existed between birth order and creativity.

The more traditionally-accepted indication of a child's intelligence (i.e. the intelligence quotient) is also likely to be positively correlated with the fluency variables because fluency depends on the amount of stored information an individual possesses - an attribute on which the usual type of intelligence scale largely depends - but will not be significantly correlated with other divergent-production variables. This has been found to be true in many studies, e.g. Getzels and Jackson (44), Wallach and Kogan (134) and Styles (117). Wallach and Kogan point out that Thorndike found word fluency and associational fluency to be more highly correlated with intelligence than with other divergent-thinking measures. It will also be correlated significantly with Father's occupation, as people in the higher occupational groups are likely to have higher I.Q.'s and also parents in these groups are more likely to provide a stimulating intellectual background for their children and to encourage the attainment of knowledge.

In Schulman's (107) study on creativity, he found significant positive correlations between the scores on his Enclosed Areas and Changing Figures (CFT) tests and creativity scores. His Enclosed Areas and CFT tests were supposed to measure "openness of perception" - the ability to be aware of subtle changes in perceptual cues in the environment. He concluded that openness of perception was a condition for creativity. It would be worthwhile to compare the results of the writer's study with Schulman's.

All tests, scoring methods and methods of testing the five hypotheses listed above are described in the next chapter. The detailed descriptions of the test variables mentioned under each hypothesised factor in this chapter will aid in understanding the meaning of each factor.

CHAPTER IV
EXPERIMENTAL DESIGN

PRELIMINARY STUDY:

The writer wished to study creative processes along the lines discussed in Chapter III and to conduct the study with children as young as possible. Thus a small preliminary study was carried out on a group of six children - two of 3 years, two of 4 years and two of 5 years of age - using a wide range of tests and activities including all the tests listed later in this chapter. This was to determine which tests could be used and what age group would be best to work with without altering the whole structure of the study.

As a result of this study, it seemed that the earliest age at which one could use the majority of the tests and activities and obtain meaningful results, was 5 years. Only the simplest activities such as painting and block sorting could be understood by the 3 and 4 year olds and even then, several carefully-trained assessors would have to be used to assess the methods and products of the children - and such assessors were not available. The 5 year olds managed all the activities except for two, one of which was Path Interpretation (used by Wallach and Kogan, 134) in which a picture of a route taken by a hypothetical person is shown to the subject who then has to invent a "character" for such a person. The other was Stick Figures (Wallach and Kogan, op. cit.) in which a series of stick figures is shown to the subject who has to interpret the "mood" or feelings of the figure. Both of these tests were dropped from the test battery. A test which was dropped because of the practical difficulties involved, was Incongruities. This was evolved by the writer from Bruner and Postman's (11) work on perception. The writer's hypothesis was that if creative people are more "open to perception" and tend to reject standard ways of perceiving objects and situations, then they should be quicker than non-creative individuals in perceiving incongruity in situations because they are more "open" to their environment

and more willing to allow the perception of unexpected, "dangerous" incongruity. (See Rogers in chapter II). Bruner and Postman used playing cards with reversed colours (e.g. red spades) for their incongruous objects. The writer used pictures, some of which depicted incongruous objects, e.g. a person with snakes for hair, a man with a hat on in a bath-tub. These were to be shown tachistoscopically and the number of trials the subject took to notice the incongruous pictures was recorded. In practice, however, the equipment proved too bulky and the procedure too long for the inclusion of the test in the test battery to be worthwhile.

Of the remaining tests, some had their methods of presentation and explanation modified to make them easier to understand and carry out. Detailed descriptions of these methods and instructions are given later in this chapter.

Tests were chosen according to the hypotheses set forward and thus included both creativity and perceptual tests. Some were adapted from other studies (e.g. Guilford's and Torrance's studies) and some were constructed by the writer as new and possibly useful instruments. At least two marker tests were included for each hypothesised factor. This is correct, standard practice in factor analysis (Cattell, 15; Guilford, 54).

If the aims and hypotheses of this study are somewhat brash and pretentious, the tests and testing methods are modest enough. However, the individual results as well as the results as a whole seem to justify their use. Longitudinal criteria studies would be even more convincing, but of course this must await the passage of time.

CHOICE OF SAMPLE:

As indicated by the preliminary study, the minimum age of the subjects was set at 5 years. Because a large age range is not desirable when using factor analytic methods and yet, still, a large number of subjects is necessary, the maximum age was set at 7 years. This was also a sound step because that age range (5-7 years) included children in the first two years of infant school. This meant one could study creative processes influenced as little as possible by formal schooling (Getzels and Jackson 44;

Torrance, 125) - and even then, schooling is fairly informal at that level. The selection of this age range also made it easier to contact the children because testing sessions could be arranged through the schools.

It was undesirable to include members of both sexes, since the sample should be as homogeneous as possible with respect to traits which might affect scores. Thus only boys were selected because of the greater numbers available, but also because (according to popular opinion amongst both parents and teachers) boys are far less aware of "correct" and acceptable behaviour and responses than girls are at this age, i.e. boys are less inhibited, less "schoolled" than girls are at this age. This type of attitude has been found important in creativity (Getzels and Jackson, 44; Torrance, 127; Styles, 117; Cattell, 18).

Originally there were 131 variables involved. According to Cattell (15), at least $2\frac{1}{2}$ times as many subjects as variables should be used, but only 280 subjects in 11 different schools could be contacted. However, the writer was sure that many variables would be dropped for various reasons and that not all would be suitable for inclusion in the factor analytic test battery - this proved to be the case.

There was no "selection" of subjects - every boy falling into the age range 5-7 years was included in the sample except in one school where a random sample of 20 subjects was taken because the teachers were unwilling to let every child be tested. Of the 280 children initially listed as subjects, 45 were "casualties" due to illness, failure to complete testing procedures and moving away to other towns. Two children were excluded due to defects - one child's motor co-ordination was so poor he could not draw or colour in and the other child refused to give any responses at all, despite attempts at several different approaches. The final sample thus consisted of 233 children.

The 11 schools involved are situated in various types of suburbs within the city area so the children come from many different types of social background. In order to keep a check on the effects (if any) of this variable on the children's performances

on the tests, the occupation of each child's father was obtained from school records and rated on a 7-point scale based on Centers' scale (72) of occupations and social levels, but adapted by the writer and 2 other assessors for working conditions and pay conditions in Rhodesia. This scale is given in appendix B. Different residential areas were also rated by 3 raters and placed in a "social hierarchy" from "most social status" to "least social status".

The children also differed in intellectual ability, being drawn from A, B, C and lower class streams. In order to keep a check on the influence this might have on the results, a group test of intelligence was administered to obtain some measure of each child's level of intellectual functioning. This is reported in the following section.

DESCRIPTIONS OF TESTS AND SCORING METHODS

The final battery of tests consisted of the 3 non-verbal and 7 verbal activities of the Torrance Tests of Creative Thinking (research edition) and 22 other tests - some creativity tests and some perceptual tests. Examples of the tests appear in Appendix A and scoring guides in Appendix B. Whether tests are expected to be concrete or conceptual semantic (as defined in Chapter III,) is indicated after the name of each test: "concrete, semantic" by (c) and "conceptual, semantic" by (cl).

CREATIVITY TESTS:

A. THE TORRANCE TESTS OF CREATIVE THINKING:

The Test tasks are fairly complex and include features using what is known about creative processes at this time. Quoting from Torrance (129), "Although creative thinking may manifest itself in other than verbal and figural forms, some of the most important products are found in these forms. On the basis of the author's analysis of the thinking manifested by scientists, artists, writers, and others in making outstanding creative achievement, he has tried to assemble batteries of figural and verbal activities that require kinds of thinking analogous to the thinking involved in recognised creative achievements".

NON-VERBAL:

Two forms of the Torrance Tests are available. Form B was used here and consists of 3 activities. Scoring is carried out in terms of Guilford's divergent thinking factors of fluency, flexibility, originality and elaboration. Fluency is a measure of the number of ideas a subject can think up in response to a task set or situation in which he finds himself. Fluency is the ability to produce many appropriate ideas.

Flexibility is a measure of the number of times a subject alters his view or approach to a task or situation, e.g. the number of different classes into which his responses fall. Flexibility is the ability to produce diverse ideas fulfilling certain class or category requirements. "Shift" is allied to flexibility (see Chapter III, hypothesis H_4a) and is the ability to change one's approach to a situation, to perceive it or think of it in a different way.

Originality is the ability to produce rare, unusual, but appropriate ideas in response to a specific situation. Scoring methods are described below. Elaboration (non-verbal) is the ability to add details to and embroider a given stimulus. It is measured by counting the number of additions to and embellishments on a stimulus.

1. PICTURE CONSTRUCTION: (c)

The subject has to make a picture using a jelly-bean shape made of orange-coloured paper which can be stuck in any position on a piece of paper. Crayons were supplied and the subject urged to "try to think of something no-one else will think of". To do well, a subject must be able to perceive the stimulus in an unusual way and not complete the task hurriedly, using the easiest and most common interpretations. In contrast to the form of administration suggested in the manual for this test, no time limit was set for this or any other of the Torrance tests except Circles. In the writer's opinion (and others' e.g. Wallach and Kogan, 134), pressure of time should be left out of creativity tests as far as possible. Furthermore, uncommon responses increase with time, so it is dangerous to have short time limits. Fortunately, when

dealing with children, cutting their activity short was unnecessary: no child took an excessive time to complete any task and most of them took a lot less time than that given in the manual (Torrance 129), though this would probably not be true of older subjects. No examples of responses should be given in creativity tests, because there is evidence that this reduces originality and increases fluency (Torrance, 130). Thus examples were given only in Line Meanings and Instances if the subject was completely unable to grasp what was required.

SCORING:

Each subject's picture was scored for originality (unusual use of the bean shape), using the scoring guides supplied in the test manual (Torrance, 129). The scoring scale is from 0 to 5 according to the frequency of occurrence in the 223 records analysed by Torrance. Responses occurring in 5% or more of the records receive a score of 0, (e.g. boat, cloud, roof); responses occurring in 4-4.99% receive 1 point (e.g. face, bus, tree); responses occurring in 3-3.99% receive 2 points (e.g. mouth, lake); responses occurring in 2-2.99% receive 3 points (e.g. plane, hat); responses occurring in 1-1.99% receive 4 points (e.g. neck, table). Other responses occurring in less than 1% of the records and showing creative strength, receive 5 points (e.g. bath-tub, flag, octopus). At this level, scoring is fairly subjective. In practice, the concept of "creative strength" is relatively easy to employ. Responses showing creative strength go beyond the expected, obvious, common ideas and are unusual, unexpected and yet still relevant to the task set. For instance, using the bean shape as a boat or a banana are very usual responses and involve no great departure from the expected, whereas using the shape as a bath-tub or toadstool is unusual, certainly not obvious and elicits some degree of surprise in the observer. These kinds of responses exhibit creative strength and would receive 5 points.

Each picture was also given an elaboration score. One point is given for each detail added to the shape, but only one point for each kind of detail, e.g. insect legs would obtain 1

elaboration point, not one for each leg. Points are also awarded for colouring, shading and decorations. Examples of responses are shown in Fig. 5 a, b, c, d and e. Unfortunately only a few examples can be included.

2. INCOMPLETE FIGURES: (c)

This is an adaptation of the Drawing Completion Test developed by Kate Franck and has been used in many studies on creativity (Barron, 2; Schulman, 107).

According to Torrance (129), an incomplete figure sets up tensions in the individual and these force him to complete it in the simplest and easiest way (cf. the Gestalt concept of structural completion). To produce an original, unusual response, therefore, the subject has to delay release from these tensions in order to enable him to perceive the situation in a new way.

There are 10 incomplete line drawings, each of which the subject could complete as he wishes. Each figure was scored for originality, elaboration, flexibility and fluency all according to Torrance's scoring guides. Originality scores range from 0 to 2, 0 for responses occurring in 5% or more of the records, 1 for responses occurring in 2 to 4.99% of the records and 2 points for all other responses showing imagination and creative strength.

Elaboration scoring is carried out in the same way as for Picture Construction. Flexibility scoring is done by counting the number of different categories into which the responses fall. The scoring guides include a list of 66 categories of responses, e.g. balls, containers, furniture and weapons. Only one point is given for each category. Thus, if a subject makes all 10 drawings into furniture of some sort, his flexibility score would be 1. The fluency score is the number of drawings a subject makes into meaningful pictures (maximum score = 10). As Torrance says (129), this last score is not very useful, as many children complete all 10 pictures. Examples of scoring are shown in Fig.6.

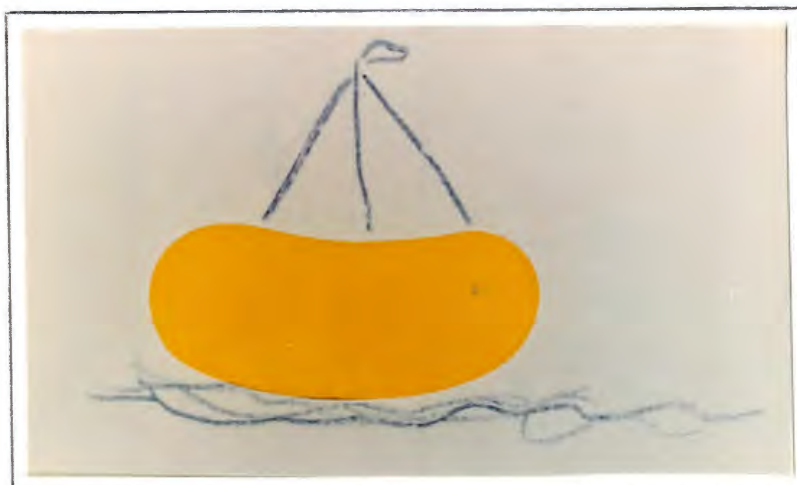


TITLE: In Fairyland where goblins live.

ORIGINALITY: 5 (high)

ELABORATION: 23 (high)

FIG. 5A: Example of Picture Construction.



TITLE: A boat on water.

ORIGINALITY: 0 (low)

ELABORATION: 4 (low)

FIG. 5B: Example of Picture Construction.



TITLE: A man and a little girl.

ORIGINALITY: 0 (low)

ELABORATION: 23 (high)

FIG. 5C. Example of Picture Construction.

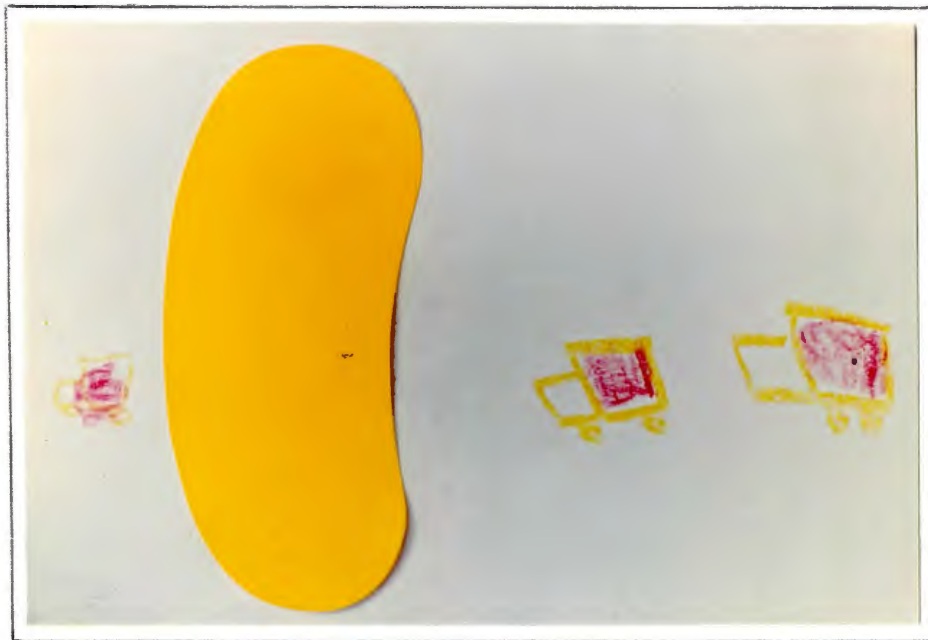


TITLE: A Cocoon.

ORIGINALITY: 5 (high)

ELABORATION: 1 (low)

FIG. 5D. Example of Picture Construction.

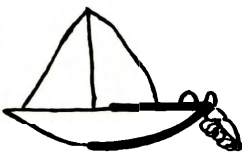
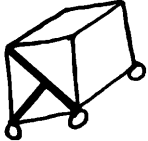


TITLE: A Tunnel and cars going through.
(The tunnel is raised to give a
3-dimensional effect).

ORIGINALITY: 6 (high)

ELABORATION: 7 (low)

FIG. 5E Example of Picture Construction.

1  O = 2 E = 6 swan	1  O = 0 E = 6 boat
2  O = 2 E = 5 swings	2  O = 0 E = 6 house
3  O = 2 E = 6 shark	3  O = 0 E = 1 hand
4  O = 2 E = 12 loggers' camp with river	4  O = 0 E = 1 box
5  O = 2 E = 3 trolley	5  O = 0 E = 3 kite

Originality • O Elaboration • E

FIG. 6 : Examples of Incomplete Figures Test with Scores indicated.

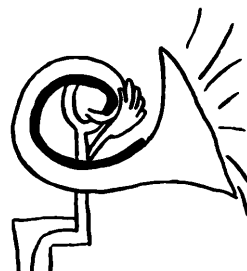
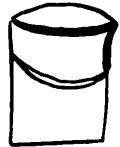
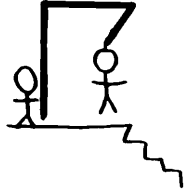
6  O = 2 E = 7 person playing a tuba	6  O = 0 E = 1 "e"
7  O = 2 E = 5 fish and pebble	7  O = 0 E = 6 man
8  O = 1 E = 3 rabbit	8  O = 0 E = 2 flower
9  O = 2 E = 3 pail	9  O = 0 E = 3 head
10  O = 2 E = 5 hanging	10  O = 0 E = 1 flag

FIG. 6: Continued.

3. CIRCLES: (c)

The stimulus material for this test is in the form of 40 circles which the subject was required to make into as many different objects as he could think of, the circle being an integral part of the response. Thus he had to be able to make multiple associations to a single stimulus - where two instances of the same response occurred (e.g. two men's faces), only one was included in the scoring. All responses were scored for fluency (the number of relevant responses completed in 10 minutes), flexibility, originality and elaboration as described for the tests above. Originality scores range from 0 to 2, but where several circles were used for one picture, (e.g. a car), extra points were added to the originality score, one for each additional circle used. Torrance says such responses "reflect a powerful ability to synthesise and depart from the commonplace and expected" (Torrance, 129). Examples of scoring are shown in Fig. 7. Both Incomplete Figures and Circles were also scored for perceptual qualities 7-11, i.e. the number of different angles from which the pictures or objects were interpreted.

VERBAL:

There are two alternative forms for the verbal section as well - Form A was used here. Scoring was also carried out in terms of Guilford's factors.

4. ASK AND GUESS: (cl)

The subject was shown a picture of a person kneeling at some water and was required to (a) ask questions about the picture which cannot be answered just by looking at the picture, (b) guess the possible causes of the action depicted in the picture and (c) guess the possible consequences of the action.

This means that the subject had to set up hypotheses, be sensitive to gaps in knowledge and think in terms of possibilities which are not suggested directly.

All 3 sections of the task were scored for fluency (the number of relevant responses), flexibility (the number of categories into which the responses fall - lists of these are given in

Originality = Orig. Elaboration = Elab.

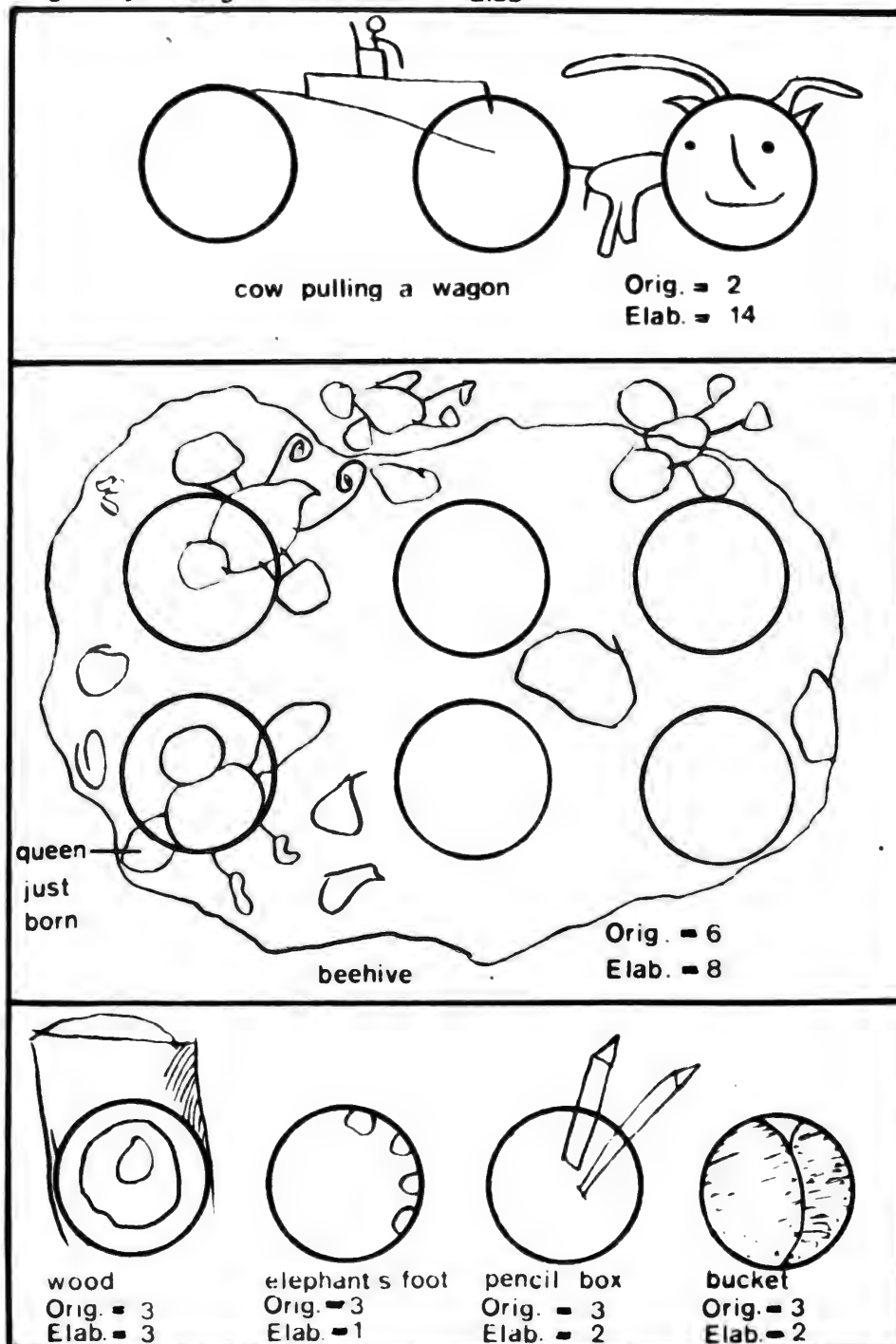


FIG. 7: Examples of Circles

the Torrance Tests' scoring guides) and originality (scores of 0, 1 or 2). Examples of scoring are:

(a) ASKING QUESTIONS.

- | | |
|----------------------|------------------------|
| 1. How big is he? | Originality Score = 1. |
| 2. What does he eat? | Originality Score = 2. |
| 3. What is his name? | Originality Score = 0. |

(b) GUESSING CAUSES.

- | | |
|-----------------------------------|-----------------------|
| 1. He was thirsty. | Originality Score = 0 |
| 2. He wanted to see his new ears. | Originality Score = 1 |

(c) GUESSING CONSEQUENCES.

- | | |
|------------------------------|-----------------------|
| 1. His clothes will get wet. | Originality Score = 0 |
| 2. He'll lose his hat. | Originality Score = 1 |

5. PRODUCT IMPROVEMENT. (cl)

Here the subject was shown a stuffed, blue toy elephant about 6 inches high and asked to suggest ways in which the toy could be improved to make it "more fun to play with". This activity allows the subject to play with ideas and express ideas he could not, or would not, put forward in a more serious task. The responses were scored for fluency, flexibility and originality (originality scores 0, 1 or 2). The flexibility score is the number of different approaches the subject uses in producing ideas, e.g. adding to the toy, changing its shape or altering its position. Examples of scoring (actual responses from this study are quoted) are:

- | | |
|--------------------------------------|-----------------------|
| 1. Make paper come out of its trunk. | Originality Score = 2 |
| 2. Make him walk. | Originality Score = 0 |
| 3. Make it stand on two legs. | Originality Score = 1 |
| 4. Make him play egg and spoon. | Originality Score = 2 |

6. UNUSUAL USES: (cl)

The subject was required to suggest uses for an empty cardboard box or boxes. This is a modification of Guilford's Brick Uses Test. The subject has to overcome a fairly rigid set in order to think of unusual uses. The responses were scored for fluency, flexibility and originality in a manner similar to that described for the other verbal tests, e.g. (actual responses),

- | | |
|--|-----------------------|
| 1. as furniture | Originality score = 1 |
| 2. dig a hole, put a box over it
and cover it with sand and use
it as a trap | Originality score = 2 |
| 3. as a drum | Originality score = 2 |
| 4. as an animal shelter | Originality score = 0 |

7. UNUSUAL QUESTIONS: (cl)

The subject was required to ask questions about cardboard boxes. This test was adapted from Burkhart's Unusual Questions Test (1961), in Torrance, 129).

Factual questions which can be answered by referring to established knowledge, whether they were simple or complex, received zero scores for originality.

e.g. What are cardboard boxes used for?

What shapes are they?

Factual divergent questions involving alteration of the object or projecting the situation into a "new" world where reality is not experienced, obtained originality scores of 4.

e.g. Is there such a thing as a girl or boy box?

Are there more boxes in the world than humans?

Personal, self-involving questions received either 1, 2 or 4 points for originality depending on their "creative strength".

e.g. What do cardboard boxes remind you of? Originality
Score = 1

What things can you make from boxes? Originality
Score = 2

What would you do if you had no
cardboard boxes? Originality
Score = 4

8. JUST SUPPOSE: (cl)

The subject was shown a picture of strings hanging down from the clouds and asked to imagine what would happen if this was actually true. This is an adaptation of Guilford's Consequences test where the individual is faced with an improbable situation and asked to predict possible outcomes.

Scoring is similar to the Ask & Guess activities, e.g.
(actual results from this study quoted),

- | | |
|--|-----------------------|
| 1. Birds wouldn't have to fly
they could just climb. | Originality score = 2 |
| 2. If white cats went up them
no-one could find them because
they'd look like clouds. | Originality score = 2 |
| 3. People could climb them. | Originality score = 0 |
| 4. We could go to the clouds for
holidays. | Originality score = 1 |
| 5. It would be like the man in the
moon fishing in a dam. Children
would eat sandwiches tied to the
strings and he'd pull them out
into the sky. | Originality score = 2 |

Instead of using static categories for flexibility scoring, flexibility, here, is defined as a change or shift in focus so that mental leaps are involved. Thus, the following set of responses would receive a shift (flexibility) score of 1.

People would tie the strings to trees.
People would tie the strings to cars.
People would tie the strings to houses.

B. OTHER CREATIVITY TESTS:

9. LINE MEANINGS: (c)

This test was modified from Wallach and Kogan's Pattern Meanings (134) which they used as a measure of original thinking. The test material consists of nine 4" x 6" white cards with a different simple line drawing on each one (see Appendix A). The subject was required to generate as many meanings or interpretations for each drawing as he could think of - thus the test is somewhat like the Rorschach Inkblots, but using simple, black-and-white pictures.

Instructions: The experimenter (E) says: "In this game, I am going to show you some pictures and I want you to tell me all the things you think the drawing could be. Here is an example

(showed Example Card), what could it be?" If the child gives a response, the E says, "Yes, that's fine. Can you think of something else as well?" If the child does not respond, the E says, "Do you think it could be the sun rising? (or a hedgehog, etc.) Fine, now what else could it be?" When the child gives relevant responses and seems to understand the procedure, the E says, "Good, I can see you know how to play this game, so let's begin".

All 8 cards were given to the child, one at a time, and all responses recorded. The child was continually encouraged when necessary.

Responses were all scored for fluency, flexibility (the number of different categories) and originality (see Appendix B for examples). Originality scores were based on statistical infrequency and the creative strength and relevance of responses within the sample of 233 subjects tested in this study, since no scoring guides were available.

Thus the frequency with which each response occurred was counted and then responses were divided into 4 groups, viz. those with frequencies of 12 or more (occurring in 5% or more of the sample): those occurring 7 to 11 times (in 3 to 4.99% of the sample): those occurring 3 to 6 times (in 1+ to 2.99% of the sample): those occurring only once or twice (in 1% or less of the sample). The originality scores corresponding to these groups are 0, 1, 2 and 3. However, a response occurring just once might not actually receive the highest originality score: it has also to have "creative strength", as discussed earlier.

Flexibility categories were also set up for each item of the test, based on the types of responses obtained from the 233 subjects.

This same procedure was followed for all the tests listed here, except for Quick Responses.

Responses were scored for all the perceptual qualities (1 to 12) listed in Chapter III, e.g. the number of side views, views from above, movement responses, 3-dimensional responses, etc.

Form scoring was also carried out, i.e. each response was given a form score of 0, 1, 2 or 3 depending on the degree to which it was a fair interpretation of the design. This has been discussed in the section on "form factor" in Chapter III. Examples of scoring are given in Fig. 8 and in Appendix B.

10. MAKE-A-FIGURE: (c)

This was adapted by the writer from Guilford's Making Object test in which subjects were given four shapes and had to combine them into named, drawn objects. This was used as a measure of the factor DFS. In the writer's version, the children did not have to draw the shapes: they were cut out in black cardboard and could be rearranged at will. Also, the objects were not named by the experimenter: the child could make anything he wished and was timed for 5 minutes. (Most children did not use all 5 minutes).

Each object was drawn by the experimenter before being broken up so that another object could be made.

Responses were all scored for fluency, flexibility (number of different categories), originality, form and movement responses (see Appendix B). Examples are shown in Fig. 9.

11. RORSCHACH INKBLOTS: (c)

This test has often been used in studies of creativity (Burchard, 12) with special emphasis on the occurrence of movement responses which have long been considered an indication of creative potential (Burchard, op. cit.). This was discussed in detail in Chapter III.

In this study, all 10 blots were not used because it was found that the children in the preliminary study lost concentration and interest after the first few cards. Instead, four cards were selected (Cards 1, 2, 8, 10) - one black, one black and red and two full-colour cards.

All responses, positions of cards and reasons for the responses were recorded. Responses were marked for fluency, flexibility and originality (based on their occurrence within this sample) and also for movement responses, e.g. fighting, dropping, running, flying, etc.

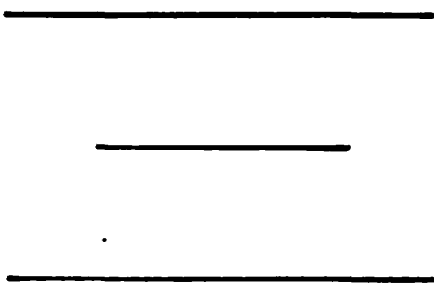
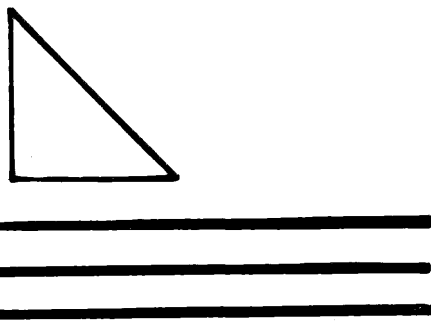
1	
	
Responses: 1. underneath of a helicopter	O F 3 2
2. Daddy, Mommy and baby snakes	1 3
3. house (sideways)	0 2
4. gale	2 2
2	
	
Responses: 1. a gun (inverted)	O F 3 2
2. roof blown in hurricane (inverted)	3 3
3. boat on water	0 3
Originality = O Form = F	

FIG. 8: Examples of Line Meanings Responses

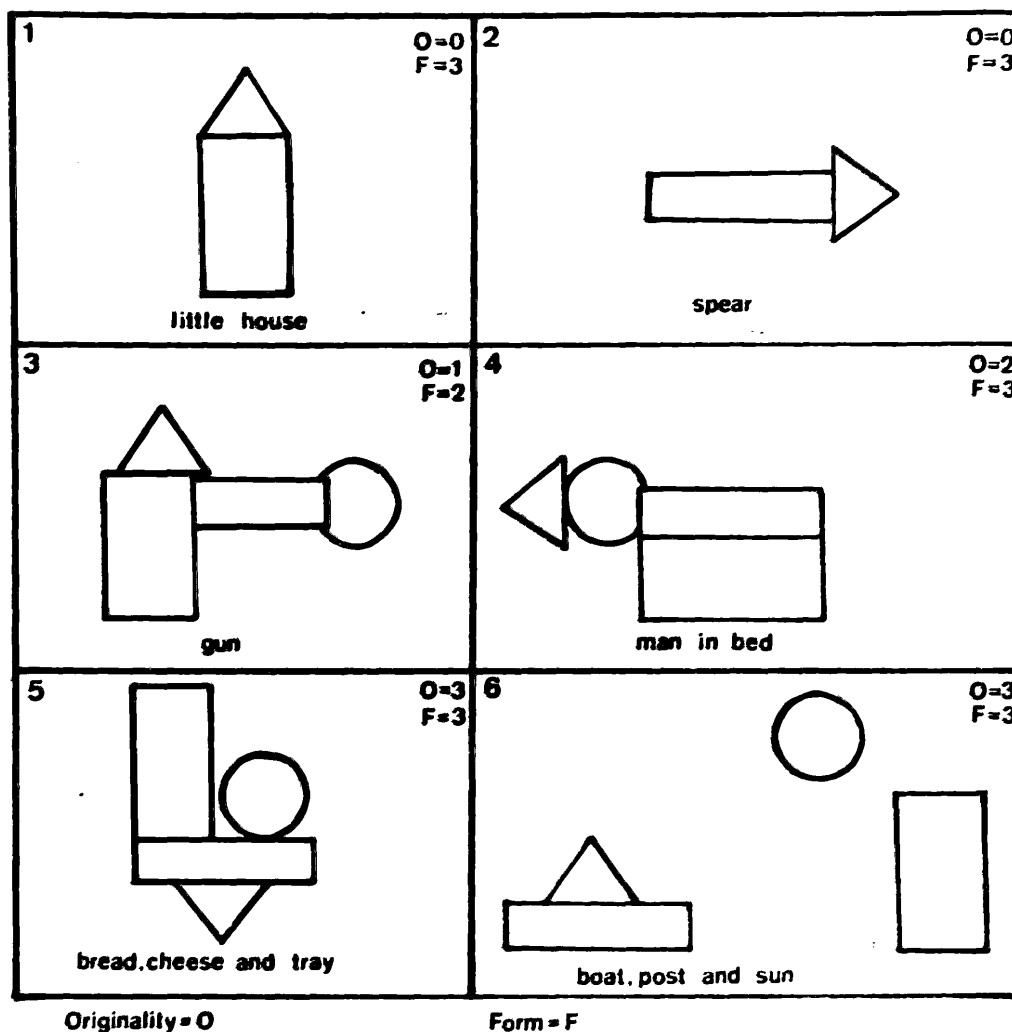


FIG. 9 Examples of Make a Figure Responses and Scores

12. INSTANCES: (c1)

This was based on Wallach and Kogan's test of the same name (134) which was used as an originality measure and on Guilford's Object Naming test (50) - a marker test for Factor DMC. The subject had to generate members of a named class concept, there being 5 classes in all.

INSTRUCTIONS:

The experimenter (E) says: "In this game, I am going to tell you something and I want you to tell me as many things as you can think of that are like what I tell you. For example, I might say, "What things hurt?" Now you tell me all the things you can think of that hurt". If the child gives responses, the E says "Yes, that's fine, I can see you know how to play, so let's begin". If the child is unable to respond, the E says "Well, falling down would hurt, wouldn't it? And burning your hand. What other things might hurt?" The test items are given when the child responds and seems to understand what is required.

All responses were recorded and marked for fluency, flexibility and originality.

13. PICTURE PREFERENCE: (c)

This test was based on Barron's test of a similar nature (2). The writer chose 11 pairs of postcard reproductions of famous paintings. Each pair depicted the same type of scene (e.g. portrait, landscape, still-life) but one of the pair was easy to interpret and understand, whereas in the other, the scene was distorted in some way (e.g. pictures belonging to the Cubism or Impressionism schools of art) and thus further from the photographic type of representation of the more classical, traditional paintings. Only pairs of pictures rated as "abstract" and "easy to understand" by 3 raters, were used in the test.

The cards were shown in pairs to the subject. The pictures were presented in random order (i.e. not always with the more abstract paintings on the same side). All choices were recorded and the subject's score was the number of the more abstract pictures he chose.

INSTRUCTIONS:

The E says, "I am going to show you some pictures, two at a time, and I want you to tell me which one you like better. There is no right or wrong picture to choose, it just depends on which one you like. Here are the first two". If the child says he likes both pictures, he is asked which one he would prefer to have for himself, if he could choose one.

14. QUICK RESPONSES: (c1)

Mednick (85, 86) has used this type of test to explain his associative hierarchy theory.

Guilford used a test of the same name and nature (as a DMT factor test) which, in turn, was based on the Kent-Rosanoff word association test. For the purposes of this study only 10 words were used.

INSTRUCTIONS:

The E says, "For this game, I am going to say a word to you and you must say the first word that comes into your head that the word I say makes you think of. For example, if I say "mother", that word might make you think of "nice" or "father". Now if I say "book", what word does that make you think of?" If the child responds with some sort of relevant response, the E says "Fine, let's begin with the first word". If the child cannot respond or obviously does not understand what is required, the E must give more examples and continue until the child understands. Responses to all 10 words were recorded and each one scored for its degree of "remoteness" from the stimulus word. The scoring guides were set up taking into account the statistical infrequency of each response and the "remoteness" scores as judged by 3 raters (see Appendix B).

15. BLOCK SORTING: (c)

This was designed by the writer who based the idea on (a) Guilford's Multiple Grouping test in which subclasses are made from a list of given words, e.g. classes of objects such as "animals" or "tools" and (b) Piaget-type concept formation tests in which blocks of similar shape, size, number of sides, etc. are sorted into different categories. It occurred to the writer

that, in the latter type of test, the more creative individual might well perceive categories or characteristics of the blocks which a less creative person might not consider because they are not "obvious".

In this test, the subject was presented with 40 blocks: 4 large cylindrical ones, 4 large triangular ones, 4 large half-moon-shaped ones, 4 large cubes, 4 rectangular ones and 4 small blocks of each of the shapes listed. Each member of a set of blocks was a different colour - either blue, red, yellow or green.

INSTRUCTIONS:

The E says, "Here is a whole set of blocks. I want you to find all the blocks that could belong together. Put them in one place on the table and tell me why they go together. See how many ways you can find of putting the blocks together".

Each grouping method was recorded, together with the number of blocks in the group. Groups received scores on originality, again based on the statistical infrequency of the particular group. Records were also scored for flexibility (number of different types of groups) and the average number of blocks in the groups.

16. ANIMAL SORTING: (c)

Because the writer had her doubts about the number of groups children could successfully find using the blocks, and because she thought toy animals would be easier for children to work with, a similar test using toy plastic animals was constructed. It was also thought there would be a greater number of possible groupings and more scope for original responses using animals.

INSTRUCTIONS:

The E says, "Look, here is a box of different animals. I want you to find all the animals that go together or belong together for some reason. Put them in one place on the table and tell me why they go together. See how many different ways you can find. Put the animals back with the others each time you find some that go together". If the child has no idea what to do, the E must give him an example of the 3 horses forming a group and then encourage him to find his own groupings.

Records were scored for the number of different legitimate groupings found, e.g. animals without tails, wild or domestic animals, animals that live in water, etc., the unusualness of the groupings and the average number of animals per group.

17. MOSAICS: (c)

This task was based on Barron's Mosaics Test (2). Subjects were given 2 packets, one containing 36 coloured squares of cardboard (9 each of the colours yellow, red, green and blue) and the other containing 18 white and 13 black cardboard squares.

Subjects were asked to make any pictures they wished on a wooden tray with two compartments - one for the coloured picture and one for the black and white picture, as the influence of colour or absence of colour on originality scores was to be studied.

The titles, comments on the pictures and the pictures themselves were all recorded and assessed for originality (see Appendix B). The number of pieces used in each picture was also counted and recorded.

18. PAINTING: (c)

This activity consisted of two parts - colour painting and black and white drawing. Subjects were given sheets of paper of standard size and the same colour range in paints and asked to paint anything they wished. For the drawings, charcoal or black crayon was used instead of paints. Comments on the pictures and titles were recorded.

At this age, for a child to be told to paint "anything" is quite an unusual experience. The uncreative children were expected to react to the strange and insecure situation by drawing simple, everyday, "safe" objects (cars, planes, trees) or depicting familiar fairy stories, whereas the creative children were expected to rise to the occasion and really be free to enjoy themselves and play with ideas. Black and white pictures were obtained in order to ascertain whether restraint on colour would affect reactions and results.

The paintings were assessed "blind" by three raters, i.e. no one rater knew the scores given to a particular picture by

the other two raters and no rater knew the identities of the painter. Two raters were trained artists both of whom had had experience in judging children's paintings: the third rater was the writer. Before assessment, the three raters discussed the concepts involved in the assessment variables listed below in order to ensure that the same standards would be used:

- (1) Use of Colour: this is the total effectiveness and uniqueness of the colours used. This variable was used in Mosteller's study on the evaluation of children's creative ability in painting (reported in Mednick, 86). Sensitivity of colour relationships and the creation and use of new and unusual colours was taken into account. It is interesting to note here that one of Lowenfeld's five major factors which he thinks distinguish gifted children, is a highly developed sensibility of movement, colour and space (Lowenfeld and Lambert Brittain, 76).
- (2) Composition: this is the use of 2-dimensional space, the utilisation of the total painting surface and the attention paid to the interrelations of the objects in the picture (Mosteller, in Mednick, 86). This is similar to Lowenfeld's description of "coherence of organisation" to achieve elegance and harmony (Lowenfeld and Lambert Brittain, 76).
- (3) Ability: considering the quality of artistic ability is yet another way of assessing painting, though the level of the use of symbolism, perspective, depth, etc. is thought to be highly correlated with intelligence, rather than being of great importance in creative ability (Mosteller, in Mednick, 86).
- (4) Originality: this implies the use of unusual subject-matter or unusual treatment of subject-matter, taking into account the overall quality and creative strength of the response and is the equivalent of Lowenfeld's "intuitive quality of imagination" (Lowenfeld and Lambert Brittain, 76), which is another quality distinguishing the child gifted in art.

19. CDD ANIMALS: (c1)

This task was originated and constructed by the writer, to whom it occurred that, if learning a language is one of the most creative activities there is (Styles, 118), and since young children very often invent their own words for objects or situations, then perhaps this type of behaviour could be elicited in older children and employed as a measure of creative ability.

The test material consisted of five 6" x 8" white cards with colour drawings of fantasy animals on each card. The subject was required to think up a name for each animal and to describe its habitat and its eating habits.

INSTRUCTIONS:

The E says, "I will show you pictures of some very strange animals you have never seen before. Now, they haven't any names so I'd like you to think up names that you have just made up in your head. I'd also like you to tell me where you think they might live and what they eat. Just make it up in your head. Here's the first animal".

It was expected that the less creative child would resort to known names elicited by a part of the fantasy animal that reminded him of a known animal, or else he would just describe the picture. The more creative child would invent fantasy names, strange places for the animal to live in and odd things for it to eat.

Responses were scored for originality and flexibility - categories of responses and their appropriate weighted scores are listed in Appendix B, e.g. known animal names received 0 for originality, known fantasy names received 2 and original fantasy names received 4. Examples of responses are also shown in Fig. 10.

20. TOY CONSTRUCTION: (c)

This was an original test constructed by the writer who considered it would be useful and interesting to try something different from the usual paper-and-pencil creativity tasks. A creative individual might give evidence of his creative potential when model-building, but the usual type of model-building with

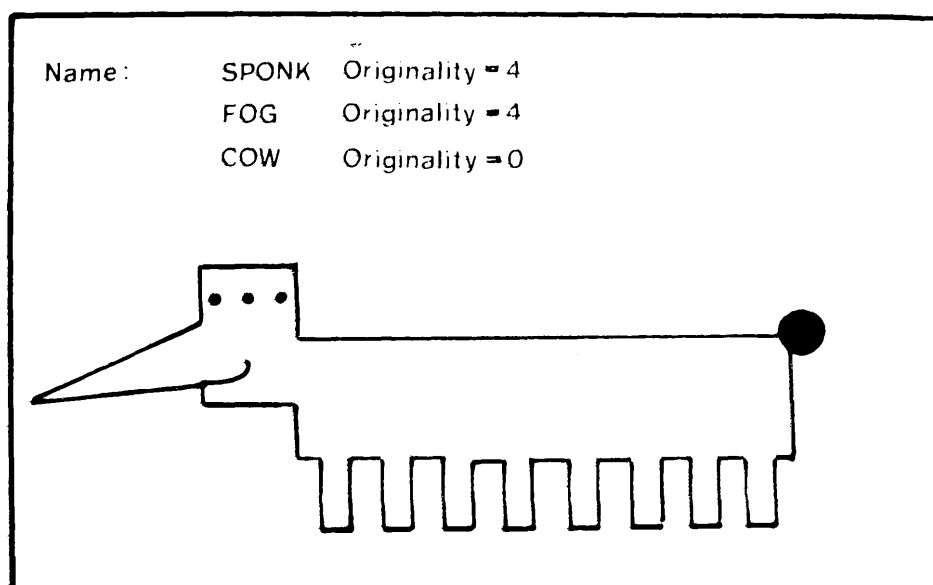


FIG. 10: Example of Odd Animals Test

standard equipment and parts, is more a test of dexterity and "talent" than an activity eliciting creative thinking. Lowenfeld (76) has stated that a creative person can synthesise as well as analyse: he can make meaningful combinations of elements, define uses for materials and exploit their possibilities in order to arrive at something new.

Subjects were each given a board 12" x 12" and a packet containing relatively "unstructured" materials such as straws, blocks, plasticine, metalic cobs, hairpins and cigarette filters and asked to make anything they wished with all or some of the articles supplied. All comments and explanations were recorded together with a drawing of the completed model.

In this activity the children were faced with something they had very probably never encountered before (indeed, several teachers adopted this idea and used it in their classes). The materials supplied were familiar, but had no clues attached as to how they could be used. The uncreative child, faced with so many uncertainties, was expected to restrict his construction to a simple object with the simpler articles, whereas the creative child was expected to explore the possibilities inherent in the unstructured material and to make the most of them and the very free situation in which he found himself.

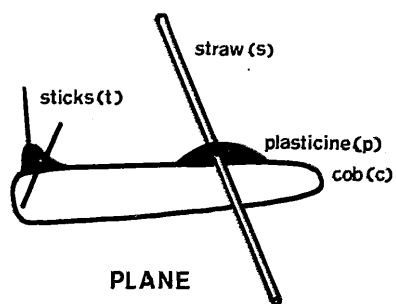
Constructions were scored for originality of theme (also incorporating originality in the use of the materials), the number of articles employed and form (i.e. was the construction fairly easy to recognise for what it was intended to be). Examples are given in Fig. 11.

21. STORIES: (cl)

The basic rationale behind this test is not new, the idea is common to Guilford's Topics and Unfinished Stories (50) and Barron's Word Arrangement Test (2) as well as to many other similar tests. The subject is presented with a series of pictures and asked to make up a story about each one. However, the form of this particular adaptation differed in one important respect - the pictures were structured to different extents, i.e. the 4 pictures presented became progressively less easy to understand

FIG. 11: Examples of the Toy Construction Test.

O= Originality



PLANE

$$0=0$$

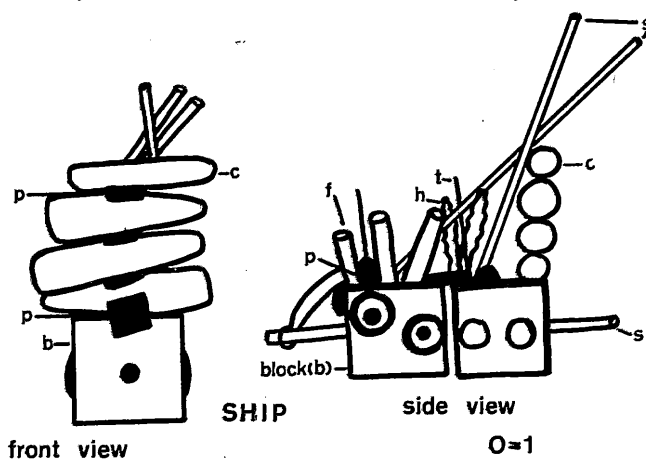
No. of pieces=6



Horse & trailer

 $0=2$

No. of pieces=9

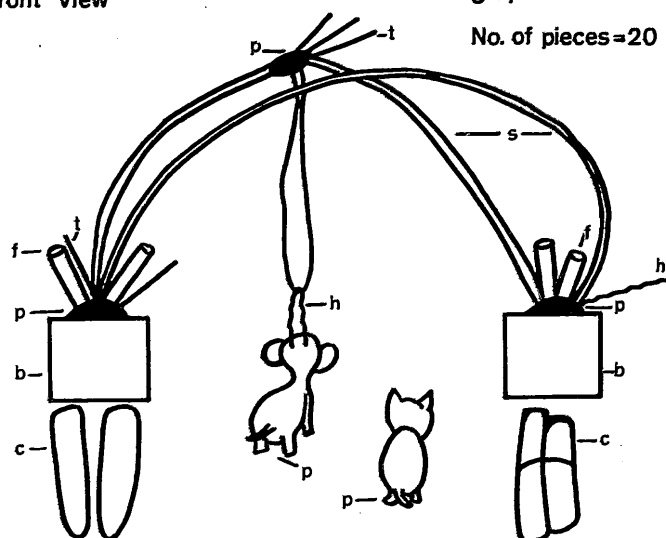


SHIP

side view

0=1

No. of pieces=20



DOORWAY of the ARC

0 = 3

No. of pieces = 28

and interpret because more and more details were omitted. They were constructed in this way in order to study hypothesis H_4 .

INSTRUCTIONS:

"In this game I am going to show you some pictures and I want you to make up a story about each picture. I am going to write down your stories so we won't forget them. You can tell me what's happening in the picture and what is going to happen. Try to make your stories exciting and imagine anything you like about the pictures. Here is the first one".

The child was encouraged to tell more about the pictures when necessary, e.g. "That's good. Can you think of anything else that might happen?"

All stories were taken down verbatim and scored for fluency (the number of words given) and originality of theme. Originality scores ranged from 0 to 4. Two raters were employed for this assessment, one being the writer and the other being an experienced infant school teacher. Assessment was done "blind" and then any discrepancies in scores discussed until a final score was sanctioned by both raters. The number of stories falling in the different categories listed in Chapter III were also counted (e.g. violence, humour, incongruity, pure description).

Examples of Stories:

Picture 3:

1. Two men fighting. One's just fallen off a stool. The other one's hitting him with a stick and they're in a house. The man threw a book at him.

Fluency = 29 Originality = 0
Categories = H, J

2. Looks like some people are climbing up a building and they bring up a stool and they stick the stool on. They want to rob the building, but just as they get in, the sticker falls off and one man falls into a goldfish pond and the book which tells him how to cut the glass, also falls in.

Fluency = 59 Originality = 4
Categories = D

22. STRUCTURED DRAWINGS: (c)

The basic rationale of this test is the same as Torrance's Incomplete Figures. "Bits" of pictures are presented to the subject who has to complete the drawing as he chooses. However, here there are four series of pictures in four stages and at each stage the picture is more structured than in the preceding stage, i.e. more details are added to the stimulus. On the first page of the test booklet, the line drawings are vague and offer few clues as to what the four objects could be, but by the fourth page, the subject would be hard-pressed to make the lines into anything but the intended objects, viz. a boat, plane, house and car/train, though the subjects were urged to make every picture different. The amount of information given determines the object perceived. (The concept of "information" is the number of different items which must be given to specify a given pattern). As more cues are added to a picture, the probability of obtaining an alternative response to the "expected" one, decreases.

The test was constructed in this way to study hypothesis H_4 .

Responses were scored for flexibility (number of different categories of responses), originality, elaboration and form in the usual manner, and also for the perceptual qualities. The stage at which the subject could no longer resist the implications of the stimulus drawings and thus made the picture into the intended object, was also recorded for each of the series. If this occurred in the first stage, the subject obtained a "change" score of 5; if it occurred in the second stage, the score given was 4, etc. If it never occurred, the "change" score was 1. Examples are shown in Fig. 12.

0. PERCEPTUAL TESTS:

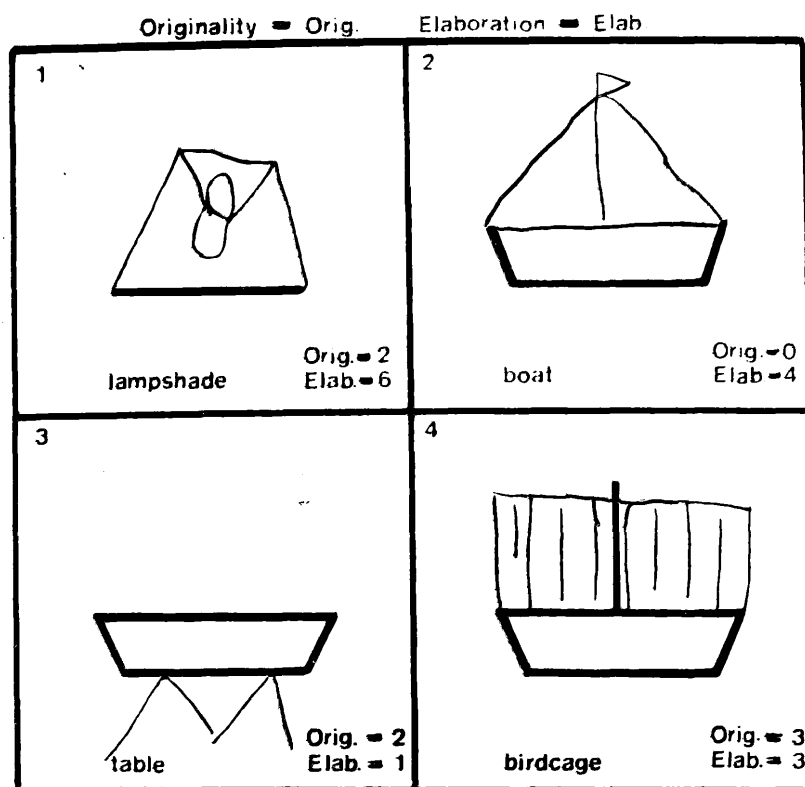
23. ENCLOSED AREAS:

This test was developed and used on 4th grade children by Dr. D. Schulman (107). The test consists of 4 pages of pictures, the same picture being shown 8 times on each page.

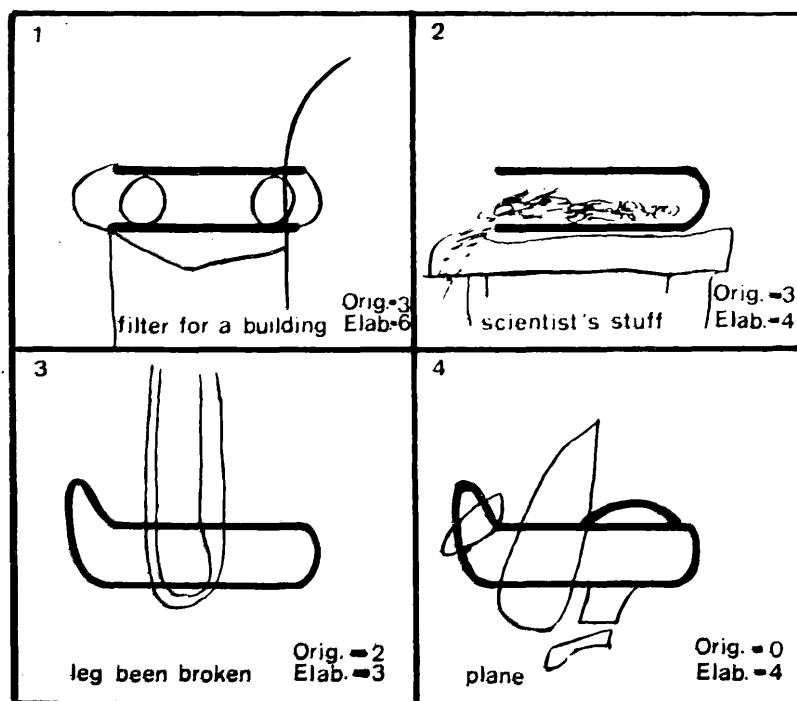
INSTRUCTIONS:

The E says, "In this book, you will find 8 pictures all the same. With your crayon, I want you to colour in a different space

FIG. 12: Examples of Structured Drawings

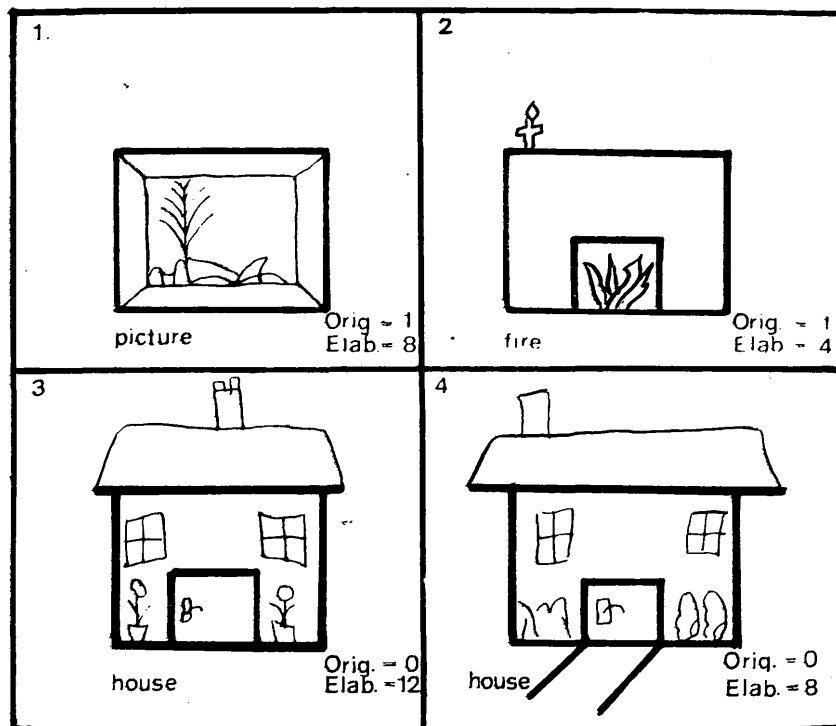


A. Series 1 — BOAT

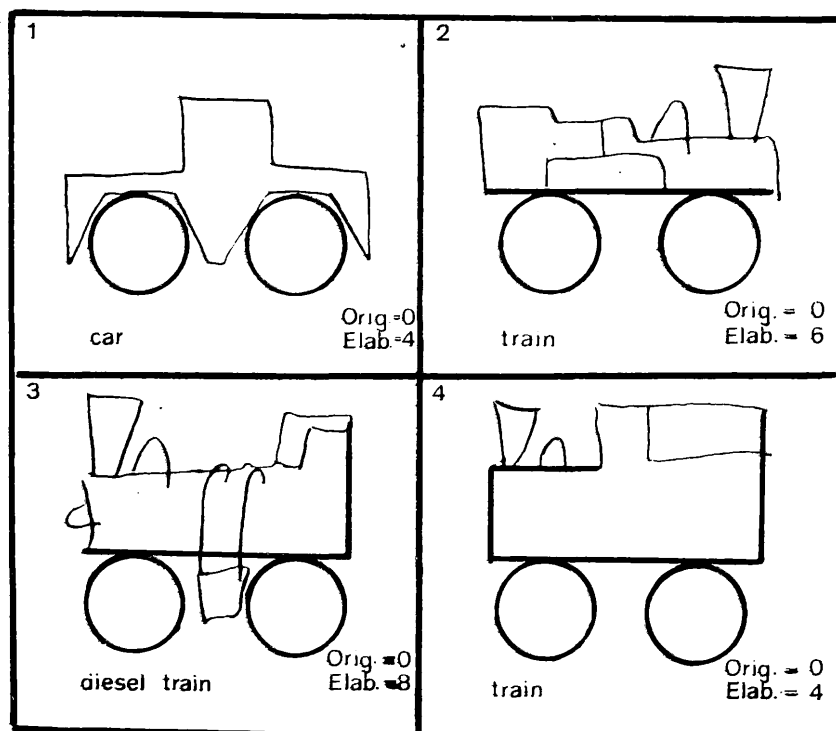


B. Series 2 — AEROPLANE

FIG. 12: (Continued)



C. Series 3 — HOUSE



D. Series 4 — CAR or TRAIN

in each picture so that each picture looks different. Look at this example of Mickey Mouse. I have coloured in just this space (hold up example card 1 and indicate the eye space). Here is another picture of Mickey Mouse: this time I have coloured in all the space except this space (hold up example card 2 and indicate eye space is now blank). Here is another Mickey Mouse (hold up example card 3 showing the whole picture coloured in). Now I want you to see how many different spaces you can find for your pictures". The E goes round to each child to make sure he understands the procedure.

Dr. Schulman describes this as a test of "perceptual openness" (107) which is an approach to the world in which "the perceiver views the world from many different vantage points in a playful manner" (op. cit.). He hypothesized that if openness of perception is absent, creativity (as measured by his Drawing Completion Test) is impossible, whereas high Drawing Completion scores would mean openness of perception is present.

The score on this test was the number of different areas coloured in (repetitions of areas were not included), e.g. Fig.13.

24. CHANGING FIGURES:

This was a modification of Schulman's CFT test (107) which, in turn, was derived from L. Frenkel-Brunswick's work (1949). The test material consists of 4 series of 12 pictures which gradually change from one object into another (see the example given in Fig. 14). The dog/car set was taken from Schulman's set, but the other three sets were new. All drawings were done in black ink on 3" x 3" cards by a trained artist.

Each picture was shown to the subject for 5 seconds while he reported verbally on what he saw. To do well on the test, a subject has to recognise the change early on in the series of 12 pictures. Thus the individual who can alter his perceptions to accommodate the changes in the stimuli, and instead of being bound by earlier perceptions, is responsive to new events, will do well.

For each series, the number of the card at which the subject changed his response from the initial to the final object, was recorded.

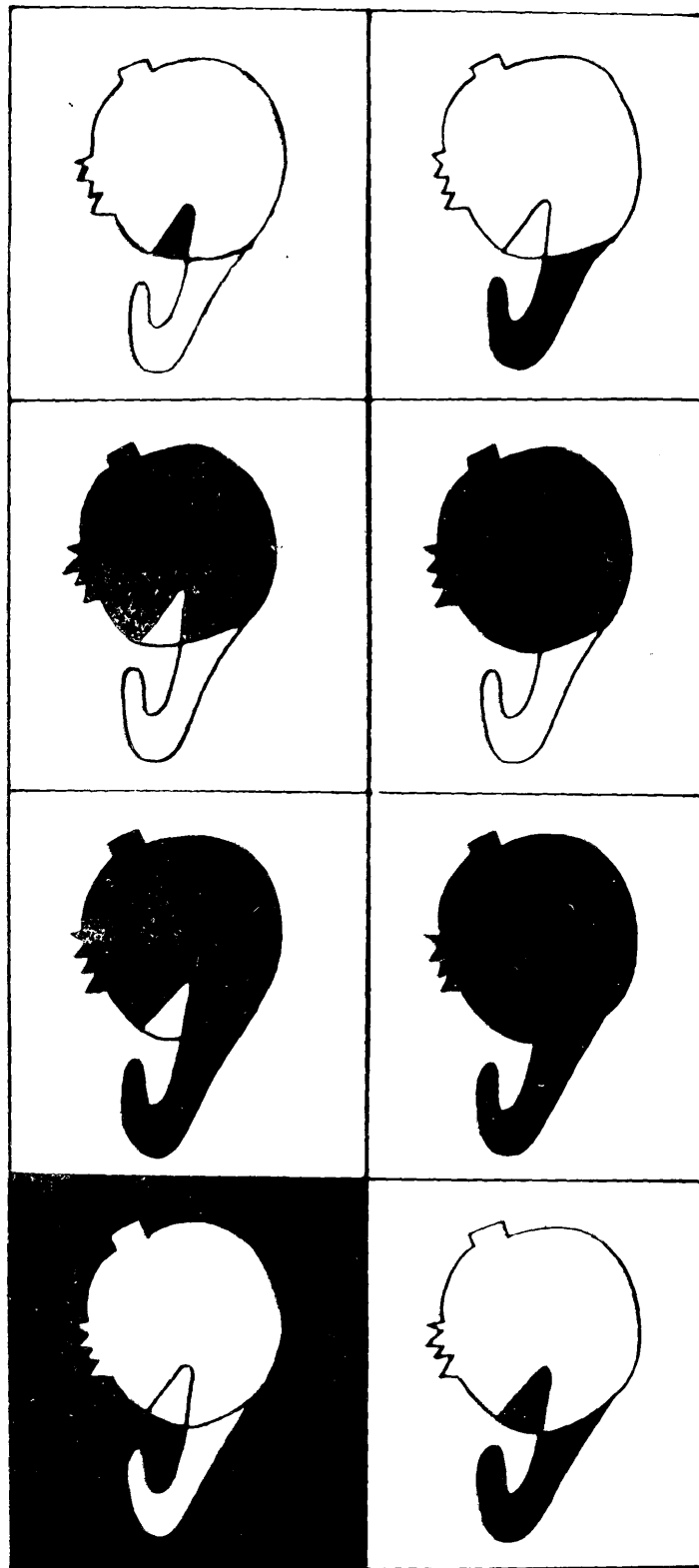


FIG. 13 Example of Enclosed Area Test with all possible areas coloured in

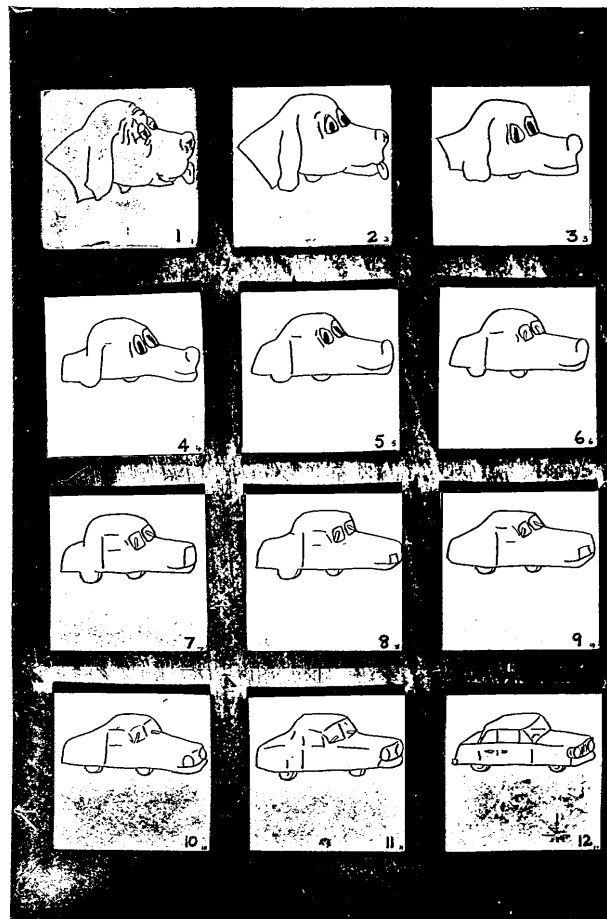


FIG. 14: Example of Changing Figures test.

25. EMBEDDED FIGURES:

This type of test has been used in many studies, e.g. Thurstone's Hidden Figures (123) and Guilford's Hidden Figures (50). The writer selected this test from Ghent's articles on the perception of embedded and overlapping figures (45). The test consists of a number (7) of Gottschaldt-type figures in which the subject is required to find and outline a simple geometric figure which is hidden in a more complex one (see Fig. 15). An example figure was used to demonstrate the procedure to the children and the E checked on every child to make sure he understood what to do.

This task seems to be similar to the Enclosed Areas, but in the latter, the subject is more free to rearrange the limiting lines of the forms chosen for each picture. Both tasks require the subject to ignore irrelevant lines even though a given set of lines may belong simultaneously to two or more figures.

The score was the total number of embedded figures found and correctly outlined (maximum score = 7).

26. HIDDEN FIGURES:

This was also selected from Ghent's test (45) using overlapping figures. The figures to be found and outlined are not submerged in more complex ones but are merely "masked" so that several figures overlap one another. Figures therefore intersect but do not share contours as in Embedded Figures.

There were 4 sets of figures. For each set, a page of similar, non-intersecting shapes was given and the subject instructed to outline the shapes on the page of intersecting figures in the same colour as he outlined the shapes on the page of nonintersecting figures (see Fig. 16).

One point was scored for each figure correctly outlined on both pages.

27. GOOD FIGURES:

This consisted of Mowatt's figures from his study on configurational properties of geometric figures considered to be "good" (91). He found that configurations tending towards symmetry, closure and simplicity, were rated "good" by most

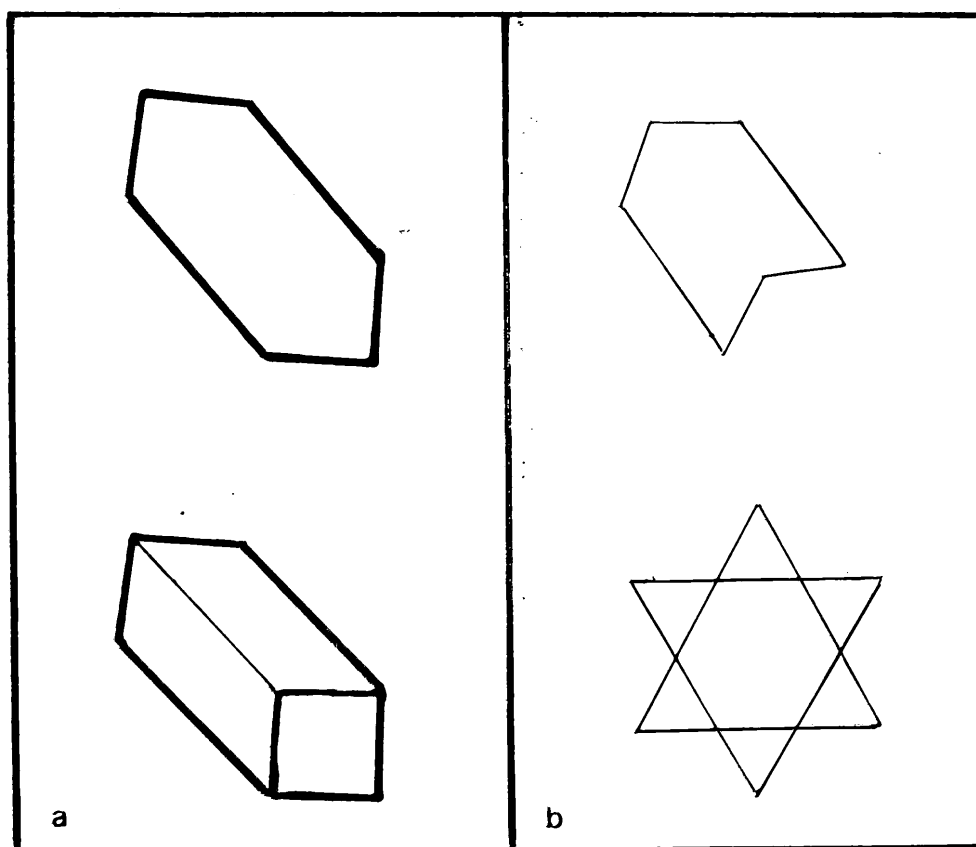


FIG. 15: Examples of Embedded Figures Test, with one example completed

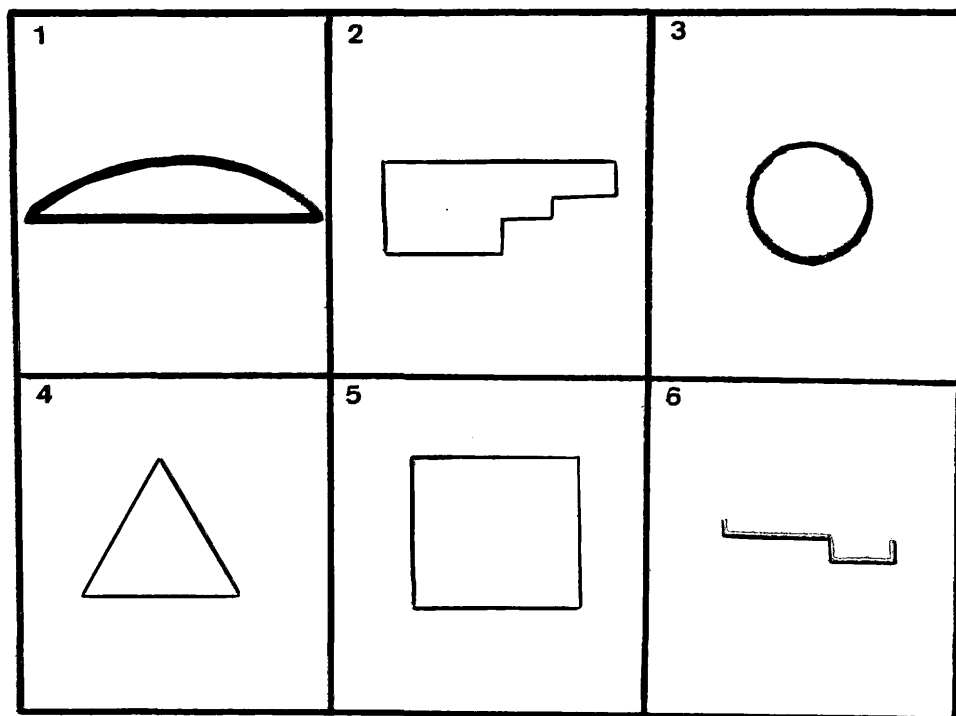
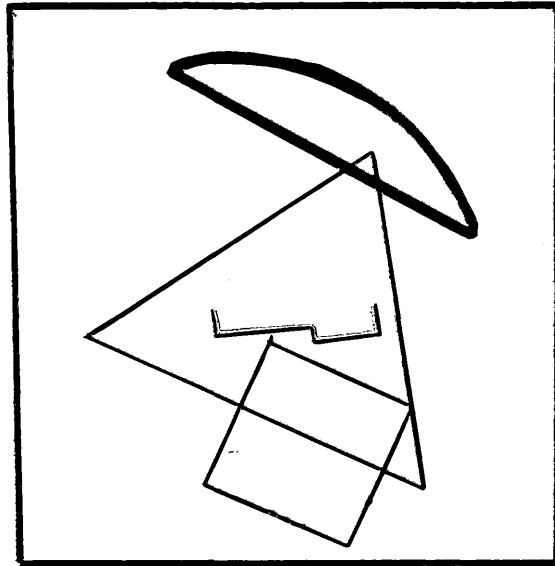


FIG. 16: Examples of Hidden Figure Test, with 2 figures completed

people. It occurred to the writer that this type of preference could bear some relationship to the creative ability of the subject. Furthermore, Barron originally found creative people prefer asymmetrical, complex figures (see Chapters II and III).

In this test, there are 5 pages of figures with 8 figures on each page. One page consists of closed, symmetrical figures, one of open, symmetrical figures, one of closed, asymmetrical figures, one of open, asymmetrical figures and one of symmetrical and asymmetrical dot patterns. The subjects were instructed to look at each picture, decide whether they liked it or not and to alter it in some way until it was acceptable if they did not like it.

Records were scored for the total number of figures on all five pages falling into each of the four categories of open/closed and symmetrical/asymmetrical figures. Results were used to study hypothesis H_2 .

28. FIGURAL SIMILARITIES:

This was based on Guilford's test of Varied Figural Classes (50), though the figures used were specially constructed. The test material consisted of 5 sets of geometric figures. For each set, the subject had to match as many figures as he could find with one or more other figures in the set for as many reasons as he could find. (See the example given in Fig. 17).

This activity calls for flexibility in reclassifying figures according to different properties they share. Guilford found this test very weak on DFC, though it was designed to measure CFC (50) and he reasoned that the number of potential classes was too limited. The writer attempted to remedy this by adding more figures so that the subjects had a wider choice.

Responses were marked as follows: the number of matchings on different figural properties were counted, e.g. matchings on colour, the number of lines and the shapes and the total number of matchings were also recorded.

29. SCRIBBLE COLOUR:

This was originated and constructed by the writer, the idea being obtained from watching children at work in art classes at

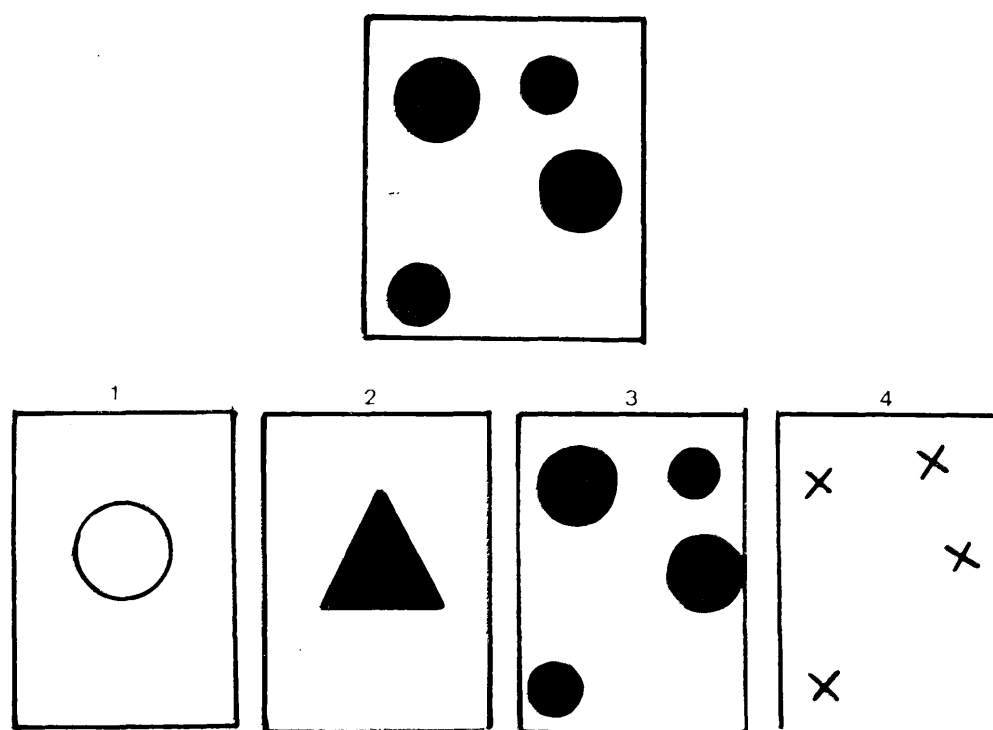


FIG. 17: Example of Figural Similarities

- eg 1 goes with the top picture because both are round
- 2 goes with picture because black
- 3 goes with picture because same shape, size and colour
- 4 goes with picture because 4 objects and in same configuration

school.

The subject was given a standard pattern made by drawing random, flowing lines in black ink on blank paper, thus creating many different spaces and shapes which the subject was required to colour in as he wished. This is similar to the Enclosed Areas test except that the subject does not have to disregard limiting lines. It was expected that the creative child would find many more spaces and use more colours than the less creative child.

Scores were the total number of spaces coloured in in different colours and the total number of colours used.

D. MISCELLANEOUS MEASURES:

30. OTIS INTELLIGENCE SCALE FOR CHILDREN:

Some measure of the subjects' levels of intelligence was necessary in order to assess the influence (if any) of this variable on the creativity variables.

Although the Otis test is not a particularly good one, it was chosen as the best to use under the circumstances imposed by the nature and size of the research. The test had to be carried out in groups (individual tests of intelligence usually take from 1 to 2 hours to administer), be appropriate for the age group and not be excessively long.

The A form of the Primary examination was used according to the instructions given in the manual (Otis, 96). The form consists of 8 subtests, which are:

- (1) Following Directions (comprehension)
- (2) Association (similar to the Wechsler coding test)
- (3) Picture Completion (vocabulary and comprehension)
- (4) Maze.
- (5) Picture Sequence (similar to Wechsler's Picture Arrangement)
- (6) Similarities
- (7) Synonym-Antonym (vocabulary, education or relations)
- (8) Common Sense (reasoning).

Total raw scores were converted into I.Q. equivalents from the table of norms supplied in the manual.

31. INFORMATION ON CHILDREN:

From a questionnaire circulated to all the teachers concerned with the children, the following information was obtained:

- (a) Birth Order: i.e. whether the child was first, second or third-born, etc. in his family.
- (b) Sibling Number: the number of brothers and sisters the child has.
- (c) Originality Ratings: the teacher had to rate each child on a simple 4-point scale.
- (d) Father's Occupation: this was obtained and rated as described earlier in this chapter.

This information was used in studying hypotheses H_1 and H_3 .

ADMINISTRATION OF TESTS:

Some of the above-mentioned tests were administered to groups of children and the rest had to be given individually.

Group administration was conducted during school hours at the schools concerned. Different schools agreed to allow testing to be carried out at different times of the day and days of the week. Thus timetables were arranged to complete all the group testing in the shortest possible time to minimise inconvenience to the teachers and disruption to the school programme, but also so that no set of children had to complete more than three tests of activities in any one day.

In order to facilitate individual testing, letters were sent to the parents of all 280 children, requesting their permission to see their child/children for 1 to 2 hours out of school hours either in the afternoons, the week-ends or during the school holidays and either at the writer's house, the child's house or at the school. Just over 50% of the 280 parents contacted, replied and only two refused permission to let their children be tested.

Timetables were drawn up to test each child individually for three-quarters of an hour at a time (two separate sessions to cover all the tests) and the times arranged with the parents. Children whose parents did not reply to the letter were tested individually during school hours.

The group and individual testing was completed in just over five months of continual testing. All the tests were presented to the children as "games", the nature of the tests being such that this was never questioned. The Otis Intelligence Scale was administered as the last test of all since it is the only one in which there are obviously "correct" answers and in which pressure of time was involved. This type of atmosphere might have affected the other test results had it not been left until the end.

Report with the children was good on the whole. The children saw the experimenter several times before group testing began and so were fairly used to her presence. In individual testing, some children began by being nervous, worried or shy, but very soon relaxed. The order of the tests was specially arranged to enhance this sense of being at ease and their very nature also, of course, helped. Most children enjoyed all the activities and many stated this.

Teachers were requested to present the writer as someone (not a teacher) interested in children's games.

GROUP ADMINISTRATION:

Not more than 20 children were tested at one time in one room. Each child was seated at a desk by himself and the desks spaced as widely apart as possible to prevent copying.

All instructions were standardised and presented clearly to all groups. For those tests in which examples were used, the examples were drawn on large pieces of cardboard which were held up so that every child could see them. As soon as the group started on a test, the experimenter went round to each child to make sure he knew what was expected of him.

Since few tests were timed, children who finished ahead of the majority were told to sit quietly until the others had finished or were allowed to continue with the next test, instructions being given quietly so as not to disturb the other children. All comments and titles of pictures were recorded on the answer sheets by the experimenter. For the bigger groups, the experimenter was aided in this by three helpers.

Each child was supplied with the necessary pencils and crayons for the particular test being done.

The group tests were presented in the same order to all groups and were as follows:

1. Torrance Non-Verbal Tests of Creative Thinking.
2. Enclosed Areas.
3. Embedded Figures.
4. Hidden Figures.
5. Good Figures.
6. Structured Drawings.
7. Toy Construction.)
8. Scribble Colour.)
9. Mosaics.) Order did not matter here.
10. Painting and Drawing)
11. Otis Intelligence Scale for Children.

Where teachers were willing to help, the activities 7-10 were carried out by the teachers themselves after they had received detailed instructions on what must be said and not said to the children. The writer drew the constructions and mosaics and collected all materials and paintings when they had been completed.

INDIVIDUAL ADMINISTRATION:

Wherever possible (and this constituted about 95% of the cases) the individual testing was conducted in two sessions separated by at least 24 hours. If it had to be done all at once, then a quarter of an hour break was taken between the two sets of tests.

The order of the tests was arranged so that the child would be interested, set at ease and not influenced in his responses by previous types of tests. (Thus Quick Responses was given before Instances so that a subject would not respond with class instances when giving word associations and Animal Sorting was given before Block Sorting because the children grasped the idea of sorting more easily when animals were used).

If a child appeared to be tiring, a rest was taken. None of tests (except Make-a-Figure) was timed, so the children were not forced to think for a long time when it was plain that no more responses would be forthcoming. Further, it was not

necessary to cut off any child because he had overstepped any time limit.

Some children needed a lot of encouragement and praise: others, very little. Some of the more talkative children had to have their attention brought back to the task at hand every now and again, but the atmosphere was always made as relaxed, enjoyable, playful and unhurried as possible.

The two sets of tests were administered in the following order:

- | <u>Part 1</u> | <u>Part 2</u> |
|--------------------------|---------------------------|
| 1. Picture Preference. | 1. Block Sorting. |
| 2. Changing Figures. | 2. Terrance Verbal Tests. |
| 3. Make-a-figure. | 3. Rorschach Inkblots. |
| 4. Figural Similarities. | 4. Stories. |
| 5. Line Meanings. | 5. Odd Animals. |
| 6. Animal Sorting. | |
| 7. Quick Responses. | |
| 8. Instances. | |

ANALYTICAL METHODS:

Data:

When all the tests had been scored and assessed and the totals of scores found, all the data was punched onto computer cards, each variable's results beginning on a new set of cards. The punched cards were checked for errors and the number of scores in each set of data checked to see if $N = 233$ (number of subjects) using program 1. (All program specifications are given in Appendix C). Any cards with punching errors were repunched and rechecked until all the data was correct.

MEANS AND NORMALITY OF DISTRIBUTION:

The mean, standard deviation and variance of each variable was computed and the scores for each variable tested for normality of distribution by means of program 2. Although factor analytic methods do not assume normal distributions of scores, very skewed distributions are not desirable because they tend to make the factor structure "fuzzy". The χ^2 test for normality of distribution was employed. Maximum and minimum values of scores

occurring within one variable were supplied and the scores divided into a suitable number of groups, the frequencies of scores in each group being counted. The χ^2 formula is given by

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

where f_e = expected frequency

f_o = obtained frequency for each category into which the variable has been divided, the expected frequency being the number of cases which should occur in a particular category if the scores are normally distributed (Milton-Smith, 89).

LINEARITY OF REGRESSION:

The fundamental importance of using only variables that are linearly related to one another, has been discussed in detail in the factor analytic theory in Chapter II.

Linearity of regression was tested using the F test of curvilinearity. The formula is given by

$$F = \frac{(\eta^2 - r^2)}{(1 - \eta^2)} \times \frac{N - G}{G - 2}$$

where η = correlation ratio.

r = Pearson Product-Moment correlation coefficient
between the two variables considered.

N = number of subjects.

G = number of groups or arrays into which the scores are divided (McNemar, 81).

The significance level of F was obtained from tables of F for degrees of freedom $n_1 = N - G$ and $n_2 = G - 2$ (Pearson and Hartley, 97).

Originally, it was hoped to test every pair of variables. However, after writing and running program 3 for linearity of regression on several test variables, the writer realised that such a task would take approximately 100 hours of actual computer time. There were 8121 possible variable combinations which could be tested. The writer thus took a random sample of 121 combinations and tested only these for linearity of regression. This gave some estimate of the number of non-linear relationships amongst all the combinations.

RELIABILITY:

Reliability of variables was tested wherever possible by the split-half method since test-retest methods were impracticable.

The formula is

$$r_{1/2} = \frac{\sum x_{ij}}{\sqrt{\sum x^2 + \sum y^2}}$$

where $x = X - \bar{X}$, $y = Y - \bar{Y}$, $\bar{X}$ and $\bar{Y}$ are the means of 2 variables (in this case, each half of the variable being tested) and X and Y are paired scores from each half of the variable.

This estimate was corrected for the full-length test by the Spearman-Brown extension formula

$$r' = \frac{2r_{1/2}}{r_{1/2} + 1}$$

where r' is the reliability coefficient.

Program 4, was used to compute the reliability coefficients of 45 variables, including interscorer reliabilities on the Painting & Drawing variables as an indication of the degree of agreement between the three ratings on these variables.

SELECTION OF VARIABLES:

At this stage, the most suitable variables of the initial 128 were selected, taking into account their performance on the tests of normality of distribution, reliability and linearity of regression as well as the overall performance of the subject on the tests. The reasons for dropping various variables are discussed in Chapter V. The final set of variables to be used in the factor analytic section, numbered ninety. Twenty-three other variables were retained for use in other statistical analyses concerned with hypotheses H_3 and H_4 . The fact that they were non-normal and non-linear was not important for this section of the analysis.

Following, is a resume of the steps involved in factor analysis in order to study hypotheses H_1 (a), H_1 (b) and H_2 .

1. INTERCORRELATIONS:

Besides being the first step in factor analysis, the results of this step were used in hypothesis H_5 .

The 90 variables were correlated with one another using the Pearson Product-Moment method in which the correlation coefficient between two variables X and Y is given by

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}}$$

where the symbols have the usual meanings. The significance levels of the coefficients were obtained from tables of r for degrees of freedom $N-2 = 231$ (Pearson and Hartley, 97).

The writer originally wrote a program to compute the correlations but the estimated running time was too long so it was rewritten using the method of "packing" scores and made very much faster. (Program 5 (Time of run = 7 hours)). Unities were put in the diagonals of the intercorrelation matrix.

2. COMMUNALITIES:

One of the best methods of estimating communalities is that of squared multiple correlations (SMC's) (Harman, 58; Browne, 9). The theory of this method has been presented in Chapter II.

To obtain SMC's, the first step required is the inversion of the intercorrelation matrix R. This was accomplished using program 6.

SMC's were then calculated using program 7. The formula is given by

$$SMC_j = 1 - \frac{1}{r_{jj}}$$

where SMC_j = communality estimate of variable j and r_{jj} is the element of the jth row and column of the inverted matrix R^{-1} .

The entire intercorrelation matrix R was repunched on cards with the communality estimates in diagonals, using program 8.

3. EIGENVALUES AND EIGENVECTORS:

Since the standard program for the computer ICL 1301 for calculating eigenvalues and their associated eigenvectors was not designed for a matrix of the order of 90 x 90, Mr. M. Lawrie modified it for this purpose (program 9) and also wrote program 10 to check the results.

The eigenvalue calculation program (calculations by Jacobi

method) was run for a total of 52 hours, the convergence of iteration measure being set at .0005, i.e. iterations were continued until every off-diagonal element was $\leq .0005$. Thus the error in the eigenvalues is $\leq 90 \times .5 \times 10^{-3}$, i.e. $\leq .045$.

The program could be halted and restarted again from where it was stopped. At one stage, the entire memory of the computer had to be punched onto cards and then reloaded because the computer had to be moved and set up again.

The confidence check program LC2 (program 10) calculated the differences between $\lambda \bar{x}$ and $\bar{y}$, where $\bar{y} = A\bar{x}$ and A is the M^2 intercorrelation matrix. The largest difference was 2×10^{-2} ; most were much smaller.

4. SELECTION OF EIGENVALUES:

In order to ascertain the number of meaningful, relevant, "substantive" factors, three methods were employed:

- (1) A scree graph of all the eigenvalues in descending order of magnitude was plotted. Cattell (15) mentions this as one way of selecting factors but only when they have been extracted using an unreduced matrix R . However, the writer thought it might be helpful.
- (2) The percentage contribution of each factor (or eigenvalue) to the total sum of all the original SMC's was calculated. The total percentage contributions of the selected factors should be close on 100% (Harman, 58).
- (3) Rotation (Step 6) was carried out on two sets of M factors, one with $M = 18$ and one with $M = 30$ (since 30 factors seemed to be indicated from (1) and (2), but after rotation initially only 18 factors could be relatively easily identified). This method of trial-and-error selection, trying out different M values was suggested to the writer by Dr. Browne of the M.I.P.R., Johannesburg.

Taking into account the results of all three of the above methods, M was set at 30.

5. FACTOR LOADINGS:

The writer wrote program 12 to select all eigenvalues ≥ 0.50624947 (which was the value of the 30th largest eigenvalue) and to calculate the M loadings on each factor M using the formula

$$a_{ij} = \alpha_{ij} \sqrt{\lambda_j}$$

where a_{ij} = loading

λ_i = eigenvalue of factor number

and α_{ij} = the j th eigenvector associated with eigenvalue λ_i .

At the same time, the percentage contributions of each factor to the sum of the communalities were calculated.

6. VARIMAX ROTATION:

Since the solution obtained from steps 1-5 is a mathematically arbitrary one, the solution can legitimately be rotated (using either orthogonal or oblique axes) to obtain more psychologically meaningful results. Rotation was done "blind" according to a standard program (Program 13).

Varimax rotation is one of the better types of orthogonal rotation (Cattell, 15; Harman, 58). The varimax criterion is given by

$$V = n \sum_{p=1}^m \sum_{j=1}^n (b_{jp} / h_j)^4 - \sum_{p=1}^m \left(\sum_{j=1}^n b_{jp}^2 / h_j^2 \right)^4$$

i.e. factors are rotated two at a time and the whole cycle of $n(n+1)/2$ pairings repeated until V no longer increases beyond a certain set number of decimal places.

The writer wrote a program to accomplish this, but was unsure of the correctness of the results, hence the results obtained from Step 5 were submitted to the N.I.P.R. Johannesburg, which has standard rotation programs.

Rotations were carried out for $M = 18$ and $M = 30$, but, as mentioned earlier, the set of $M = 30$ proved to be more meaningful.

Oblique rotation would seem to be the ideal type of rotation in order to achieve simple structure, but in practise the results are very difficult to interpret - for reasons listed in Chapter II.

However, the writer felt that an attempt at this type of rotation should be made and hence tried (unsuccessfully) to program the Oblimin method of oblique rotation as this seems to be the most worthwhile (Jennrich and Sampson, 65). Because the attempt failed (probably because not enough detailed literature

on the methods involved was available at the time), the U.I.P.R. was also requested to run the results on their Promax (oblique rotation) program. Results from both types of rotation are reported in Chapter V, though only the Varimax results are interpreted in detail. The wariness of researchers in interpreting oblique rotational solutions seems justifiable to some extent.

7. SIGNIFICANCE OF LOADINGS:

In reports of the factor analytical results of most studies, an arbitrary value of ± 0.30 is set as the cut-off point for selecting significant loadings on factors (Guilford, 56; Cattell, 15). Values of ± 0.1 and less are definitely not significant.

The writer felt that this practise has little justification and, therefore, used the Harris test of significance of factor loadings instead (Cattell, 15). This is given by

$$|a_{ji}| \sqrt{\frac{N-M-1}{(1-h_j^2) dff_i}} > t_x$$

where t_x = t value of a particular P level of significance (obtained from tables of t: Pearson and Hartley, 97).

a_{ji} = loadings of variable j on factor i

N = number of subjects

M = number of factors

$(1-h_j^2)$ = uniqueness of variable j

and dff_i = the diagonal element of the ith row and column of the inverse matrix R^{-1} .

Critical t values selected were 2.58 ($P=.01$) and 1.95 ($P=.05$) for degrees of freedom $N-1 = 232$. Thus all factor loadings with t values of ≥ 2.58 were considered significant at the 1% level and their respective variables were considered to be significantly loaded on the factor concerned.

8. INTERPRETATION OF FACTORS:

Each factor was studied in detail, taking cognisance of the types of variables significantly highly loaded on it, the variables loaded significantly on more than one factor, the variables with zero or non-significant loadings on the factor, the occurrence of univocal variables, the performance and positions of marker

variables, etc. As stated previously, only the Varimax results were studied and reported in detail.

DIVISION OF TORRANCE TESTS' DATA:

In order to obtain some idea of the differences in performance between high and low creativity groups for use in studying hypothesis H_3 , the writer decided to use total scores on the Torrance Non-Verbal and Verbal Tests as a basis for comparison.

Program 15 was written to divide the score ranges of the fluency flexibility and originality variables of the Torrance tests into four groups and to print out the numbers of the subjects falling in each group. Four groups were found to make too coarse a distinction between individuals, so the data was resorted into eight groups or score-intervals from the highest to the lowest scores.

Then scores on other selected variables could be divided into 8 groups on the basis of the Torrance Tests' divisions. The frequencies of certain score-intervals within each of the 8 groups were then compared across the 8 groups to ascertain whether differences in creative ability (as indicated by the Torrance Tests) would influence performance on these other variables, viz. the perceptual quality variables and Story categories and also the variables of the two degree-of-structure tests, Structured Drawings and Stories. P.Q. 9 and Story category F were omitted because there were too few cases involved in them. Significance of differences amongst frequencies were analysed using the χ^2 test,

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

where the symbols have the usual significance.

χ^2 tables for each variable were drawn up and, where necessary, groups compounded so that no table had more than 5% of its cells with frequencies of < 5 (Siegel, 199). Computations were carried out with the aid of a calculating machine since the computer was no longer available.

Graphs of the frequency distributions of the variables according to the 8 creativity groups were drawn.

A similar (χ^2 test) method of analysis was used to study the effects of differing degrees of structure (or information given) in the stimulus material of the Structured Drawings and Stories tests on the creativity variables fluency, flexibility and originality and also on the form variables. This was done across the whole sample to ascertain any general trend and across the 8 creativity groups to ascertain whether differences in creative thinking ability would influence these trends in any way. (Hypothesis H_4). Graphs of these results were also drawn. Contingency coefficients, C , were also calculated. C is a measure of the "extent of association or relation between two sets of attributes" and is given by

$$C = \sqrt{\frac{\chi^2}{N + \chi^2}}$$

where χ^2 is the value already calculated and N is the total number of cases. C is significant if χ^2 is.

CORRELATIONS:

The intercorrelation matrix R was studied to ascertain the roles (if any) played by the variables Intelligence level, Birth order, Age and Father's occupation in creative performance (for hypothesis H_5), i.e. all significant correlations were extracted and are reported in Chapter V. ($r = .23$ at $P = .01$ and $r = .17$ at $P = .05$ level).

TESTS:

Correlations of the Enclosed Areas and Changing Figures tests with creativity variables were studied to see whether Schulman's results were supported (Schulman, 197) and graphs of examples of the Quick Responses word association and Instances tests drawn to study Mednick's associative hierarchy theory (Mednick, 85, 86).

All the results, tables and graphs mentioned above are reported in Chapter V, together with interpretative comments on them.

CHAPTER V

RESULTS

A list of the initial 123 variables employed appears in Table 1 and a list of the final 113 variables actually used in analysis, in Table 2. Variables were dropped from the test battery for various reasons, but mostly because of their performance in the preliminary testing for normality of distribution, linearity and reliability and hence will be discussed after the results of these tests have been reported.

NORMALITY OF DISTRIBUTION:

As mentioned in Chapter IV, all initial variables (except some of the obviously non-normal P.Q. scores) were tested for normality of distribution of their scores. Table 3 shows the χ^2 values obtained and the respective P level of each value. 54 of the 117 variables had significantly non-normal distributions ($P \leq .005$). Of the 54, 22 were dropped because of their extremely skewed distributions. These were Animal Sorting Originality and Average number score, all the Block Sorting variables, all the Figural Similarities variables, Residential Area, Unusual Questions, all the Stories categories and all Perceptual Quality variables except for numbers 7, 10 and 11. The remaining 32 were retained because none of their distributions was very badly skewed and because of their importance in the factor analytic test battery. Factor analysis does not assume normal distributions of the variables employed, though normal score distributions can aid in giving clearer simple structure (Cattell, 15; Guilford, 54). As for as the non-normally-distributed variables are concerned, the writer decided not to try rescaling methods as these "making a silk purse out of a sow's ear" methods assume that the distribution of scores in the population (universe) is normal. There is no information as to whether this might actually be so for these variables (Guilford, 54).

LINEARITY OF REGRESSION:

The results of the random sample of 121 combinations of var-

TABLE 1

LIST OF INITIAL VARIABLES

<u>CODE NUMBER</u>	<u>VARIABLE NAME</u>
1	Age
2	Animal Sorting Categories
3	Animal Sorting Originality
4	Animal Sorting: Average Number
5	Birth Order
6	Block Sorting Flexibility
7	Block Sorting Originality
8	Block Sorting: Average Number
9	Changing Figures
10	Embedded Figures
11	Enclosed Areas
12	Father's Occupation
13	Figural Similarities S.
14	Figural Similarities C.
15	Figural Similarities L.
16	Figural Similarities O.
17	Figural Similarities T.
18	Good Figures Category 1
19	Good Figures Category 2
20	Good Figures Category 3
21	Good Figures Category 4
22	Good Figures Category 5
23	Good Figures Category 6
24	Good Figures: Change Number
25	Hidden Figures
26	Instances Fluency
27	Instances Flexibility
28	Instances Originality
29	Line Meanings Fluency
30	Line Meanings Flexibility
31	Line Meanings Originality
32	Line Meanings Movement Score (P.Q. 12)
33	Line Meanings Form
34	Make-a-Figure Fluency
35	Make-a-Figure Flexibility
36	Make-a-Figure Originality
37	Make-a-Figure: Average Number
38	Make-a-Figure Form
39	Make-a-Figure Movement Score (P.Q. 12)
40	Mosaics: Number of Pieces

TABLE 1

- continued -

CCDE NUMBER	VARIABLE NAME
41	Mosaics Originality
42	Odd Animals Categories
43	Odd Animals Originality
44	Originality Rating
45	Otis I.Q.
46	Painting Originality
47	Painting: Use of colour
48	Painting: Ability
49	Painting: Detail
50	Drawing Originality
51	Drawing: Ability
52	Drawing: Detail
53	Picture Preference
54	Quick Responses
55	Residential Area
56	Rorschach Fluency
57	Rorschach Flexibility
58	Rorschach Originality
59	Rorschach Movement Score (P.Q. 12)
60	Scribble Colour: Number of Colours
61	Scribble Colour: Number of Spaces
62	Sibling Number
63	Stories Fluency
64	Stories Originality
65	Structured Drawings Flexibility
66	Structured Drawings Originality
67	Structured Drawings Elaboration
68	Structured Drawings Form
69	Structured Drawings: Change Number
70	Toy Construction: Number of pieces
71	Toy Construction: Originality
72	Toy Construction Form
73	Picture Construction Originality
74	Picture Construction Elaboration
75	Incomplete Pictures Fluency
76	Incomplete Pictures Flexibility
77	Incomplete Pictures Originality
78	Incomplete Pictures Elaboration
79	Circles Fluency
80	Circles Flexibility
81	Circles Originality
82	Circles Elaboration
83	Torrance Form
84	Ask and Guess Fluency

TABLE 1

- continued -

CODE NUMBER	VARIABLE NAME
85	Ask and Guess Flexibility
86	Ask and Guess Originality
87	Product Improvement Fluency
88	Product Improvement Flexibility
89	Product Improvement Originality
90	Unusual Uses Fluency
91	Unusual Uses Flexibility
92	Unusual Uses Originality
93	Unusual Questions Fluency
94	Unusual Questions Originality
95	Just Suppose Fluency
96	Just Suppose Flexibility
97	Just Suppose Originality
98	Stories Category A
99	Stories Category B
100	Stories Category C
101	Stories Category D
102	Stories Category E
103	Stories Category F
104	Stories Category G
105	Stories Category H
106	Stories Category J
107	Line Meanings P.Q. 1
108	Line Meanings P.Q. 2
109	Line Meanings P.Q. 3
110	Line Meanings P.Q. 4
111	Line Meanings P.Q. 5
112	Line Meanings P.Q. 6
113	Line Meanings P.Q. 7
114	Line Meanings P.Q. 8
115	Line Meanings P.Q. 9
116	Line Meanings P.Q. 10
117	Line Meanings P.Q. 11
118	Torrance P.Q. 1
119	Torrance P.Q. 4
120	Torrance P.Q. 7
121	Torrance P.Q. 8
122	Torrance P.Q. 10
123	Torrance P.Q. 11
124	Structured Drawings P.Q. 1
125	Structured Drawings P.Q. 7
126	Structured Drawings P.Q. 8
127	Structured Drawings P.Q. 10
128	Structured Drawings P.Q. 11

TABLE 2

LIST OF FINAL VARIABLES

CODE NUMBER	NAME OF VARIABLE
1	Age
2	Animal Sorting Categories
3	Birth Order
4	Changing Figures
5	Embedded Figures
6	Enclosed Areas
7	Father's Occupation
8	Good Figures Category 1
9	Good Figures Category 2
10	Good Figures Category 3
11	Good Figures Category 4
12	Good Figures Category 5
13	Good Figures Category 6
14	Good Figures: Change Number
15	Hidden Figures
16	Instances Fluency
17	Instances Flexibility
18	Instances Originality
19	Line Meanings Fluency
20	Line Meanings Flexibility
21	Line Meanings Originality
22	Line Meanings P.Q. 12
23	Line Meanings Form
24	Line Meanings P.Q. 7
25	Line Meanings P.Q. 10
26	Line Meanings P.Q. 11
27	Make-a-Figure Fluency
28	Make-a-Figure Flexibility
29	Make-a-Figure Originality
30	Make-a-Figure: Average Number
31	Make-a-Figure Form
32	Make-a-Figure P.Q. 12
33	Mosaics: Number of Pieces
34	Mosaics Originality
35	Odd Animals Categories
36	Odd Animals Originality
37	Otis Intelligence Scale
38	Painting Originality
39	Painting: Use of Colour
40	Painting: Ability
41	Painting: Detail
42	Drawing Originality
43	Drawing: Ability
44	Drawing: Detail

TABLE 2

- continued -

CODE NUMBER	NAME OF VARIABLE
45	Picture Preference
46	Quick Responses
47	Rorschach Fluency
48	Rorschach Flexibility
49	Rorschach Originality
50	Rorschach P.Q. 12
51	Scribble Colour: Number of spaces
52	Sibling Number
53	Stories Fluency
54	Stories Originality
55	Structured Drawings Flexibility
56	Structured Drawings Originality
57	Structured Drawings Elaboration
58	Structured Drawings Form
59	Structured Drawings: Change Number
60	Structured Drawings P.Q. 10
61	Structured Drawings P.Q. 11
62	Toy Construction: Number of Pieces
63	Toy Construction Originality
64	Toy Construction Form
65	Picture Construction Originality
66	Picture Construction Elaboration
67	Incomplete Pictures Fluency
68	Incomplete Pictures Flexibility
69	Incomplete Pictures Originality
70	Incomplete Pictures Elaboration
71	Circles Fluency
72	Circles Flexibility
73	Circles Originality
74	Circles Elaboration
75	Torrance Form
76	Ask and Guess Fluency
77	Ask and Guess Flexibility
78	Ask and Guess Originality
79	Product Improvement Fluency
80	Product Improvement Flexibility
81	Product Improvement Originality
82	Unusual Uses Fluency
83	Unusual Uses Flexibility
84	Unusual Uses Originality
85	Just Suppose Fluency
86	Just Suppose Flexibility
87	Just Suppose Originality
88	Torrance P.Q. 7

TABLE 2
- continued -

CODE NUMBER	NAME OF VARIABLE
89	Torrance P.Q. 10
90	Torrance P.Q. 11
91	Stories Category A
92	Stories Category B
93	Stories Category C
94	Stories Category D
95	Stories Category E
96	Stories Category F
97	Stories Category G
98	Stories Category H
99	Stories Category J
100	Line Meanings P.Q. 1
101	Line Meanings P.Q. 2
102	Line Meanings P.Q. 3
103	Line Meanings P.Q. 4
104	Line Meanings P.Q. 5
105	Line Meanings P.Q. 6
106	Line Meanings P.Q. 8
107	Line Meanings P.Q. 9
108	Structured Drawings P.Q. 1
109	Structured Drawings P.Q. 7
110	Structured Drawings P.Q. 8
111	Torrance P.Q. 1
112	Torrance P.Q. 4
113	Torrance P.Q. 9

TABLE 3

 χ^2 VALUES FOR NORMALITY OF DISTRIBUTION OF VARIABLES

VARIABLE NUMBER	χ^2 VALUES	DEGREES OF FREEDOM, df	P LEVEL
1	23.31	6	.001
2	9.71	6	.10
3	30.20	16	.005
4	625.32	17	<<.001*
5	45.30	8	<.001*
6	5452.19	6	<<.001*
7	5236.20	10	<<.001*
8	101.69	16	<.001*
9	9.16	13	.75
10	15.59	7	.025
11	24.12	13	.025
12	12.82	6	.05
13	14.17	10	.15
14	63.36	15	<.001*
15	96.46	13	<.001*
16	372.62	8	<<.001*
17	10.35	10	.40
18	5.24	10	.80
19	17.53	11	.10
20	23.58	11	.015
21	25.07	14	.03
22	30.77	5	<.001*
23	85.59	5	<.001*
24	29.86	17	.025
25	30.36	17	.025
26	20.43	14	.10
27	20.65	11	.03
28	25.82	13	.025
29	28.52	18	.05
30	20.39	11	.04
31	23.23	11	.02
32	75.37	11	<.001*
33	55.07	16	<.001*
113	158.52	8	<<.001*
116	59.43	11	<<.001*

These numbers refer to the list of initial variables given in Table 1. Variables marked * are significantly non-normally distributed at .001 level.

TABLE 3
- continued -

VARIABLE NUMBER	χ^2 VALUES	DEGREES OF FREEDOM, df	P LEVEL
127	57.86	14	< .001*
34	24.26	16	.10
35	8.23	10	.60
36	27.48	15	.025
37	73.25	6	< .001*
38	57.84	15	< .001*
39	164.57	18	< .001*
40	81.20	12	< .001*
41	53.62	7	< .001*
42	8.78	8	.40
43	29.25	13	.005
44	2.65	3	.50
45	10.43	13	.75
46	21.15	13	.06
47	14.28	12	.25
48	20.36	14	.10
49	19.65	12	.07
50	16.79	8	.025
51	14.28	9	.10
52	5.38	6	.50
53	13.17	12	.40
54	19.11	12	.10
55	94.89	8	< .001*
56	23.12	13	.04
57	20.53	17	.25
58	20.32	13	.10
59	216.18	14	< .001*
60	59.04	7	< .001*
61	23.04	11	.02
62	20.03	8	.01
63	26.26	14	.025
64	23.59	15	.06
65	32.95	15	.005
66	36.54	20	.02
67	72.47	12	< .001*
68	75.62	16	< .001*
69	52.77	16	< .001*
27	15.13	10	.10
28	53.86	13	< .001*
70	56.54	11	< .001*
71	22.47	14	.10
72	40.52	6	< .001*
73	73.20	6	< .001*

TABLE 3

- continued -

VARIABLE NUMBER	χ^2 VALUE	DEGREE OF FREEDOM	P LEVEL
74	30.08	15	.01
75	73.83	7	< .001*
76	37.24	10	< .001*
77	33.65	16	.01
78	10.10	12	.50
79	35.97	17	.005
80	35.82	13	< .001*
81	27.87	14	.02
82	38.26	15	.001
83	11.11	15	.75
122	61.10	18	< .001*
123	41.35	14	< .001*
84	42.92	11	< .001*
85	28.82	16	.025
86	22.34	13	.05
87	22.52	10	.02
88	25.63	8	.001
89	25.56	14	.03
90	30.68	18	.025
91	18.98	9	.025
92	28.01	14	.02
93	634.78	9	<< .001*
94	504.88	5	<< .001*
95	15.47	10	.10
96	30.36	9	.001
97	6.37	10	.75
98	66.63	4	< .001*
102	61.90	3	< .001*
104	101.71	4	< .001*
105	10.16	4	.05
125	901.76	3	<< .001*
117	647.03	4	<< .001*
118	120.92	8	<< .001*
119	687.55	15	<< .001*
110	251.46	3	<< .001*
112	970.31	8	<< .001*

iables on the F test of curvilinearity, are given in Table 4. All except three pairs of variables are linearly related to one another. The three pairs are significantly non-linearly related at the 1% level. This constitutes about 2.4% of the random sample. The amount of error this percentage introduces into the factor analytic results is difficult to estimate. However, in view of the small percentage and the small probability of non-linear relationships between variables (remembering, too, that normal distributions also increase the chances of linear relationships - Cattell, 15; Guilford, 54), it was assumed all variables included in the test battery were linearly related to one another.

MEANS, STANDARD DEVIATIONS AND RANGES OF SCORES:

The above values for all the final variables are listed in Table 5. The smallest range of scores is 4 (Toy Construction form) and the largest is 665 (Stories fluency). The majority of the ranges are fairly large and, therefore, adequate.

RELIABILITY

Reliability coefficients are also reported in Table 5. Coefficients computed using the split-half method are marked *. Other estimates (for variables whose coefficients could not be calculated by any of the usual methods) are the respective communalities of the variables concerned. Since

$$r_{jj} = h_j^2 + b_j^2$$

i.e. reliability = communality + specificity of a variable, such a value is probably an under-estimate of the actual reliability coefficient which could be calculated by the test-retest method.

As can be seen, all reliability coefficients are well above the values of r at both the .05 ($r=.17$) and .01 ($r=.23$) levels of significance. Thus it can be said that all the variables used were reliable.

Interscorer reliability coefficients for the painting and drawing assessments are reported in Table 6. There were three raters and hence three scores for each type of assessment. All coefficients are significant at the .01 level of probability or better, except for Painting Detail (raters 2 and 3). It thus seems valid to assume that the raters were assessing the paint-

TABLE 4

F VALUES OF LINEARITY OF REGRESSION TESTS
OF RANDOMLY-SELECTED VARIABLES

VARIABLE CODE NUMBERS ^a	VALUE OF F	N1	N2	% LEVEL OF SIGNIFICANCE
1/2	0.77	5	226	> 25%
1/3	1.20	5	226	25%
1/4	0.79	5	226	> 25%
1/5	1.09	5	226	> 25%
1/6	0.19	5	226	> 25%
1/7	0.56	5	226	> 25%
1/8	0.75	5	226	> 25%
1/9	0.51	5	226	> 25%
1/10	0.02	5	226	> 25%
1/11	1.40	5	226	25%
1/12	0.84	5	226	> 25%
73/74	1.39	5	226	25%
73/75	1.12	5	226	25%
73/76	1.39	5	226	25%
73/77	0.35	5	226	> 25%
73/78	2.13	5	226	5%
73/79	0.78	5	226	> 25%
73/80	0.67	5	226	> 25%
73/81	1.09	5	226	> 25%
73/82	0.60	5	226	> 25%
73/82	0.83	5	226	> 25%
73/84	0.80	5	226	> 25%
73/85	0.93	5	226	> 25%
74/75	1.01	14	217	25%
74/76	0.94	14	217	25%
74/77	1.42	14	217	10%
74/78	0.84	14	217	> 25%
74/79	1.05	14	217	> 25%
74/80	1.24	14	217	25%
74/81	1.19	14	217	25%
74/82	2.02	14	217	5%
74/83	1.11	14	217	25%
74/84	1.58	14	217	5%
74/85	1.24	14	217	25%
26/27	0.17	13	218	> 25%
26/28	2.44	13	218	5%
26/29	1.71	13	218	5%
26/30	1.31	13	218	25%

^aRefer to List of Variables given in Table 1.
 Pairs of variables marked * are significantly
 non-linearly related at the 1% level.

TABLE 4
-- continued --

VARIABLE CODE NUMBERS	VALUE OF F	N1	N2	% LEVEL OF SIGNIFICANCE
26/32	0.35	13	218	> 25%
26/33	1.85	13	218	2.5%
26/34	0.96	13	218	> 25%
26/35	1.11	13	218	> 25%
26/36	0.96	13	218	> 25%
26/37	1.43	13	218	10%
2/1	0.31	5	226	> 25%
3/1	0.42	15	216	> 25%
4/1	0.53	16	215	> 25%
5/1	0.60	7	224	> 25%
6/1	0.58	15	216	> 25%
7/1	1.03	5	226	> 25%
8/1	0.58	9	222	> 25%
9/1	0.96	15	216	> 25%
10/1	0.77	12	219	> 25%
11/1	1.31	11	220	25%
12/1	0.44	10	221	> 25%
74/73	1.30	14	217	25%
75/73	0.65	6	225	> 25%
76/73	1.51	9	222	10%
77/73	1.00	15	216	> 25%
78/73	0.93	12	219	> 25%
79/73	0.60	16	215	> 25%
80/73	2.21	12	219	1%*
81/73	0.19	13	218	> 25%
82/73	0.36	14	217	> 25%
83/73	0.70	14	217	> 25%
84/73	1.59	10	221	10%
85/73	0.88	15	216	> 25%
75/74	1.05	6	225	25%
76/74	1.00	9	222	> 25%
77/74	1.07	15	216	> 25%
78/74	0.63	12	219	> 25%
79/74	1.46	16	215	10%
80/74	1.00	12	219	> 25%
81/74	1.67	13	218	10%
82/74	0.65	14	217	> 25%
83/74	0.57	14	217	> 25%
84/74	0.73	10	221	> 25%
85/74	0.70	15	216	> 25%
27/26	-2.19	10	221	2.5%
28/26	0.14	12	219	> 25%

TABLE 4
- continued -

VARIABLE CCODE NUMBERS	VALUE OF F	N1	N2	% LEVEL OF SIGNIFICANCE
29/26	0.47	17	214	> 25%
30/26	0.81	10	221	> 25%
31/26	0.79	10	221	> 25%
32/26	1.40	10	221	10%
33/26	0.63	14	217	> 25%
34/26	1.89	7	224	10%
35/26	0.43	10	221	> 25%
36/26	0.48	13	218	> 25%
37/26	1.39	15	216	10%
27/28	-0.93	10	221	> 25%
27/29	1.83	10	221	5%
63/64	0.59	6	225	> 25%
63/65	0.82	6	225	> 25%
63/66	0.46	6	225	> 25%
63/67	1.53	6	225	> 10%
63/68	0.76	6	225	> 25%
63/69	0.68	6	225	> 25%
63/70	0.68	6	225	> 25%
46/57	0.96	11	220	> 25%
46/58	1.38	11	220	25%
46/59	0.90	11	220	> 25%
46/60	0.57	11	220	> 25%
46/61	1.05	11	220	> 25%
46/62	1.06	11	220	> 25%
28/27	0.17	12	219	> 25%
29/27	0.52	17	214	> 25%
64/63	0.64	10	221	> 25%
65/63	0.50	7	224	> 25%
66/63	0.63	13	218	> 25%
67/63	1.58	14	217	> 5%
68/63	0.20	14	217	> 25%
69/63	1.27	18	213	25%
70/63	4.12	11	220	0.1%*
57/46	2.39	6	225	2.5%
58/46	1.65	13	218	10%
59/46	3.09	8	223	> .1%*
60/46	0.72	7	224	> 25%
61/46	1.08	12	219	> 25%
62/46	0.45	11	220	> 25%

TABLE 5

MEANS, STANDARD DEVIATIONS, VARIANCES, RANGES AND RELIABILITY
ESTIMATES OF FINAL VARIABLES.

VARIABLE NUMBER ^a	MEAN $\bar{X}$	STANDARD DEVIAION S	VARIANCE V	RANGE OF SCORES	r' RELIABILITY COEFFICIENT
1	6.61	0.62	0.38	5.5-8.4	.56
2	2.38	1.18	1.39	0-6	.49
3	2.42	1.37	1.88	1-9	.82
4	8.84	1.40	1.96	5.3-12	.67*
5	2.71	2.02	4.08	0-7	.58
6	11.99	4.40	19.30	3-28	.85*
7	3.64	1.78	3.17	1-7	.53
8	10.64	3.75	14.10	1-21	.74
9	8.87	3.91	15.30	0-22	.72
10	3.18	2.45	6.00	0-11	.76
11	5.17	3.15	9.92	0-14	.77
12	0.69	1.29	1.66	0-5	.79
13	1.06	1.61	2.60	0-5	.75
14	24.79	7.93	62.90	6-40	.87
15	13.24	4.22	17.80	0-17	.82*
16	22.29	7.96	63.40	4-57	.70*
17	15.54	5.40	29.20	4-37	.68*
18	11.01	8.81	121.20	1-65	.59*
19	18.16	6.28	39.40	5-40	.86*
20	13.59	4.16	17.30	5-27	.82*
21	11.31	7.60	127.90	0-41	.74*
22	6.35	6.58	43.30	0-33	.51
23	42.97	14.31	204.80	6-91	.77*
24	1.45	1.55	2.40	0-8	.66
25	5.17	3.41	11.60	0-22	.90
26	10.68	4.61	114.10	0-28	.93
27	6.25	4.20	17.60	1-17	.84
28	3.20	2.45	6.00	1-11	.78
29	4.16	2.58	6.66	0-15	.77*
30	3.20	1.20	1.44	1.2-4.0	.53

^a These numbers refer to the list of final variables given in Table 2.

Alternate - item correlations extended by Spearman - Brown formula are marked *. All other reliability estimates are communalities.

TABLE 5
- continued -

VARIABLE NUMBER	MEAN $\bar{X}$	STANDARD DEVIATION S	VARIANCE V	RANGE OF SCORES	r' RELIABILITY COEFFICIENT
31	18.16	3.54	1.25	3-32	.88*
32	2.04	3.38	1.14	0-18	.47
33	25.56	9.51	90.40	1-45	.40
34	1.04	1.32	1.74	0-7	.44
35	5.74	1.61	2.60	2-10	.60
36	9.73	6.94	48.20	0-38	.80*
37	110.21	9.42	88.70	81-132	.61
38	15.04	2.16	4.67	8-21	.61
39	13.29	2.04	4.16	8-20	.54
40	11.79	2.39	5.71	6-20	.57
41	12.76	1.87	3.50	7-19	.63
42	7.46	1.66	2.76	3-11	.67
43	6.85	1.41	1.99	2-11	.65
44	5.50	0.97	0.94	0-6	.58
45	6.00	2.94	36.00	0-12	.41
46	19.17	6.15	37.80	2-36	.43*
47	10.64	2.42	5.86	2-39	.79*
48	7.73	3.02	9.12	1-18	.75*
49	9.98	7.84	61.50	0-49	.68*
50	7.30	7.96	63.40	0-53	.58
51	37.22	13.75	189.00	6-60	.49
52	2.14	1.31	1.72	0-8	.81
53	111.50	72.84	1246	16-681	.89*
54	1.83	2.06	4.24	0-15	.81*
55	6.79	1.75	3.06	2-17	.50*
56	6.16	3.99	15.90	0-19	.54*
57	52.45	21.31	454.10	11-140	.64
58	31.88	13.82	190.90	16-48	.79
59	8.24	2.17	4.71	2-18	.43*
60	5.95	1.59	2.53	0-10	.77
61	9.16	1.92	3.69	0-13	.80
62	25.23	10.63	113.00	5-42	.48
63	2.62	1.82	3.31	0-14	.40
64	1.86	0.81	0.66	0-3	.37
65	1.31	1.65	2.72	0-6	.37
66	9.85	6.20	38.44	0-30	.54
67	8.73	1.78	3.17	3-10	.86
68	7.26	1.76	3.10	0-10	.73
69	10.50	7.20	51.84	0-16	.74
70	17.45	10.84	117.40	1-63	.64
71	6.31	3.49	12.18	0-17	.96
72	4.88	2.52	6.35	0-13	.90

TABLE 5
- continued -

VARIABLE NUMBER	MEAN $\bar{X}$	STANDARD DEVIATION S	VARIANCE V	RANGE OF SCORES	r' RELIABILITY COEFFICIENT
73	5.84	5.66	32.04	0-42	.63
74	13.22	9.68	93.70	0-59	.80
75	18.01	5.78	33.41	0-29	.79
76	1.00	1.22	1.49	0-6	.68
77	7.04	3.22	10.37	0-18	.92
78	7.65	3.18	10.11	0-14	.87
79	7.58	3.94	15.52	0-22	.94
80	5.90	2.72	7.40	0-16	.91
81	5.27	4.38	19.18	0-26	.84
82	4.23	3.27	10.69	0-20	.88
83	2.58	1.79	3.20	0-0	.83
84	3.80	1.75	3.06	0-14	.81
85	4.13	2.40	5.76	0-18	.83
86	2.88	1.46	2.15	0-9	.80
87	1.16	1.70	2.90	0-14	.67
88	3.22	1.68	2.82	0-10	.91
89	1.87	1.46	2.13	0-9	.88
90	3.65	1.62	2.62	0-10	.76
91	0.78	0.96	0.92	0-4	-
95	0.34	0.60	0.36	0-3	-
97	0.87	1.12	1.25	0-4	-
98	1.30	1.00	1.00	0-4	-

TABLE 6

INTERSCORER RELIABILITIES ON PAINTING AND DRAWING VARIABLES

<u>VARIABLE</u>	<u>SCORERS</u>	<u>VALUE of r'</u>	<u>VALUE of F</u>	<u>P LEVEL</u>
1 Painting - Originality	1/2	.65	170.84	<.001
2 Painting - Originality	2/2	.53	90.37	<.001
3 Painting - Originality	1/3	.54	94.18	<.001
4 Painting - Use of Colour	1/2	.72	252.81	<.001
5 Painting - Use of Colour	2/3	.18	7.73	.01
6 Painting - Use of Colour	1/3	.49	74.75	<.001
7 Painting - Ability	1/2	.61	138.93	<.001
8 Painting - Ability	2/3	.33	27.39	.001
9 Painting - Ability	1/3	.58	116.60	<.001
10 Painting - Detail	1/3	.80	392.23	<.001
11 Painting - Detail	2/3	.07	1.04	<.05
12 Painting - Detail	1/3	.40	50.42	<.001
13 Drawing - Originality	1/2	.56	103.83	<.001
14 Drawing - Ability	1/2	.52	86.84	<.001

ings according to a set standard and that the scores are reliable. (Averages of the three scores on each variable were taken).

VALIDITY:

The problem of validity has been discussed elsewhere (Chapter II). The results of factor analysis are, themselves, indications of the validities of the variables concerned. Thus variables measuring the same trait to a greater or lesser extent will appear on the same factor or factors. Validity studies on the Torrance Tests of Creative Thinking have been reported. (Chapter II). For more detailed studies, refer to Torrance, 129.

SELECTION OF VARIABLES:

Animal Sorting Originality and Average number score, together with all three Block Sorting variables, were dropped from the battery because of their extremely skewed score distributions. In Block Sorting this was due to the fact that most children found the usual groupings on colour and shape and only a few found the more unusual possibilities. The same problem was encountered with Figural Similarities - a problem Guilford also found with his test of the same name (Guilford, 50). It seems these tests are not good creativity tests - at least at this age level. Most subjects cannot think divergently when faced with these types of grouping tasks.

The Residential Area variable was dropped because it had a markedly non-normal distribution and because the writer felt that the variable Father's Occupation was adequate as a check on the possible influence of social background on creative performance.

Nearly all the children found great difficulty in understanding what was required of them in Unusual Questions. Most obtained zero scores. Both variables associated with this test were, therefore, dropped from the list of variables.

The writer considered that the teacher ratings on originality were not detailed enough - one should rather attempt to obtain several ratings on different questions associated with creativity. This approach could be a complete study in itself and, therefore, this rating was dropped. Scribble Colour (number of colours used) did not seem to be of any value and was omitted.

Most of the perceptual quality variables 1 to 12 showed extremely skewed score distributions and thus all were omitted from the factor analytic battery except for P.Q.'s 7, 10, 11 and 12. This meant that hypothesis H_2 (factor 4 b) had to be left out of the factor analytic section of the study and the variables P.Q.1 to 6, 8 and 9 from hypothesis H_2 (factor 6). All perceptual quality variables were retained for studying hypothesis H_3 , except for P.Q.'s 8 and 9 which occurred too few times to be considered at all.

All Stories categories were omitted from the factor analytic battery because of their distributions, but were retained for studying hypothesis H_3 (for which non-parametric analysis used). Category F (failure to produce any story at all) was dropped because it occurred only once in the whole sample.

The results on all the other tests were extremely interesting. The main drawback of the austere, "sterilised" approach to creativity used in this study, is that the work of the warm, living subject is largely lost. Without looking at all the test material, one can only guess at the rich, wealth of responses - good, bad and mediocre - which every day of testing brought. The examples given in Chapter IV and the scoring guides in Appendix B are inadequate representatives of the quantity and quality of the responses obtained. The children appeared to enjoy almost all of the activities all the time and appeared highly entertained by them as well as entertaining the writer at the same time. The writer feels that both the creativity and perceptual tests are worthwhile. The factor analytic results would seem to support this contention. Without doubt there are many other methods of assessing creative ability and perceptual mechanisms. The ones used here are just some of the more instructive, interesting and valuable ways.

Of the final variables, the first 90 listed in Table 2 were used in factor analysis: the other 23 were used in various other analytical sections for the purpose of studying hypotheses H_3 , and H_4 , and H_5 .

FACTOR ANALYTIC RESULTS:

In all tables listed from here onwards, the variable code numbers refer to those given in Table 2.

Table 7 shows the diagonal elements of the inverse intercorrelation matrix corresponding to each of the 90 variables, together with their respective SMC's or estimates of communalities and their uniquenesses.

The intercorrelation matrix (upper half only) of the 90 variables with SMC estimates of communalities in the diagonal, is given in Table 8. All correlations coefficients of ≥ 0.17 are significant at the .05 level of probability and coefficients ≥ 0.23 are significant at the .01 level of probability.

(These values were obtained from tables of r in Pearson and Hartley (97), for d.f. = $233-2 = 231$).

Table 9 lists the eigenvalues of the 90 principal components for the 90 variables, obtained by the Jacobi Method, and Fig. 18 shows the skree graph of these values in descending order of magnitude - the usual decreasing exponential curve is obtained. Cattell (15) suggests selecting a cut-off point where the skree graph begins to flatten out and taking that number of factors as being substantive, "real", interpretable factors - at least for eigenvalues calculated from an unreduced intercorrelation matrix. The writer hoped that a skree graph might be useful even though the intercorrelation matrix in this case was reduced.

Table 10 shows the 30 selected eigenvalues with their respective percentage contributions to the sum of the original communalities (sum = 62.973). As can be seen, 30 factors account for 96.26% of the total variance, which is a substantial amount. From the results listed later, it will be seen that considering even this number of factors, not all can be interpreted - it would seem some of the latter ones are "formless" factors, due to errors or not enough marker variables to enable them to be interpreted, etc.

Table 11 lists the unrotated factor matrix of the 30 selected factors and 90 variables.

TABLE 7

DIAGONAL ELEMENTS OF INVERSE MATRIX,
ESTIMATES OF COMMUNALITIES AND UNIQUENESSES.

VARIABLE NUMBER	DIAGONAL ELEMENT	SMC (estimate of h^2)	UNIQUENESS ($1-h^2$)
	dff		
1	2.27	.56	.44
2	1.97	.49	.51
3	5.51	.82	.18
4	2.07	.52	.48
5	2.37	.58	.42
6	1.70	.41	.59
7	2.11	.53	.47
8	3.82	.74	.26
9	3.60	.72	.28
10	4.09	.76	.24
11	4.11	.77	.23
12	4.81	.79	.21
13	3.97	.75	.25
14	7.50	.87	.13
15	2.06	.51	.49
16	9.23	.89	.11
17	8.94	.89	.11
18	5.13	.81	.19
19	53.04	.98	.02
20	5.73	.83	.17
21	5.09	.80	.20
22	2.02	.51	.49
23	23.42	.96	.04
24	2.96	.66	.34
25	9.69	.90	.10
26	14.73	.93	.07
27	6.16	.84	.16
28	4.56	.78	.22
29	2.08	.52	.48
30	2.14	.53	.47
31	6.36	.84	.16
32	1.90	.47	.53
33	1.65	.40	.60
34	1.77	.44	.56
35	2.48	.60	.40
36	2.71	.63	.37
37	2.56	.61	.39
38	2.55	.61	.39
39	2.19	.54	.46
40	2.31	.57	.43
41	2.67	.63	.37
42	3.05	.67	.33

TABLE 7

- continued -

VARIABLE NUMBER	DIAGONAL ELEMENT dff	SMC (estimate of h^2)	UNIQUENESS ($1-h^2$)
43	2.83	.65	.35
44	2.39	.58	.42
45	1.70	.41	.59
46	1.84	.46	.54
47	9.59	.90	.10
48	4.62	.78	.22
49	7.19	.86	.14
50	2.39	.58	.42
51	1.95	.49	.51
52	5.28	.81	.19
53	2.54	.61	.39
54	2.15	.54	.46
55	2.85	.65	.35
56	2.99	.67	.33
57	2.74	.64	.36
58	4.84	.79	.21
59	2.68	.63	.37
60	4.38	.77	.23
61	4.89	.80	.20
62	1.91	.48	.52
63	1.66	.40	.60
64	1.59	.37	.63
65	1.58	.37	.63
66	2.15	.54	.46
67	7.36	.86	.14
68	3.65	.73	.27
69	3.79	.74	.26
70	2.80	.64	.36
71	26.59	.96	.04
72	10.03	.90	.10
73	2.67	.63	.37
74	4.95	.80	.20
75	4.74	.79	.21
76	17.34	.94	.06
77	11.57	.91	.09
78	6.21	.84	.16
79	8.00	.88	.12
80	5.84	.83	.17
81	5.20	.81	.19
82	5.76	.83	1.17
83	4.88	.80	.20
84	3.04	.67	.33
85	11.14	.91	.09
86	8.63	.88	.12
87	4.13	.76	.24
88	3.16	.68	.32
89	12.41	.92	.08
90	8.78	.87	.13

55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
-02	-02	-04	03	-03	-15	16	-09	-05	29	-06	03	-01	06	02	08	-01	01	03	-01	02	08	11	02	01	03	00	03	01	05	09	03	05	-02	-01	02
04	08	12	21	-03	03	-04	01	00	-09	00	12	04	04	09	17	22	16	18	19	22	26	27	20	17	22	15	05	06	00	04	08	02	10	15	08
04	03	-01	00	11	14	-13	00	00	-04	06	-05	01	-01	-01	-02	-03	-02	-12	-05	-08	-16	-18	-14	-08	-05	-14	-07	-09	-14	-05	-05	-09	-03	-02	-03
-05	-01	02	01	-05	-01	04	-10	-12	19	02	07	-03	00	-04	11	-03	-02	-10	-13	10	00	05	-04	-05	-06	-06	-04	-02	-05	-03	-02	-05	-05	03	-09
09	17	28	40	-11	-04	11	17	11	-03	10	06	09	09	15	17	28	23	32	35	29	30	31	16	24	29	23	16	17	16	17	14	11	01	18	19
01	00	19	29	-07	-06	11	07	11	00	05	04	02	-01	-01	07	18	12	09	22	13	19	16	14	19	15	09	08	08	01	12	11	09	-05	13	12
11	14	08	20	03	11	-02	08	-01	-02	14	10	12	10	20	08	24	21	26	30	20	18	21	13	25	22	15	12	17	16	09	08	08	11	13	22
00	-06	-01	10	-10	-19	20	01	05	00	07	-01	-05	-03	00	03	07	07	13	08	10	09	10	06	06	07	03	07	-02	15	15	12	10	-03	05	
03	-01	05	11	-03	-08	12	01	-01	-05	09	-06	01	-05	12	02	03	-06	-04	10	06	20	20	16	13	14	07	10	17	03	13	10	10	-01	-01	05
00	12	00	-06	05	10	-09	-02	-05	-03	-11	-10	-04	-03	-14	-06	-07	-07	-06	-10	-09	-01	-04	-06	00	-05	07	-01	-01	-09	-05	-03	-06	06	-05	-10
-01	-00	-02	-21	-00	-02	-10	-04	-08	-10	01	-08	01	-02	-07	-10	-07	-05	-07	-18	-09	-06	-09	-05	-01	-02	-03	04	00	05	01	00	00	-01	-01	-09
05	09	-03	-03	09	06	-15	-09	02	09	-07	06	-05	00	-09	-08	-04	-02	00	-05	-07	-13	-13	-08	-07	-07	01	-09	-13	-09	-11	-12	-10	-08	-06	-04
-01	08	06	03	06	01	-08	00	07	03	-17	05	-13	-06	-13	-11	-03	02	-04	-06	-09	-10	-13	-08	-03	-03	05	-09	-14	-13	-09	-10	-12	-02	-07	-05
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17	16	23	03	-01	-02	06	10	08	01	08	10	09	09	10	12	26	23	18	29	27	34	37	30	30	28	19	21	13	07	26	26	15	07	17	16
08	-02	04	23	10	-08	14	-03	10	05	07	03	12	08	09	12	24	21	10	17	23	44	42	38	40	41	35	35	33	20	42	39	27	14	15	15
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13	18	03	20	02	-05	09	07	10	08	10	16	16	10	17	09	22	16	12	18	19	29	22	25	25	21	16	22	20	07	20	19	16	14	25	13
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06	08	00	10	-06	-09	10	-03	-01	01	07	03	16	09	21	-03	18	16	10	12	13	14	14	17	07	08	09	10	16	01	20	18	19	05	16	08
16	18	05	24	-02	-05	10	06	14	05	13	14	17	11	18	10	24	17	14	23	24	31	25	25	22	17	28	23	07	25	25	22	12	19	13	
00	01	02	01	00	-07	02	12	08	-01	05	00	02	01	01	01	19	15	12	19	11	17	19	13	12	13	10	12	13	03	13	11	14	12	21	00
06	09	00	15	-05	-03	06	-03	06	03	11	12	13	05	14	06	15	11	02	16	18	24	22	22	19	19	13	23	18	05	23	25	23	09	09	15
02	13	02	17	-05	-07	11	-06	09	02	-01	13	04	-01	-02	05	11	07	18	13	06	24	24	15	23	18	16	14	08	-05	18	15	05	06	02	12
12	18	09	20	04	-06	09	-10	16	04	-08	-01	03	00	-06	04	13	15	11	11	07	22	23	15	19	11	13	12	09	-02	15	10	03	06	02	13
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05	18	08	24	-03	-04	12	-09	-12	05	05	13	08	04	04	09	18	13	23	15	13	27	29	16	28	25	21	19	12	04	19	15	04	07	10	12
14	12	05	08	04	06	03	01	-07	04	-04	00	-04	00	07	08	01	00	06	06	-06	05	04	12	13	13	15	02	05	01	-06	-04	-04	02	03	02
-07	-04	04	04	01	08	00	10	-04	-02	07	05	05	02	04	07	-05	-05	02	01	05	03	07	05	00	-03	-06	-04	-07	-01	-04	-03	-10	06	-07	07
15	11	05	06	08	02	-02	01	08	-02	-05	-02	-05	-03	06	-09	13	13	10	02	-03	12	07	06	11	09	10	09	07	07	05	08	-04	19	-05	-05
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01	01	29	30	-07	-08	07	01	09	-09	08	22	16	12	15	28	22	22	16	29	30	04	11	-01	21	22	17	03	-02	01	08	09	05	03	14	19
03	09	26	23	04	-01	01	05	05	-06	03	32	09	-05	08	21	22	18	22	28	13	07	06	08	20	13	17	10	14	09	06	01	12	14	13	
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10	01	12	17	-04	01	03	-05	01	-05	03	05	15	13	09	14	18	21	14	20	26	11	10	12	10	12	11	02	07	11	07	08	07	08	07	21
03	04	-08	-20	09	08	-15	05	-09	-05	-04	-09	-06	-02	-02	-08	-07	-06	-03	-11	-17	-11	-11	-12	-10	-07	-13	07	16	12	-05	-06	-05	02	-11	-03
-01	-04	03	-03	11	08	-10	-05	03	02	09	07	07	02	06	08	02	01	00	08	09	11	14	10	17	19	13	10	08	-04	09	05	12	-01	05	07
08	14	03	16	09	-01	06	16	14	-02	22	13	17	13	21	09	25	14	16	26	24	38	31	37	35	34	28	30	28	11	34	29	30	-02	22	21
06	11	-01	12	10	-04	06	08	15	-01	20	07	13	09	18	03	29	22	15	26	20	38	31	34	29	29	24	29	33	14	36	30	25	06	22	16
05	12	04	14	04	-03	05	08	16	04	19	13	14	12	21	09	34	25	21	30	23	39	32	38	33	32	27	31	35	15	32	28	33	07	21	25
07	-02	-05	02	00	-12	12	00																												

INTERCORRELAT

	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45		
3	-03	-15	-14	03	13	03	04	01	02	-02	-01	01	08	-01	00	-07	13	-08	02	06	05	36	02	-01	-07	05	06	05	02	-01	-05	-03	-07	06	-02	-01	09		
2	13	-06	-10	04	-06	-02	21	20	21	17	31	33	27	15	33	13	15	27	24	19	22	-06	03	-01	-07	10	07	08	30	13	16	19	16	07	17	09	-06		
6	-04	-06	-05	-05	01	07	-05	-03	-05	-06	-14	-12	-13	-15	-14	-06	-04	-13	-15	-12	-10	12	-17	-12	10	-01	-08	-10	-10	-03	-11	-04	-01	02	-04	04	04		
6	-09	-05	+00	01	06	-10	02	02	07	-04	-06	-03	-04	-09	-06	-02	04	-13	-14	-13	-20	46	-08	-10	-02	-05	02	02	01	-05	-13	00	-01	04	-02	06	03		
4	11	-02	-02	-15	-16	05	36	18	21	19	11	16	09	14	19	13	00	08	18	19	10	08	29	05	03	16	-01	13	47	10	13	19	13	17	18	15	00		
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72			-37	-40	-41	12	07	12	16	14	13	11	13	08	14	07	-02	11	06	11	13	01	01	09	-05	11	01	07	15	05	05	00	-02	03	02	00	02		
		76				-07	-06	-09	-16	-15	-08	-09	-03	-15	-05	-10	-08	04	-03	08	-06	04	-01	08	-01	-01	02	-07	03	06	-02	-01	01	-08	05	-05			
			76		-08	-03	-44	-03	-01	-01	-06	-17	-17	-09	02	-18	00	-13	-12	00	-03	-06	-07	-01	-06	00	01	13	06	-06	-09	01	-03	01	00	-03	10	-01	
				79		-06	-07	-03	-02	-03	-07	01	-05	-03	14	-09	03	-03	-02	04	-02	04	-10	-01	03	07	-11	03	-01	-02	-01	06	07	-08	-03	10	-01		
					79			-05	-07	-06	-07	-08	-08	02	-10	-11	15	-14	01	-04	-03	-07	-03	04	-04	-01	12	07	-16	06	-02	01	02	00	03	-08	03		
					87			04	03	09	15	13	13	-08	15	01	07	14	-06	-03	-05	09	-04	00	04	-07	-13	-11	11	-02	-01	00	-02	-09	-01	-04	03		
						51		24	25	16	12	18	10	03	17	09	02	12	19	23	13	03	31	04	09	00	14	22	21	02	01	14	04	03	07	07	03		
							89					30	31	29	09	29	13	02	32	26	23	13	03	31	04	09	00	14	25	21	02	19	14	05	10	08	-09		
												31	33	32	11	33	12	00	33	24	23	14	07	28	02	10	00	19	25	25	01	04	14	04	07	06	08	03	
												32	28	32	16	24	13	-01	29	18	18	13	-05	21	08	09	-03	12	29	20	00	04	08	07	-01	04	05	04	
												33	32	36	24	24	13	57	77	36	32	32	32	32	32	18	11	11	19	21	20	-03	05	03	07	02	01	04	05
												34	33	32	81	22	55	62	32	36	37	02	34	18	11	13	20	25	22	04	10	05	10	03	01	06	00		
												35	32	32	80	60	60	60	32	32	32	-02	31	19	08	05	20	24	19	06	11	06	10	03	03	05	-03		
												36	32	32	96	19	20	31	13	10	13	-08	13	19	-02	11	12	15	21	11	08	09	06	03	08	-01	12	-11	
												37	36	32	26	49	76	36	32	31	-02	36	18	07	15	19	21	28	-01	10	07	13	04	01	06	03			
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												39	36	32	90	05	24	28	26	26	10	15	11	08	10	15	15	11	08	-01	01	09	08	-01	00	-05			
												40	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												41	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												42	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												43	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												44	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
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												46	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												47	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												48	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												49	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												50	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												51	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												52	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												53	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												54	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												55	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												56	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												57	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												58	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												59	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												60	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												61	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												62	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												63	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01	-05	-01	05	10		
												64	36	32	93	06	26	93	27	23	27	-09	25	12	13	03	09	12	13	-08	05	00	01						

TABLE 9

EIGENVALUES OF 90PRINCIPAL COMPONENTS FOR 90 VARIABLES

NUMBER	EIGENVALUE	NUMBER	EIGENVALUE
1	3.80	46	.39
2	-.08	47	1.70
3	2.50	48	-.18
4	-.25	49	-.06
5	13.38	50	.19
6	.23	51	.15
7	-.20	52	-.14
8	3.24	53	.48
9	-.16	54	.31
10	-.18	55	2.22
11	-.08	56	-0.1
12	1.56	57	1.27
13	-.13	58	-.01
14	4.63	59	.18
15	.71	60	.89
16	1.94	61	-.10
17	-.14	62	.43
18	.02	63	.44
19	.69	64	.17
20	-.13	65	.22
21	-.17	66	.44
22	.60	67	2.36
23	-.17	68	-.09
24	.76	69	.26
25	.82	70	.34
26	-.09	71	1.87
27	3.08	72	-.09
28	-.02	73	.11
29	-.03	74	.07
30	-.05	75	.10
31	-.11	76	1.84
32	.30	77	-.04
33	.73	78	.11
34	-.11	79	1.37
35	.85	80	.10
36	-.22	81	.00
37	-.04	82	1.07
38	1.60	83	.05
39	.51	84	.07
40	-.02	85	1.46
41	-.21	86	-.05
42	1.12	87	.00
43	.02	88	.06
44	.01	89	1.05
45	.57	90	.94

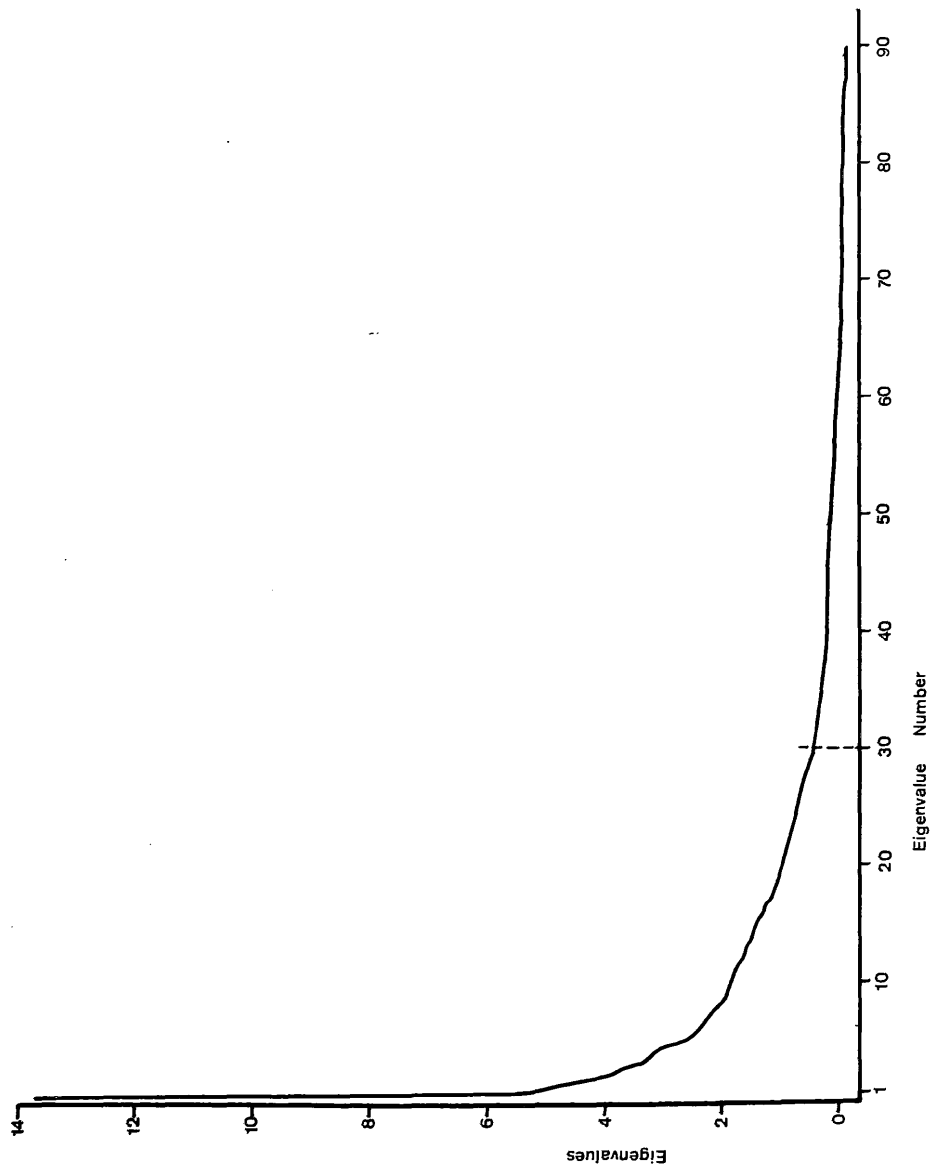


FIG.18: Scree Graph of 90 Eigenvalues.

TABLE 10

EIGENVALUES OF 30 SELECTED PRINCIPAL COMPONENTS
FOR 90 VARIABLES WITH PERCENTAGE CONTRIBUTIONS OF EACH FACTOR
TO THE SUM OF THE COMMUNALITIES.

ORDER	EIGENVALUE	PERCENTAGE of $\sum h^2$
1	13.38	21.30%
2	4.63	7.34%
3	3.80	6.04%
4	3.24	5.16%
5	3.08	4.90%
6	2.50	3.97%
7	2.36	3.74%
8	2.22	3.53%
9	1.94	3.09%
10	1.87	2.98%
11	1.84	2.92%
12	1.69	2.69%
13	1.60	2.54%
14	1.56	2.48%
15	1.46	2.31%
16	1.37	2.21%
17	1.27	2.01%
18	1.12	1.78%
19	1.07	1.70%
20	1.05	1.67%
21	0.94	1.49%
22	0.89	1.41%
23	0.85	1.35%
24	0.82	1.30%
25	0.76	1.21%
26	0.73	1.16%
27	0.71	1.13%
28	0.69	1.10%
29	0.60	0.96%
30	0.57	0.91%

Original sum of communalities = 62.973

Calculated sum of communalities = 60.576

Total percentage of sum of communalities = 96.26%

Table 12 gives the orthogonally-rotated factor matrix, together with the differences between original and calculated communalities. Differences are small, being of the order of 1×10^{-4} . As was mentioned in Chapter IV, the factor matrix was also rotated obliquely but the results are more difficult to interpret and seem not as meaningful as those obtained from orthogonal rotation. Reasons for this have been discussed in Chapter II. In view of this, only the results obtained by orthogonal rotation will be discussed in detail: results obtained by oblique rotation will be reported and discussed briefly later.

Each factor will be set out with the variables which were found to have significant loadings on the particular factor. The T values of the loadings (calculated by the Harris test of significance of factor loadings) and their respective levels of significance are given in the same table. Each factor will be discussed on its own before the factor analytic results as a whole are interpreted - this will give a clearer picture. Since some of the factors have been hypothesised for the first time (as far as the writer knows), the results should be treated more as indications than as irrefutable evidence of the existence of such factors. They will require further analysis before they are really acceptable. Further, one cannot hope to offer explanations and interpretations of all the results - this would be presumptuous as well as near impossible.

TABLE II

(decimal points omitted)																																	
UNROTATED FACTOR MATRIX OF 30 SELECTED FACTORS.																																	
FACTORS																																	
VARIABLE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	h		
1	04	01	03	07	10	39	-27	-21	-19	16	05	28	11	-06	-05	-11	-10	03	-17	-04	14	-04	-08	-10	-02	-05	04	-01	06	06	56		
2	38	-01	-22	-09	12	-13	-06	09	00	-03	05	-09	-01	11	01	04	-10	02	06	-09	-04	19	04	-08	-19	08	07	14	02	-03	49		
3	-18	-11	11	08	-20	06	-36	-27	44	-08	18	-17	08	-37	14	10	06	-04	11	20	02	06	10	-01	-02	-01	-06	02	04	-05	82		
4	-09	-05	11	06	04	38	-29	-30	-03	06	18	04	-06	-04	-11	02	-15	04	-19	-01	-03	03	00	-04	05	09	09	-01	-12	-06	52		
5	44	-20	04	-10	22	-15	-13	06	02	07	02	04	-22	02	-11	-11	22	08	-08	01	03	03	16	09	-01	05	00	06	13	-03	58		
6	28	-08	-04	-10	18	-04	-05	-10	08	10	17	16	-16	-10	-06	-11	02	04	-06	13	-06	-02	-04	18	00	-09	-02	-11	02	01	41		
7	29	-22	11	-06	-05	-20	-12	12	01	-03	01	06	15	-08	-16	-14	17	-20	-10	-13	-07	12	-08	-05	-26	03	03	-11	09	-02	53		
8	19	05	-06	25	32	-16	-20	02	08	23	-08	29	-01	04	13	-02	-23	-22	-01	06	16	17	02	18	10	12	06	13	-16	06	74		
9	24	14	11	30	17	-35	-27	12	-02	-07	-06	21	03	05	11	06	-11	-27	-02	07	07	13	12	-05	-08	-04	-14	-02	01	05	72		
10	-13	-01	01	-44	-09	01	31	13	03	-13	24	-13	-21	-20	-09	-04	08	-04	-24	-05	03	-03	-11	-24	-04	-11	-13	03	10	03	76		
11	-13	02	14	-33	-10	02	40	07	10	-08	21	-02	-26	-19	-24	-03	-05	02	-27	-01	-03	-09	07	06	02	-04	06	10	-20	-11	77		
12	-14	-03	-22	-40	-11	28	18	-20	-13	23	11	-04	24	25	12	-03	12	14	25	06	00	17	-07	04	-09	10	-03	-05	02	00	79		
13	-16	-03	-17	-43	-07	32	17	-23	-13	25	11	-13	25	16	16	-07	11	-02	16	15	06	06	-02	02	01	-01	00	01	09	07	75		
14	14	-06	02	57	01	-06	-35	05	-01	-17	-31	-10	10	00	-04	07	06	20	07	-13	-19	-27	-03	05	08	-07	08	-11	08	-06	87		
15	44	-12	06	-19	15	-04	-15	00	-02	10	08	04	-14	03	09	-20	03	08	07	07	-03	07	00	02	-06	-09	09	09	06	-12	51		
16	58	22	25	-11	05	24	-02	06	42	-05	-06	-06	10	31	-04	07	-07	05	-09	12	-11	-07	05	-06	-13	03	-06	07	-03	-05	89		
17	59	23	24	-07	09	23	-02	06	58	-02	01	-02	08	32	-09	10	-10	01	-11	18	-15	-02	05	-01	-10	01	01	01	-02	-02	89		
18	55	21	26	-03	-03	14	-01	06	35	04	-02	-06	13	35	03	03	-04	00	-10	09	-04	-11	06	-02	-08	01	-09	-07	-07	-01	81		
19	62	40	-53	21	-14	08	01	-13	-01	-04	-02	-12	-13	03	-02	11	01	00	01	-01	04	05	-06	08	-01	-04	02	06	01	-05	98		
20	61	26	-49	14	-09	12	-02	-04	-02	-07	01	-10	-12	01	-05	09	-03	-06	-03	00	-06	02	00	00	-14	-07	00	02	03	-01	83		
21	61	31	-40	13	-12	09	03	-11	-02	-01	-05	-08	-09	-03	01	10	-05	-07	-10	-09	03	-06	-06	02	02	02	-03	-05	-01	-02	80		
22	34	13	-23	09	-06	-03	21	-10	-06	10	11	04	-18	04	11	06	-06	-06	-03	-01	15	-05	12	-03	-01	09	-10	-19	-10	01	51		
23	65	35	-50	20	-03	02	-01	-12	-01	-01	01	-08	-18	02	-02	08	-02	05	00	03	-05	11	-07	06	01	-06	02	04	04	-06	96		
24	28	07	-02	09	-02	-13	06	-01	00	25	11	-18	-14	-01	-03	00	-24	07	-08	-05	-06	02	03	23	14	26	-37	03	12	-01	66		
25	27	13	-53	-02	-07	22	-12	-19	-19	00	-05	-01	06	-17	-02	09	12	-29	08	-03	-07	21	-06	19	-29	06	00	03	-15	-07	90		
26	50	38	-32	22	-09	02	09	00	13	-13	-04	-14	-18	15	01	03	01	20	00	-01	15	21	-02	-18	15	-23	16	-05	06	06	93		
27	40	23	-39	-27	28	04	01	24	17	-06	00	21	19	-23	-03	-10	-02	19	07	-06	-01	-04	10	-03	06	14	-06	01	01	01	84		
28	38	18	-38	-26	25	04	-10	24	20	-04	-04	28	09	-22	-06	-14	-08	03	10	08	-07	-06	-05	08	09	-12	01	-02	-06	11	78		
29	33	17	-31	-16	10	02	-01	19	03	-11	-06	11	15	-19	06	00	02	-11	-03	-06	09	03	00	-03	-08	-15	-05	-01	04	13	52		
30	00	-09	08	07	03	31	-35	-13	-07	04	18	16	-03	-02	-17	-07	-12	15	-19	-05	-06	04	-07	-03	03	01	-09	-11	08	-04	53		
31	46	13	-34	-31	29	07	-03	24	17	-07	-01	24	10	-22	-09	-06	-01	24	06	-04	-08	00	08	02	06	16	01	-01	05	03	34		
32	15	11	-21	-11	-03	-07	-03	03	-19	-10	-06	01	13	05	08	13	09	-01	-13	-01	12	-09	20	-23	-07	14	-17	-09	03	04	47		
33	02	01	-07	06	-02	13	-04	05																									

TABLE 12.

(decimal prints omitted).						ORTHOGONALLY ROTATED FACTOR MATRIX OF 30 FACTORS.																														COMMUNALITY CHECK	
VA- TABLE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	New-Original						
1	07	00	03	00	08	-04	-66	-02	-06	-03	01	09	03	-05	01	00	07	-07	09	-13	04	01	04	04	06	-11	-01	-01	-05	00	-41						
2	-11	-03	-27	10	-04	-07	08	-07	-10	-01	14	17	-21	13	07	-01	-21	-01	04	11	10	13	03	09	-04	04	00	-14	-10	-28	-65						
3	03	00	11	01	-14	-02	-14	-07	81	01	-03	-09	10	-02	11	05	02	11	-06	06	-01	07	00	00	00	02	00	-01	-03	04	-56						
4	-02	07	03	-11	07	04	-57	-05	19	01	-06	-14	-05	05	-02	03	-01	-07	-15	07	01	-09	04	-04	-06	03	-09	-09	12	-01	-67						
5	07	-16	-02	08	-03	-08	03	-14	08	-07	08	-15	-56	03	-14	-14	-05	09	05	08	08	-08	-05	02	05	09	14	01	11	-07	-47						
6	06	-09	-11	08	09	08	-03	-08	13	06	01	07	-39	02	-01	-03	-16	-04	-12	01	-05	-02	06	-16	04	20	-01	09	-08	04	-33						
7	-06	-20	16	25	-13	-15	09	-06	05	-13	13	13	-17	-02	-15	-24	02	-16	03	22	-19	16	17	11	02	-15	09	-15	-10	02	-74						
8	18	-12	05	06	13	-59	-13	-11	-12	10	-02	09	-10	04	18	12	-02	-05	-06	05	10	-03	-01	08	04	06	-01	02	00	00	-34						
9	04	06	-05	17	-01	-70	06	-04	-05	02	15	04	-05	02	03	00	02	-06	09	01	08	13	01	-05	00	00	-01	-07	01	06	-24						
10	-08	08	15	-07	-02	46	30	05	14	02	08	14	-06	-09	-09	09	00	-27	02	-07	-07	07	-01	06	02	-04	-01	02	-04	00	-49						
11	03	08	14	-17	03	38	26	01	12	-02	-13	04	-12	-03	-27	25	-01	-30	-04	03	01	-03	-01	-02	-03	04	-01	-08	02	03	-64						
12	-01	-03	00	03	-11	63	-18	-13	-24	09	08	-01	13	00	31	-01	06	-01	05	05	-02	02	-04	02	03	-06	-05	-03	00		-73						
13	03	-07	03	00	-05	63	-19	-08	-14	17	13	-04	13	-04	35	-07	05	-12	05	-13	00	-07	05	00	-01	-07	02	12	03	-01	-65						
14	-11	-05	-13	13	06	-44	-13	13	07	-16	-04	-09	12	08	-18	-28	-06	47	-02	01	-07	-01	03	-06	03	-04	07	13	-02	00	-29						
15	17	-10	-02	11	-08	-02	-12	-02	-08	-06	15	15	-48	08	03	-03	-16	-01	-06	08	20	08	-05	04	03	-02	06	03	-03	-02	-42						
16	26	-11	-16	04	-03	-02	-02	-07	03	-04	21	15	-09	79	-09	-04	01	-03	-01	00	-04	04	-02	05	02	02	03	03	-01	-05	-39						
17	22	-10	-18	06	02	-07	-05	-12	00	-03	21	13	-12	77	-10	01	03	-09	-05	03	-05	-02	-04	02	-03	01	-04	03	-02	-02	-84						
18	31	-17	-13	12	-10	-07	02	-03	-07	00	21	07	-04	70	-04	-06	03	-01	09	-07	-08	04	-03	03	06	03	01	00	04	07	-32						
19	07	-06	-93	17	-03	-04	-02	01	-01	-05	03	16	-02	10	-06	-06	01	00	-01	02	01	-03	08	01	04	07	05	04	02	-01	-35						
20	00	-12	-30	10	-02	-05	-04	01	-01	-10	08	20	-08	10	-05	-07	-03	-08	04	00	04	-01	14	02	-02	07	00	-08	-10	02	-45						
21	14	-13	-77	14	-03	-05	-03	01	-01	-06	11	16	-01	08	-06	-03	-04	-09	13	-01	-08	00	14	04	-02	07	03	07	06	03	-52						
22	16	-07	-46	08	05	01	06	-07	-10	-11	03	-01	-10	-04	08	17	-01	-11	33	-06	-01	01	04	-04	-07	09	-09	-03	20	06	-44						
23	09	-06	-38	19	-03	-08	-03	-01	-04	-07	02	17	-13	09	-06	-01	-04	02	00	05	05	02	02	03	01	08	01	07	01	-02	-67						
24	05	-17	-24	18	08	-04	02	04	00	09	-03	-10	-18	09	-04	26	-19	-01	02	00	-01	07	-03	05	-05	74	08	04	03	-01	-51						
25	-05	-15	-56	00	-05	05	-21	-07	04	05	14	20	11	-26	06	-26	08	-19	06	-06	04	-10	71	03	-01	-08	08	-02	-03	01	-19						
26	10	07	-72	11	00	-03	14	07	-04	-11	-04	11	-17	29	-09	01	-01	16	03	05	-12	-03	-41	04	00	-09	-06	-03	09	-04	-29						
27	03	-01	-21	08	05	05	02	-02	-05	02	06	83	-09	10	02	03	-08	02	07	03	00	01	03	04	04	04	-02	04	05	01	-79						
28	03	-08	-19	00	-05	-09	-03	-01	-03	05	01	79	-13	08	03	01	-05	-10	-11	-17	00	-01	10	02	06	-05	-13	12	-13	10	-63						
29	02	-07	-25	04	-03	-07	08	04																													

INTERPRETATION OF FACTORS:TABLE 13:iFACTOR 1

VARIABLE CODE NO:	VARIABLE NAME	LOADING	T VALUE	P LEVEL
87	Just Suppose O.	.72	22.52	< .001
85	Just Suppose Fl.	.84	18.50	< .001
86	Just Suppose Flex.	.82	11.60	< .001
82	Unusual Uses Fl.	.36	6.94	< .001
18	Instances O.	.31	5.74	.001
16	Instances Fl.	.22	5.56	.001
17	Instances Cats.	.22	5.26	.001
30	Product Improvement Flex.	.26	5.01	.001
83	Unusual Uses Flex.	.28	4.92	.001
53	Stories Fl.	.35	4.39	.001
47	Rorschach Fl.	.16	3.94	.001
81	Product Improvement O.	.19	3.82	.001
79	Product Improvement Fl.	.17	3.41	.001
49	Rorschach O.	.13	2.77	.01
48	Rorschach Cats.	.16	2.68	.01
36	Odd Animals O.	.19	2.48	.02
21	Line Meanings O.	.14	2.46	.02

This factor is identified as the hypothesised creativity factor "semantic, conceptual originality". The marker tests 87, 18 and 81 all have high loadings. The marker test Stories O. is the only one that has not appeared.

Measures of originality have included (a) statistically rare responses, (b) remotely associated responses and (c) "clever" responses. The adjective that seems to cover all three types of responses is "unusual". This concept is mentioned in many discussions on creativity (Flieger, Mednick, Hacker). A response must be unusual to be original. Thus it is not surprising that the variable Odd Animals O, has a significant loading on this factor. Further, Odd Animals is a test involving the conceptual type of material. The occurrence of Rorschach O and Line Meanings O - supposedly concrete information tests - is more puzzling. The appearance of Rorschach variables in other conceptual-type factors indicates that subjects have to deal with this test (which consists of vague, complex stimuli) in an abstract way.

Guilford has stated (56) that his factors LMC (spontaneous flexibility) and DMT (originality) often share measures. To

obtain unusual responses, a subject has to change classes (i.e. be flexible) and alter his approach to the situation. He actually defines DMT (the divergent production of semantic transformations) as "the production of a number of changes of interpretation, neither immediate nor obvious, that are appropriate to a general requirement" (op.cit.). The conception of change and restructuring forms an integral part of Ghiselin's definition of creative thinking - a concept the writer has included in her own definition given in Chapter II. The clue to originality and flexibility measures being loaded on the same factors (but to different extents) lies in transformations. The writer has set forward her explanation of the relationship in Chapter III under hypothesis H₁ (4b). Originality involves unusual transformations: flexibility involves transformations which may or may not be unusual. The occurrence of flexibility variables 86, 17, 80, 83 and 48 is therefore explicable on these grounds.

All flexibility variables are from conceptual material tests as well. This is the first indication that the writer's subdivision of Guilford's semantic content area into semantic concrete and semantic conceptual areas is justified.

The presence of Stories Fl. is an anomaly, but could perhaps be explained on the grounds that the person who has the ability to think of unusual responses to conceptual material, can also think up many ideas and express himself fluently. The writer suspects that the other fluency variables occur here because of their high correlations with their respective flexibility variables. Otherwise this could be an indication of the different creativity factors not being clearly distinguished at this age level. The first reason seems to fit the results best.

Contrary to expectation (at least from Mednick's theory), Quick Responses does not appear on this factor. Guilford (50) has also mentioned that "remoteness" scoring variables have loadings (on originality factors) that are not as high as variables dealing with "clever" or "uncommon" scoring. It would seem that a different ability is involved in producing remote associations, i.e. production of remote associations is not synonymous

with the concept of originality as defined in Hypothesis H_1 , 4(b).

TABLE 13 ii

FACTOR 2

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
71	Circles Fl.	.85	35.30	<.001
73	Circles O.	.59	22.20	<.001
72	Circles Flex.	.83	15.50	<.001
89	Torrance P.Q.10	.51	11.92	<.001
74	Circles Elab.	.63	8.26	<.001
90	Torrance P.Q. 11	.29	7.49	<.001
88	Torrance P.Q. 7	.47	7.05	<.001
81	Product Improvement O.	.22	4.26	.001
25	Line Meanings P.Q. 10	.15	4.00	.001
49	Rorschach O.	.15	3.47	.001
69	Incomplete Figures O.	.16	3.46	.001
75	Torrance Form	.18	3.34	.001
18	Instances O.	.17	3.30	.001
79	Product Improvement Fl.	.13	3.17	.002
84	Unusual Uses O.	.21	3.09	.002
68	Incomplete Figures Flex.	.17	2.99	.005
7	Father's Occupation	.20	2.98	.005
16	Instances Fl.	.11	2.84	.005
67	Incomplete Figures Fl.	.16	2.68	.01
17	Instances Cats.	.10	2.59	.01
21	Painting: detail	.18	2.52	.02
5	Embedded Figures	.16	2.151	.02
58	Struc. Drawings Form	.13	2.51	.02
21	Line Meanings O.	.13	2.47	.02
20	Line Meanings Flex.	.12	2.44	.02
37	Otis I.Q.	.18	2.44	.02
63	Toy Construction form	.20	2.16	.05
64	Toy Construction O.	.18	.197	.05

This seems to be the hypothesised creativity factor 4(a) - "semantic, concrete originality" because of the marker variables 73, 49, 69 and 21. Variables 81, 18 and 84 have probably loaded on the factor because although these are mainly "verbal" (conceptual) tests, it is relatively easy to represent them in a concrete way. Perhaps some subjects did just that, i.e. a subject could easily picture things that are round or white (as in Instances) or made of boxes (as in Unusual Uses). These variables have quite low loadings on this factor and much higher ones on their "own" factor - semantic conceptual originality. This is to be expected.

All that was said about originality and flexibility under factor 1 also applies here, of course, and serves to explain the presence of the flexibility variables 72, 68, 17 and 20.

The variables measuring the more unusual ways of perceiving concrete stimuli (Torrance P.Q. 10 and P.Q. 7, Line Meanings P.Q.10) are very interesting. They may indicate that the ability to perceive stimuli from unusual angles is important in the process of arriving at an unusual (original) response. It appears that the Torrance P.Q. 11 variable represents the uncommon way of viewing 'Circles' and 'Incomplete Figures' test material. This will be seen to be supported by the evidence of later factors.

Toy Construction O. is worthy of note even though it has a small loading. It was hypothesized as a measure of "free", unrestrained originality when dealing with concrete information. Its occurrence here is therefore not surprising and adds strength to the postulate that this factor is concerned with concrete-type material.

In view of the types of variables involved, we can name this factor "the ability to produce rare, unusual, but appropriate ideas when dealing with semantic, concrete material". (Chapter III). This ability requires seeing a situation in a novel way by transforming or redefining it.

Structured Drawings O. and Make-a-figure O. have not appeared here, though they were expected to do so. Reasons for this are discussed later.

TABLE 13 iii

FACTOR 3

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
19	Line Meanings Fl.	.93	33.40	<.001
23	Line Meanings form	.80	22.40	<.001
20	Line Meanings Cats.	.72	9.92	<.001
21	Line Meanings O.	.56	8.90	<.001
47	Rorschach Fl. (R.score)	.25	3.90	.001
48	Rorschach Cats.	.26	3.57	.001
22	Line Meanings P.Q. 12	.46	3.44	.001
71	Circles Fl.	.13	3.31	.001
76	Ask and Guess Fl.	.16	3.26	.002
49	Rorschach O.	.27	2.92	.005
16	Instances Fl.	.18	2.87	.01
27	Make a Figure Fl.	.21	2.67	.01
89	Torrance P.Q. 10	-.17	2.62	.01
53	Stories Fl.	.31	2.50	.02
17	Instances Cats.	.16	2.47	.02
31	Make a Figure form	.19	2.42	.02
28	Make a Figure Cats.	.19	2.05	.05
2	Animal Sorting Cats.	.27	1.94	.05

This factor could be creativity factor 1(a), viz. "semantic, concrete fluency", which is defined as "the ability to produce many appropriate ideas when dealing with semantic, concrete material".

Marker variables 19, 47, 71 and 27 all make their appearance - only Incomplete Figures Fl. is absent.

The "unexpected" variables 76, 16 and 53 may be here for a reason similar to one mentioned before. Subjects may actually deal with the test material in a concrete way; again, it is easy enough to represent Ask and Guess, Instances and Stories in a pictorial manner.

The two originality variables 21 and 49 can be explained by their correlations with their respective fluency variables, or, perhaps, to be fluent in the Line Meanings and Rorschach tests, the subject has also eventually to give unusual responses. The same can be said for their flexibility (Cats.) scores. If a person is fluent, he cannot help changing his approach quite often at the same time.

TABLE 13 iv
FACTOR 4.

VARIABLES CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
47	Rorschach Fl.	.82	21.20	<.001
48	Rorschach Cats.	.71	16.58	<.001
49	Rorschach C.	.76	12.50	<.001
77	Ask & Guess Flex.	.23	7.60	<.001
50	Rorschach P.Q. 12	.53	6.75	.001
78	Ask & Guess C.	.26	5.48	.001
90	Torrance P.Q. 11	.21	5.26	.001
71	Circles Fl.	.12	4.98	.001
76	Ask & Guess Fl.	.16	4.41	.001
86	Just Suppose Flex.	.12	3.31	.001
83	Unusual Uses Flex.	.18	3.30	.001
82	Unusual Uses Fl.	.16	3.23	.001
7	Father's Occupation	.25	3.00	.005
87	Just Suppose C.	.17	2.87	.005
30	Product Improvement Flex.	.12	2.84	.005
36	Odd Animals C.	.20	2.71	.01
79	Product Improvement Fl.	.13	2.62	.01
21	Line Meanings C.	.14	2.57	.02
24	Line Meanings P.Q. 7	.18	2.56	.02
88	Torrance P.Q. 7	-.14	2.03	.05
35	Odd Animals Cats.	.15	1.97	.05
53	Stories Fl.	.15	1.97	.05

This might be the creativity factor 3(b) "conceptual adaptive flexibility". The concept of restructuring is important in this type of flexibility. An individual who possesses this ability performs transformations by revising his conceptions of the situation and his tactics in dealing with it. Henle's remarks on the birth and death of ideas being important in creative thinking are pertinent. Persistently following one line of thought is no good. To be flexible, one has to abandon old ideas and follow new ones. It has all the expected marker variables but also some variables which were expected to load on the concrete, adaptive flexibility factor 3(a). The Rorschach has again appeared with the conceptual rather than the concrete type of variables - this supports the idea the subjects tend to deal with the test in an abstract way. In Unusual Uses (which was not expected to have a significant loading on this factor, but rather on factor 2(b)), a subject could be altering his approach to the situation and

redefining it. Also, of course, there are found to be elements common to both types of flexibility in thinking. Guilford (58) says, "... change of class may come about because of a transformation of meaning" - hence the connection between adaptive (shift) and spontaneous (change of class) flexibility. It must be noted that the writer is not using "adaptive flexibility" in the same way Guilford does. For Guilford, measures of adaptive flexibility force the subject to be flexible: in order to attain a solution, the subject has to change his approach and adapt his methods. In the Just Suppose, Ask and Guess, Rorschach and Product Improvement tests, the subject is not forced to adapt and redefine, though to obtain original solutions he must do so. This explains the presence of the originality variables 49, 78, 87, 36 and 21.

The occurrence of the perceptual quality variables 50, 90, 24 and 88 is of interest. Redefinition is surely a function involved in the perception of stimuli from uncommon angles. In view of the negative loading of variable 88 (Torrance P.Q. 7) and the performance of this variable and the variables Torrance P.Q. 10 and P.Q. 11 on factor 3, it would seem that these variables are acting in ways opposite to those expected. It seems that P.Q. 11 is the more uncommon way of perceiving stimuli in the Circles and Incomplete Figures tests that comprise the Torrance measures. This is quite logical if one considers the type of stimuli given. This will be investigated further under Hypothesis H₃.

On the evidence of these results, the writer's hypothesis of distinct flexibility factors in both the semantic conceptual and semantic concrete areas, has won some support. The position will become clearer as the other flexibility factors are discussed.

TABLE 13 v

FACTOR 5

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
60	Struc. Drawings P.Q. 10	.75	12.10	<.001
61	Struc. Drawings P.Q. 11	-.64	11.00	<.001
59	Struc. Drawings Change No.	.69	8.74	<.001
56	Struc. Drawings C.	.64	8.53	<.001
55	Struc. Drawings Flex.	.65	8.50	<.001
3	Birth Order	.14	2.58	.01
38	Painting: Originality	.16	1.96	.05

This appears to be a factor in which the "structure" of the concrete type of information given in the stimulus is the main element. This factor was not hypothesised - it was expected that the various Structured Drawings variables would load on their respective semantic, concrete factors. It seems, however, that the different degree of structure in the test sets it apart as involving a separate ability. Individuals are forced to employ a different type of thinking when dealing with situations structured to different degrees. The writer tentatively names this factor "the ability to adapt concrete material which is structured to different degrees, in unusual ways". The negative loading of variable 61 (P.Q. 11, i.e. viewing a stimulus from the side) lends weight to this interpretation.

The Variable 38 makes an interesting contribution. Painting was completely unstructured - the subjects were restrained only by the actual materials available. To do well on the Structured Drawings variables 59, 56 and 55, a subject had to give original responses and be flexible throughout all four sections of the test, even though structure was a minimum at the beginning. Thus, this factor may be "the ability to define semantic concrete material in unusual ways when the structure of the situation is a minimum."

TABLE 13 vi
FACTOR 6.

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
12	Good Figures Cat. 5	-.63	12.55	<.001
9	Good Figures Cat. 2	.70	12.10	<.001
13	Good Figures Cat. 6	-.62	11.40	<.001
14	Good Figures Change No.	.44	11.20	<.001
8	Good Figures Cat. 1	.59	10.60	<.001
10	Good Figures Cat. 3	-.46	8.61	<.001
11	Good Figures Cat. 4	-.38	7.11	<.001
76	Ask & Guess Fl.	.12	4.40	.001
77	Ask & Guess Flex.	.14	4.28	.001
61	Structured Drawings P.Q.11	.18	3.68	.001
50	Rorschach P.Q. 12	.15	2.12	.05

Instead of finding two separate factors for figure preferences (as hypothesised), only one has emerged. The two hypothesised perceptual factors 5(a) and 5(b) were (a) preference for asymmetrical figures/dislike of symmetrical figures and (b) preference for open figures/dislike of closed figures.

From the above results, it appears that only the open/closed distinction is important. This is extremely interesting in view of Mowatt's finding that closure seemed to be more important than symmetry, i.e. his subjects tended to change open, asymmetrical figures to closed ones rather than making them symmetrical.

The negative loadings above belong to variables 12, 13, 10 and 11, which were the figure categories: open symmetrical, open asymmetrical, symmetrical dot figures and asymmetrical dot figures (the latter two are, of course, open figures as well). Variables 8 and 9 were categories of closed figures. This bipolar factor represents undoubtedly, therefore, a preference for closed figures and, conversely, a dislike of open ones.

Variable 61 is probably loaded on this factor because it is a measure of a subject's preference for viewing a pictorial stimulus from a common angle (sideways). It is likely that individuals with these preferences (and dislikes) prefer "safe", tidy views of their environment with which they can cope. There is little room for ambiguity and uncertainty in their worlds. This whole approach to the world is tied up with Rogers'

"tolerance of ambiguity" (see Chapter II).

The occurrence of variables 76 and 77 is difficult to explain - it does not fit the interpretation the rest of the variables lend this factor. The absence of Picture Preference is disappointing. It must be that preference for different types of painting is separate from preference for relatively simple geometric figures.

TABLE 13 vii

FACTOR 7.

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
1	Age	.66	8.22	<.001
30	Make-a-Figure: Av.No.	.58	6.91	<.001
54	Stories C.	.57	6.88	<.001
4	Changing Figures	.57	6.78	<.001
14	Good Figures Change No.	.13	5.97	.001
25	Line Meanings P.Q. 10	.21	5.97	.001
10	Good Figures Cat. 3	-.30	5.40	.001
26	Line Meanings P.Q. 11	-.14	5.02	.001
77	Ask and Guess Flex.	.16	4.43	.001
11	Good Figures Cat. 4	-.26	4.38	.001
76	Ask and Guess Fl.	.13	4.36	.001
64	Toy Construction form	.35	4.23	.001
89	Torrance P.Q. 10	.11	3.76	.001
12	Good Figures Cat. 5	.18	3.23	.002
13	Good Figures Cat. 6	.19	3.21	.002
3	Birth Order	.14	2.74	.01
82	Unusual Uses Fl.	.11	2.20	.05
8	Good Figures Cat. 1	.13	2.09	.05

This factor is not clearly indentified. It might have something to do with the hypothesised perceptual factor 2 - "openness of perception", though only marker variable 4 appears. However, there are many other perceptual variables loaded on this factor as well. Thus it is probably a perceptual ability - perhaps a kind of perceptual approach to a situation, being able to take advantage of the possibilities inherent in a task. This might account for the variable 30 which is measure of the number of elements a subject used in constructing objects, and variable 54 in which a subject must be aware of the implications in each picture in order to arrive at an original story.

If this can be interpreted as an "open approach" to an environment, being aware of possibilities and exploiting them to advan-

tage, then it seems this type of approach affects the angle from which an individual views a scene or object. The connection is easy to understand and accounts for the positive loadings of Line Meanings P.Q. 10 and Torrance P.Q. 10 and the negative loading of Line Meanings P.Q. 11. However, one would expect variables 10 and 11 to have positive loadings and 8 to have a negative loading. In fact, the reverse has occurred.

This factor needs a lot more investigation. Since it is the first time it has happened, it is impossible to interpret it with much certainty. One can but note its apparent anomalies and hope the position can be clarified at a later date.

TABLE 13 viii

FACTOR 8.

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
42	Drawing: Orig.	.75	7.86	<.001
43	Drawing: Ability	.71	7.31	<.001
44	Drawing: Detail	.56	5.24	.001
76	Ask and Guess Fl.	-.15	3.65	.001
77	Ask and Guess Flex.	-.17	3.45	.001
58	Struc. Drawings form	.25	3.31	.001
38	Painting: Orig.	.31	2.99	.005
40	Painting: Ability	.28	2.58	.01
78	Ask and Guess C.	-.15	2.23	.05
90	Torrance P.Q. 11	.12	2.22	.05
17	Instances Cats.	.12	2.21	.05
61	Struc. Drawings P.Q. 11	.16	2.16	.05

This would seem to be creativity factors 6(a) - originality (free). This means that the type of thinking involved here is the production of unusual responses using concrete materials in a very free, unrestrained situation. Mosaics and Toy Construction have not appeared, probably because they involve the use of three-dimensional materials, not two-dimensional like the tests listed above.

Ability to draw well seems to play a part in this type of activity because variables 43, 58 and 40 are all loaded on this factor.

The presence of variables 76, 77, 73 and 17 is somewhat of a puzzle and at present, irreconcilable with the rest of the inter-

pretation of this factor. This, too, needs further investigation.

TABLE 13 ix

FACTOR 9.

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
3	Birth Order	.81	12.11	<.001
52	Sibling Number	.84	12.00	<.001
12	Good Figures Cat. 5	-.24	3.28	.001
60	Struc. Drawings P.Q. 10	.15	1.96	.05

This factor was not hypothesised though it might have been expected. It could be labelled "Position in Family" since the two highest loadings are concerned with the child's birth order, i.e. whether he was first-born, or second, or third, etc. and with the number of brothers and sisters he has. The occurrence of variables 12 and 60 in this factor is obscure and cannot be adequately explained as yet.

TABLE 13 x

FACTOR 10

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
67	Incomplete Figures Fl.	.88	14.02	<.001
68	Incomplete Figures Flex.	.79	9.65	<.001
90	Torrance P.Q. 11	.54	8.89	<.001
69	Incomplete Figures C.	.74	8.55	<.001
75	Torrance form	.63	8.08	<.001
89	Torrance P.Q. 10	.37	8.00	<.001
72	Circles Flex.	.27	7.98	<.001
71	Circles Fl.	.24	4.42	.001
26	Line Meanings P.Q. 11	.11	2.50	.02
74	Circles Elab.	.18	2.36	.02
77	Ask and Guess Flex.	.11	2.16	.05
47	Rorschach Fl.	.11	2.03	.05

This is identified as the creativity factors 2(a) - semantic, concrete spontaneous flexibility which is defined as "the ability to produce diverse ideas fulfilling certain class or category requirements when dealing with semantic, concrete information". This ability, unlike adaptive flexibility, involves changing classes of ideas rather than shifting or adapting ideas.

The marker variables Incomplete Figures flexibility and Circles flexibility both load on this factor. Structured Drawings does not (for reasons discussed under factor 5), neither does Animal Sorting Categories. This may be because Animal Sorting is not a paper-and-pencil type of test whereas all the other variables occurring here, are. Semantic, concrete flexibility thus seems to involve an ability to structure pictorial stimuli so that they fall into many different categories. A subject has to add to the stimulus given: he does not merely interpret it.

Ask and Guess flexibility probably makes an appearance here because some subjects tend to deal with it in a concrete way. It does not, however, fit the picture of adding actual lines to a stimulus before interpreting it. But it does involve elaborating (at least verbally) on the stimulus given. It is likely that the perceptual quality variables P.Q. 10 and P.Q. 11 are loaded on this factor because they are part of the process of interpreting a stimulus

TABLE 13 xi

FACTOR 11

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
79	Product Improvement Fl.	.74	12.40	<.001
76	Ask and Guess Fl.	.51	12.00	<.001
80	Product Improvement Flex.	.71	10.25	<.001
81	Product Improvement C.	.71	9.48	<.001
77	Ask and Guess Flex.	.46	9.00	<.001
78	Ask and Guess C.	.48	7.05	<.001
69	Torrance P.Q. 10	.20	4.19	.001
71	Circles Fl.	.13	3.32	.001
16	Instances Fl.	.21	3.75	.001
17	Instances Cnts.	.21	3.75	.001
82	Unusual Uses Fl.	.25	3.58	.001
83	Unusual Uses Flex.	.27	3.52	.001
85	Just Supposed Fl.	.16	3.13	.002
18	Instances C.	.21	2.80	.005
47	Rorschach Fl.	.15	2.78	.01
25	Line Meanings P.Q. 10	.14	2.57	.02
38	Painting: Originality	.26	2.42	.02
58	Structured Drawing form	.20	2.56	.02
75	Torrance form	.18	2.30	.05
32	Make a Figure P.Q. 12	.25	2.05	.05
37	Otis I.Q.	.22	2.02	.05

This factor is well supported and is identified as the hypothesised creativity factor 5(b) - conceptual elaboration or "seeing implications". The marker variables 79, 76, 82 and 85 all have significant loadings, the first two being especially high. This is to be expected because Product Improvement and Ask and Guess are purer measures of the ability concerned than are Unusual Uses and Just Suppose. The essence of the ability is setting up hypotheses. This means being able to see the implications involved in a situation and inventing solutions. An individual with this ability would be able to predict from and improve on a situation.

This factor is not Guilford's "sensitivity to problems" which he has placed in his CMI cell. CMI tests keep to things the subject has experienced in connection with one another before. In conceptual elaboration, the subject has to invent many connections and hence it is a divergent-production ability. This factor is also not identical with Guilford's DMI because of the writer's hypothesised splitting of the semantic (M) area. It could be the conceptual counterpart of DMI, but this cannot be stated categorically because no marker tests similar to Guilford's were used. (Guilford's tests were: Possible Jobs, Planning, Effects and Unusual Methods)

Shapiro hypothesised an ability "sensitivity to implications" as distinguishing high and low creative research scientists. His measure of this was a test involving the ability to generate hypotheses, i.e. a test similar in conception to Ask and Guess. He says Guilford's factor is one aspect of a more complex activity called "sensitivity to implications". The two stages in this activity are (1) sensing an anomaly in a situation and (2) trying to clarify the anomaly. Thus the writer's use of "sensitivity to implications" is not the same as Shapiro's because in the tests used here, the "anomaly" is pointed out - the subject just has to see the implications involved.

Terrance has called this ability "sensitivity to disharmony and deficiencies", the problem being vague and ill-defined. The creative individual sets out to achieve some solution - he does not just ignore the problem. Gough's factor of "inquiringness a habit of mind" fits in here. The originality variables 81, 78 and 18 probably appear here because in predicting and inventing, an

individual will often entertain unusual ideas - this is part of the ability involved.

Note the occurrence of the two less common perceptual quality variables 89 and 23 and the low loading of the Otis I.Q. General reasoning ability would seem to play a minor part in being able to generate hypotheses and elaborate on conceptual material.

The fluency variables may occur because in being fluent, the subject has to elaborate on an idea and not perceive just one aspect.

The interpretation of this factor is by no means clear but the main indications of its meaning are present. The occurrence of the subsidiary variables needs more research to clarify their positions.

TABLE 13 xii

FACTOR 12

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
27	Make-a-Figure Fl.	.83	11.30	<.001
31	Make-a-Figure form	.82	11.15	<.001
28	Make-a-Figure Cats.	.79	9.15	<.001
20	Line Meanings Cats.	.20	6.23	.001
23	Line Meanings form	.17	7.64	.001
29	Make-a-Figure C.	.52	4.11	.001
19	Line Meanings Fl.	.20	2.68	.01
15	Instances Fl.	.15	2.48	.02
80	Product Improvement Flex.	.15	2.34	.02
89	Torrance I.Q. 10	-.12	2.31	.02
90	Torrance P.Q. 11	.14	2.31	.05
17	Instances Cats.	.13	2.11	.05

Two out of three marker variables appear here to lend support to the interpretation of this factor as possibly being "concrete, adaptive flexibility" (creativity factor 3(a)). Both 28 and 20 have highly significant loadings. The Rorschach is missing yet again - it must definitely be seen as a conceptual rather than a concrete type of test, perhaps because of its complexity and ambiguity.

80 and 17 have probably occurred because some subjects tend to deal with these tests in a concrete manner - which certainly

is easy enough to understand.

This is the semantic, concrete counterpart of factor 4 and hence almost everything stated there can be restated here. The distinction between the two types of content area is clear enough. Both types of content appear in both factors but conceptual content variables have higher loadings on factor 4 and concrete content variables have higher loadings on this factor. The ability involved is defined as "the ability to shift or change one's approach to a situation involving semantic, concrete material". In both Make-a-Figure and Line Meanings, the stimulus has continually to be redefined and seen in a different way. The restructuring principle common to both adaptive flexibility and originality has been discussed and accounts for the presence of variable 29. Resistance to restructuring could be called "Gestaltbinding" and is the opposite of adaptive flexibility. Thurstone used the term to describe his flexibility of closure factor, but it is just as useful and pertinent here.

The fluency variables appear because an individual who is continually adapting his approach and redefining a stimulus must surely put out many responses at the same time.

TABLE 13 xiii

FACTOR 13

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
76	Ask and Guess Fl.	.45	10.80	<.001
77	Ask and Guess Flex.	.46	9.20	<.001
71	Circles Fl.	.22	6.58	.001
58	Struc. Drawings form	.46	5.99	.001
5	Embedded Figures	.56	5.15	.001
37	Cats I.Q.	.52	4.94	.001
78	Ask and Guess O	.32	4.79	.001
89	Torrance P.Q. 10	.21	4.49	.001
15	Hidden Figures	.48	4.10	.001
75	Torrance form	.30	3.90	.001
23	Line Meanings form	.13	3.89	.001
51	Scribble Colour: Spaces	.45	3.79	.001
57	Struc. Drawings Elab.	.31	3.39	.001
74	Circles Elab.	.24	3.19	.002
47	Rorschach Fl.	.17	3.18	.002
6	Enclosed Areas	.39	2.99	.005
31	Make-a-Figure form	.19	2.84	.005
53	Stories Fl.	.27	2.56	.02
85	Just Suppose Fl.	.12	2.39	.02
48	Rorschach Cats.	.17	2.10	.05
29	Line Meanings P.Q. 10	-.11	2.06	.05
61	Struc. Drawings P.Q. 11	.15	1.99	.05
56	Struc. Drawings O	.19	1.96	.05

This is the most clearly identifiable factor. It is very strongly supported by all its marker variables 5, 15, 51 and 6 and, therefore, is identified as perceptual factor 1 - perceptual flexibility or figural redefinition.

The factor has been found many times before. (Botzum, 1951; O'Sullivan et al., 1965; Ruff, 1952; in Guilford (50); Frick et al. (38)).

The ability here is "to change the function or significance of structural element of an object to use them in a new way" (Frick et al., 38).

The ability to isolate parts of larger organisations and produce new subwholes by reorganisation of line elements, is necessary to do well on all the above-mentioned marker variables.

Redefinition involves changes of meaning or significance either with concrete (structural) or conceptual material: restructuring involves changes in the direction of thinking. This point

distinguishes the redefinition factors from adaptive flexibility and originality factors. Another point which distinguishes them is that redefinition belongs to the convergent-production factors (e.g. there is only one correct solution in Embedded Figures) and restructuring belong to the divergent-production factors. However, in Enclosed Areas, there are actually eight different ways of redefining the line elements. This is probably why its loading is not highly significant - it is really neither clearly a convergent-production nor a divergent-production type of test.

Apparently this redefining of line elements is an important part of the Ask and Guess test. Perhaps subjects find it necessary to actually redefine the lines comprising the Ask and Guess picture. The same may be said of the Borschach pictures. The occurrence of form variables 58, 75, 23 and 31 is interesting. One can understand the relationship between redefining line elements and achieving good form or organisation of line elements (which is what the form variables measure).

The fluency variables may be appearing here because of the similar concepts inherent in the scoring methods. Fluency is the number of responses made; scores for all figural redefinition variables are the number of correct solutions found. The two elaboration variables 57 and 74 are difficult to interpret in the context of this factor.

An interesting aside to note is that Witkin et al ((1962), reported in Guilford, 50) found positive correlations between their Embedded Figures Test and FID (Field independence-dependence) measures. The latter measures included the well-known Rod and Frame and Body Adjustment tests. The FI type of person did better than the FD person on the Embedded Figures Test. This means that the person who pays too much attention to what he sees and who holds onto it, should be less likely to see changes in the figures and thus be less likely to redefine them. This again ties up with the perceptual modes associated with creative thinking, viz. the ability not to remain stimulus-bound and not to wish to remain within the stultifying boundaries of safe, "known" and easily understood perceptions.

TABLE 13 xiv

FACTOR 14

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
16	Instances Fl.	.79	10.42	<.001
17	Instances Cats.	.77	10.15	<.001
76	Ask and Guess Fl.	.70	6.90	<.001
77	Ask and Guess Flex.	.54	5.56	.001
18	Instances C	.62	4.92	.001
26	Line Meanings P.Q. 11	.29	4.85	.001
25	Line Meanings F.Q. 10	-.26	3.53	.001
19	Line Meanings Fl.	.32	3.48	.001
85	Just Suppose Fl.	.21	3.04	.005
86	Just Suppose Flex.	.20	2.48	.02
79	Product Improvement Fl.	.17	2.11	.05
90	Torrance P.Q. 11	.16	2.11	.05

This is interpreted as the creativity factor 1(b) - semantic, conceptual fluency which is "the ability to produce many appropriate ideas when dealing with semantic, conceptual stimuli". The marker variables 16, 76, 85 and 79 all appear. Unusual Uses Fluency and Stories Fluency are missing. One possible explanation is that the subject tends to deal with these two tests in a concrete way. Indeed, Stories fluency did appear on the concrete content counterpart (factor 3) of this factor.

The flexibility variables probably occur because, when producing many ideas, subjects tend also to change categories of ideas at the same time.

Since sheer quantity of output is the essence of this factor, it is not surprising the variables 26 and 90 have positive loadings (both are measures of common ways of viewing stimuli). Variable 25 has a negative loading - it is a measure of a less common way of viewing a stimulus and hence did not occur very often.

TABLE 13 xv

FACTOR 15

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
82	Unusual Uses Fl.	.67	15.50	<.001
83	Unusual Uses Flex.	.67	12.30	<.001
77	Ask and Guess Flex.	.10	5.95	.001
12	Good Figures Cat. 5	-.55	5.30	.001
13	Good Figures Cat. 6	-.31	5.57	.001
79	Product Improvement Fl.	.21	4.96	.001
80	Product Improvement Flex.	.22	4.44	.001
76	Ask and Guess Fl.	.18	4.42	.001
14	Good Figures Change No.	.18	4.14	.001
85	Just Suppose Flex.	.13	4.14	.001
85	Just Suppose Fl.	.15	3.07	.005
8	Good Figures Cat. 1	-.18	2.92	.005
87	Just Suppose C	.16	2.70	.01
49	Rorschach C	.12	2.68	.01
17	Instances Cats.	.10	2.51	.02
78	Ask and Guess C	.12	2.48	.02
3	Birth Order	-.11	2.16	.05
45	Picture Preferences	.19	2.04	.05

This could be the conceptual counterpart of factor 10, viz. semantic, conceptual spontaneous flexibility (creativity factor 2(b)). It is defined as "the ability to produce diverse ideas fulfilling certain class or category requirements when dealing with semantic, conceptual information". Tests of this factor measure the degree to which a subject changes set without instruction, i.e. without being forced to do so. This is the opposite of "inertia in thinking". The relatively unstructured situations allow the subject to do as he wishes - he can shift set freely or remain tied to one mental set, unable to break loose.

All three marker variables 85, 80 and 17 have appeared on this factor. The distinction between conceptual adaptive flexibility and this flexibility factor is, however, not as clear as the concrete flexibility factors. Thus 77 and 86 have occurred here. Now a change of class may come about because of a transformation of meaning (as occurs in the "shift" activity in adaptive flexibility). This could account for the connection between the two types of flexibility factors. It could also account for the clearer distinction between the two concrete flexibility factors.

Transformation of meaning may be more difficult to perform with concrete than with conceptual information. Some variance also comes from DMT (Guilford, 50) or what the writer has called DMT(u). Guilford has found this to occur and suggests it is because in adapting the use of an object or situation, some drastic transformations occur (which must include unusual ones). This could account for the presence of variables 37, 49 and 78. Note that all these additional variables are from conceptual-type tests (the performance of the Rorschach has already been noted). Fluency variables appear because of their high correlations with their respective flexibility variables.

The presence of variables 12, 13, 14, 3 and 45 is difficult to reconcile - explanation must await further research.

TABLE 13 xvi
FACTOR 16

VARIABLE CCODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
58	Struc. Drawing form	.50	4.26	.001
57	Struc. Drawings Elab.	.50	3.27	.001
25	Line Meanings P.Q. 10	.26	3.18	.001
90	Torrance P.Q. 11	.25	3.05	.001
70	Incomplete Figures Elab.	.45	2.97	.005
66	Picture Construction Elab.	.35	2.94	.005
11	Good Figures Cat. 4	-.25	2.01	.05
74	Circles Elab.	.25	2.00	.05
75	Torrance form	.33	1.97	.05
40	Painting: Ability	.21	1.97	.05
5	Embedded Figures	.21	1.96	.05

This factor has been well supported and can easily be identified as the hypothesised "concrete elaboration" factor (creativity factor 5(a)). Four out of six marker variables appear, viz. 57, 70, 66 and 74.

As mentioned in Chapter III, this factor is not the equivalent of Guilford's DFI (figural elaboration) factor, but rather the semantic, concrete half of his DMI cell. This factor is defined as "the ability to add details to and to embroider semantic, concrete material. Most of the embellishments themselves are meaningful and not merely decorations" (as they are in measures of DFI).

The other two variables postulated to load on this factor were Painting (detail) and Drawing (detail). There are three possible reasons why they have not done so: (1) The marking scheme for "detail" was not the exact equivalent of elaboration scoring. "Detail" was used to mean something closer to "composition" and "use of space and construction of the picture". It was thought that elaboration is part of these activities, but it seems it is not so. (2) Both Guilford (53) and Lowenfeld and Brittain (79) have stated that although divergent thinking in art is parallel to divergent thinking in other figural (actually the writer's "concrete") areas, it is not identical with it. (3) Both Painting and Drawing were "free" activities, i.e. the only restraint imposed on the subjects lay in the materials they had to work with. The situation was structured only to that extent. By comparison, the tests appearing on this factor are much more structured: much more information and guidance were given to the subjects.

Thus in reasons (2) and (3), different types of thinking are probably involved. Perhaps the "free" activities form an elaboration factor on their own (see discussion under factor 17). Painting ability may also be regarded as a measure of "form" or good organisation of concrete material so it is easily recognisable. Perhaps this ability is what we commonly call "talent" in drawing, i.e. ability to produce well-formed objects and figures.

Elaboration seems to play a part in different (probably uncommon) ways to perceiving a concrete stimulus (variables 25, 90). The reverse performance of the Torrance P.Q. 10 and P.Q. 11 variables has been commented on previously. In fact, perception seems involved to quite a large degree, because variables 11 and 5 also occur. Their exact contribution is impossible to assess at this stage.

TABLE 13 xvii
FACTOR 17

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
41	Painting: detail	.67	4.47	.001
40	Painting: ability	.57	3.44	.001
39	Painting: use of colour	.53	3.10	.002
33	Painting: C	.45	2.84	.005
70	Incomplete Figures Elab.	.37	2.45	.02
74	Circles Elab.	.27	2.39	.02
71	Circles Fl.	.12	2.38	.02
66	Picture Construction Elab.	.40	2.34	.02
79	Product Improvement Fl.	.18	2.04	.05
89	Terrance F.Q. 10	.14	1.99	.05

Many variables here also occur on factor 16 and make it difficult to assess the different abilities involved. At first, it was thought that this might be the hypothesised creativity factor G(a) - "free invention using concrete materials to produce original responses". However, the important product here seems to be detail: the main mode of thinking is in terms of elaborating, not producing original products. Further, it seems to involve the use of colour because colours were used in Painting, Picture Construction, Circles and Incomplete Figures. Significantly, Drawing (in which only black and white were used), does not appear. Product Improvement Fl. may be here because it does, in fact, involve elaboration and though it was postulated to be a conceptual-type test, it would be easy to deal with it in concrete terms.

Mosaics and Toy Construction have not made their mark. This could be because the above tests can be considered as paper-and-pencil tests whereas Mosaics and Toy Construction are tests requiring the manipulation of three-dimensional materials.

In the absence of any clearer indications, this factor would seem to involve three characteristics: (1) colour, (2) structuring a concrete situation and (3) elaborating at the same time. We can tentatively name it "the ability to embellish a picture (using colour) which has to be constructed from relatively unstructured materials at the same time".

TABLE 13 xviii

FACTOR 13

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
14	Good Figures Change No.	.47	6.86	<.001
35	Odd Animals Cats.	.53	4.84	.001
36	Odd Animals C.	.51	4.38	.001
77	Ask and Guess Flex.	.22	3.85	.001
26	Line Meanings P.Q. 11	-.16	3.23	.002
11	Good Figures Cat 4	.30	3.22	.002
25	Line Meanings P.Q. 10	.19	3.12	.002
78	Ask and Guess O.	.23	3.02	.005
10	Good Figures Cat. 3	.27	2.89	.005
88	Torrance P.Q. 7	.24	2.21	.05

There are not enough decisive variables to make the interpretation of this factor clear. Two of the most significant loadings belong to variables 35 and 36 which were hypothesised to load on creativity factor 6(b) - "free verbal invention". The other postulated variable, Stories originality, has not appeared.

This might even be concerned with an ability to perceive and interpret stimuli (probably concrete stimuli) in unusual ways, since the "uncommon" perceptual qualities (25, 33) have positive loadings and the "common" perceptual quality (26) has a negative loading. In addition, the two "preference of open figures" variables (11, 10) have positive loadings.

It may be that individuals who can invent freely under the minimum of restraint and with minimum guidance, are also the individuals who prefer the more "unusual" angles and types of perception.

TABLE 13 xix

FACTOR 19

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
32	Make-a-Figure P.Q. 12	.56	5.29	.001
31	Make-a-Figure form	.21	3.59	.001
22	Line Meanings P.Q. 12	.33	3.24	.002
38	Painting O.	.28	3.02	.002
50	Rorschach P.Q. 12	.21	1.90	.05
53	Stories Fl.	.20	1.39	.05

In view of the appearance of the three marker variables 32, 22 and 50, this factor is identified as the hypothesised perceptual factor 4(a) which the writer called Perceptual Elaboration (movement). The occurrence of such a factor is gratifying and certainly warrants further research. It seems there is a distinct ability to introduce the dimension of movement when structuring and interpreting static pictorial stimuli. A person who possesses this ability is not stimulus-bound, i.e. dependent on the stimulus given. Such a person can perceive and structure beyond what is given.

It is interesting that Painting (originality) is significantly loaded on this factor. In the painting activity, because the subject was given completely free rein to do as he wished, he did, indeed, have to go beyond what was given in order to do well. This ability could also be important in thinking up ideas for stories and would thus explain the presence of variable 53. Variable 31 is difficult to reconcile with the general ability involved in this factor.

TABLE 13 xx
FACTOR 2C

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
65	Picture Construction O	.44	4.69	.001
73	Circles O.	.23	3.23	.002
77	Ask and Guess Flex.	.11	3.07	.002
20	Make-a-Figure Cats.	-.17	3.03	.002
7	Father's Occupation	.23	2.78	.01
50	Struc. Drawings form	.15	2.70	.01

The variable Picture Construction Originality has not appeared in factor 2 as was hypothesised. It seems to involve a different type of thinking.

This factor appears to be concerned with the organisation or structuring of mainly concrete, semantic material. Variables 65, 73, 20 and 50 all require the organisation of ambiguous material into coherent systems. The ability to organise and structure coherently has been mentioned by both Guilford (in Torrance, 130) and Lowenfeld and Brittain (76) as one characteristic of creative

activity.

Therefore, this factor is tentatively described as an ability to organise a situation involving concrete information into a meaningful whole, by viewing it in an unusual way.

TABLE 13 xxi

FACTOR 21

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
34	Mosaics C	.58	1.92	.05
33	Mosaics: No. of pieces	-.55	1.74	.05

Only one variable is significantly loaded on this factor, though 33 also has a high loading. It would appear to have something to do with thinking up original ideas when dealing with non-paper and pencil materials in two dimensions. Paucity of variables makes it impossible to interpret properly.

TABLE 13 xxii

FACTOR 22

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
46	Quick Responses	.60	2.51	.05

Only one variable is significantly loaded on this factor, hence it cannot be interpreted.

TABLE 13 xxiii

FACTOR 23

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
25	Line Meanings P.Q. 10	.71	9.65	<.001
26	Line Meanings P.Q. 11	-.41	6.05	.001

A bipolar doublet involving a preference for seeing, or ability to see line pictures from an unusual angle, viz. from the front rather from the side. Although this factor was hypothesised, several marker variables are missing and, therefore, it cannot be interpreted with any certainty.

TABLE 13 xxivFACTOR 24

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
80	Torrance P.Q. 7	.74	6.22	<.001

Only one variable is significantly loaded on this factor and hence makes it impossible to interpret.

TABLE 13 xxvFACTOR 25

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
89	Torrance P.Q. 10	-.56	11.06	<.001
90	Torrance P.Q. 11	.62	10.50	<.001

Another bipolar doublet involving a preference or ability for interpreting line drawings from a common, obvious angle, viz. sideways rather than from the front or from above. Again, such a factor was hypothesised, but more marker variables were expected. It appears that this ability varies with the type of test content, since Torrance and Line Meanings P.Q.'s have appeared as separate factors.

TABLE 13 xxviFACTOR 26

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
24	Line meanings P.Q. 7	.74	10.60	<.001
89	Torrance P.Q. 10	.11	3.22	.001

A doublet factor which seems to represent a preference for viewing line drawings from unusual angles (P.Q. 7 and P.Q. 10 i.e. from the front or from above.) So few variables are involved in factors 24, 25 and 26, that it will be necessary to carry out further research before the position can be stated with any certainty.

TABLE 13 xxviiFACTOR 27

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
62	Toy Construction: No. of Pieces	.63	7.15	<.001
58	Struc. Drawings form	-.19	3.36	.01
47	Rorschach Fl.	.11	2.83	.01

Unidentified - probably this factor involves some type of fluency ability.

TABLE 13 xxviiiFACTOR 28

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
63	Toy Construction	.63	7.15	<.001

This factor is impossible to interpret because it possesses only one significant loading.

TABLE 13 xxixFACTOR 29

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
53	Stories Fl.	.44	6.36	.001
31	Make-a-Figure form	.27	6.22	.001
29	Make-a-Figure	-.26	3.47	.01
66	Picture Construction Elab	.24	3.25	.01
22	Line Meanings P.Q. 12	.21	2.83	.01
28	Make-a-Figure Cats.	-.13	2.61	.01
75	Torrance form	.13	2.56	.01

An unidentified factor - possibly some type of perceptual ability is involved (because of variables 31, 22, 75), otherwise this is just an "error" factor with no particular ability underlying this collection of variables.

TABLE 13 XXX
FACTOR 30

VARIABLE CODE NO.	VARIABLE NAME	LOADING	T VALUE	P LEVEL
61	Struc. Drawings P.Q. 11	.40	-	-
2	Animal Sorting Cats.	.29	-	-
60	Struc. Drawings P.Q. 10	.24	-	-
45	Picture Preference	.23	-	-
31	Make-a-Figure form	.21	-	-
40	Painting: ability	.21	-	-

An unidentified factor probably involving some type of perceptual ability (because of variables 61, 60, 45, 31) or possibly just a meaningless collection of variables) an "error" factor.

OBLIQUE ROTATION RESULTS:

From Table 14, it can be seen that the factors resulting from rotating the factor matrix obliquely involve variables similar to those found by orthogonal rotation. However, many of the smaller loadings (significant in orthogonal rotation results) have been rotated out of the picture. The number of significantly - loaded variables per factor is greatly reduced and thus makes the factors extremely difficult to interpret. Other reasons why oblique rotation results are difficult to interpret (and dangerous) have been discussed in the section on factor analysis in Chapter II. The oblique rotation results have been included only for interest.

One is not justified in naming the factors as they have been named from the orthogonal rotation results. However, if in fact we actually do this, then the factors which correlate significantly at the 1% level of probability are as follows (from Table 15):

conceptual elaboration/conceptual fluency
concrete fluency/conceptual adaptive flexibility
Factor 27/Factor 29 (unidentified).

These are worthy of note simply because it does not look as though all the creativity factors correlate with one another to any marked extent. It seems as though most of them are independent and thus represent independent abilities or modes of thinking.

(decimal points omitted).

OBLIQUELY-ROTATED FACTOR MATRIX OF 30 FACTORS AND 90 VARIABLES.

FACTOR NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
VARIABLE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	-07	-01	02	05	09	03	02	-08	-02	-13	02	05	04	-07	01	04	70	-03	05	-05	04	01	-02	07	01	-05	04	07	-08	-03
2	33	03	-02	06	08	-08	10	07	-03	03	-06	15	05	06	07	04	-11	-07	-06	02	06	02	-09	04	06	06	08	-04	04	-03
3	-12	00	01	01	02	-03	-11	05	02	05	-01	02	04	06	-04	00	-02	92	-02	-09	-03	02	-01	-02	01	10	05	-02	02	00
4	-01	-03	-02	-03	-15	-03	02	09	-02	02	-07	-06	-02	10	02	04	60	08	01	07	09	-04	-04	-14	03	-06	-03	-06	01	-08
5	-09	02	01	-01	09	-01	-02	-01	02	00	06	64	-09	10	-06	05	-02	-02	-01	-02	-04	00	-04	04	-07	-09	04	01	06	14
6	06	05	-11	02	02	-01	00	-02	01	-09	-01	40	03	-01	12	-01	03	08	04	04	-03	-08	05	-12	04	01	-18	06	19	01
7	-21	24	-01	33	04	-01	-02	-04	05	04	04	26	-15	-04	-03	05	00	-03	09	08	-06	15	31	-01	19	16	07	00	-15	06
8	-05	-04	-04	00	11	-02	-03	00	04	00	-05	-02	-17	-01	00	00	07	-01	-02	-04	94	21	-09	-12	00	-05	09	08	06	04
9	03	02	-01	07	-02	-03	02	04	01	-03	03	-11	-44	01	-01	-03	-08	-02	07	11	55	64	-01	00	01	11	-05	01	-01	-01
10	-03	03	-02	08	03	05	01	-06	02	-03	-01	-06	-02	-01	04	03	03	-07	-07	72	-40	-09	06	01	-06	11	08	01	-04	01
11	-04	-04	-02	-02	05	-06	-06	06	00	00	04	06	-14	-06	-08	02	-06	-04	10	29	-17	-79	-08	05	00	06	-04	01	-01	05
12	01	00	06	-05	-04	-02	01	04	00	03	02	03	90	00	-04	01	-02	-03	-01	09	-15	04	-04	02	04	-02	-07	03	09	-08
13	-05	01	-04	02	-06	-06	01	01	09	-06	-01	01	80	04	04	-05	04	07	10	17	-11	01	04	03	04	-10	02	00	-04	03
14	-04	01	-02	05	-01	01	05	02	03	-04	-08	-01	-41	01	03	01	02	02	-05	-32	-33	09	04	-02	04	-04	-07	-02	-03	-01
15	-02	-01	00	01	07	07	17	01	-01	02	-04	51	11	07	04	-09	01	04	07	-08	-02	-11	-19	-09	-06	09	04	01	-06	06
16	05	-02	00	-04	04	07	04	92	-02	-01	05	-01	01	01	01	-02	01	02	-04	03	-01	-05	04	01	-02	02	04	05	-02	05
17	08	-04	-01	-01	01	-03	03	91	00	-07	06	07	00	-06	05	-02	03	00	05	02	05	-01	06	-05	-05	-03	01	-02	-05	-01
18	-04	09	-08	02	-03	14	00	82	06	05	-03	-01	02	-01	-02	-04	-06	-01	05	-13	-01	01	09	14	-03	05	00	08	00	01
19	99	-05	02	-04	00	-02	-03	-01	03	02	06	-05	01	00	-06	02	-02	-02	01	-01	01	04	-04	-05	11	-06	-02	06	05	06
20	82	07	04	-05	04	-01	-01	07	-04	-05	01	04	-03	03	-03	-02	-01	00	08	00	-12	08	-07	02	15	-02	-01	-05	06	-01
21	75	04	-03	03	04	08	-02	01	08	03	-04	-14	-09	-03	02	03	10	-07	02	00	-01	-04	09	12	17	01	04	01	05	04
22	42	06	05	03	-04	09	04	00	13	-03	-09	04	03	-08	03	03	-03	00	03	01	06	-09	02	43	07	09	00	-03	04	-07
23	96	-09	03	00	02	-04	-05	-02	-03	02	05	11	00	00	-02	-01	01	-02	02	-03	00	02	-07	-04	04	00	01	01	04	02
24	03	05	00	05	-04	04	-01	-05	06	03	00	-01	03	-11	-04	-01	-02	-05	-03	00	08	02	04	09	-04	06	09	-04	83	09
25	43	-03	00	00	04	01	-03	-05	00	-01	07	-02	07	03	-01	01	04	06	02	-10	00	02	-03	04	79	-01	01	00	-05	10
26	93	-04	00	-03	05	01	00	02	01	03	01	-05	01	07	-03	02	-04	-02	-08	03	-05	02	01	09	-42	-14	03	-01	-17	-08
27	01	-03	02	07	91	04	04	01	-01	00	-01	-07	03	-03	03	02	02	-04	-13	04	02	-05	06	07	03	00	01	03	07	-06
28	01	-01	01	01	84	-01	01	-01	-02	00	01	10	-01	-06	05	-01	01	-03	04	-06	08	00	03	-17	08	-01	-02	04	-03	-18
29	24	01	-05	-01	49	03	01	-05	04	-03	-03	02	-03	01	00	-03	-01	08	04	03	02	00	-02	22	03	12	02	03	-14	-02
30	-08	-04	06	-05	-02	-07	05	04	-10	04	00	11	-05	-03	01	06	65	-01	02	02	-07	08	01	-06	-07	09	-05	-02	13	-05
31	-07	16	03	-09	99	-09	-07	11	00	-04	01	05	-05	06	-06	-06	-03	07	17	-04	07	-04	-06	24	-09	-19	-18	-19	05	-04
32	01	-01	-07	10	14	-09	01	05	02	04	-01	-15	02	07	02	-03	00	00	-06	01	-11	01	01	67	00	01	-02	03	04	00
33	11	-06	04	-09	06	-08	05	05	00	00	01	06	-05	01	-01	03	00	10	05	03	-06	04	64	03	01	-04	06	00	05	18
34	10	07	-07	-13	06	01	04	-07	-01	02	05	06	-06	-05	-02	12	-04	07	-01	04	03	00	-63	02	01	09	-01	-10	01	08
35	05	11	04	03	06	-02	07	00	-06	03	-04	-01	04	02	07	-04	00	-02	77	-04	06	-07	11	-07	01	-02	-05	-02	-03	00
36	-02	09	06	06	00	06	-02	05	09	04	-02	-03	02	06	-03	08	01	-05	73	01	-04	04	-01	-04	-02	-04	04	-02	-01	-04
37	09	-02	11	09	-14	-14	-02	07	15	02	01	68	-07	-05	-03	-04	04	-10	-10	-05	03	-05	01	-04	14	09	03	03	-11	04
38	-04	-02	06	-05	-04	02	04	01	-01	04	-02	-08	00	-08	69	12	04	-01	-02	04	00	09	-07	24	03	-11	-09	-03	-09	18
39	00	01	-02	03	00	03	03	-06	02	07	-03	11	-02	-09	63	-08	-11	-05	05	-01	-04	03	-05	-04	-07	-03	03	03	-02	-01
40	01	00	07	-03	05	-01	-13	09	03	-07	-02	05	00	09	59	12	05	-03	-01	-01	02	-02	05	06	-04	03	-03	00	03	-02
41	-02	06	-11	03	02	-05	-05	00	02	03	10	00	01	18	68	-02	-03	02	-03	-02	02	-01	07	-09	07	15	12	-05	03	-03
42	00	-10	04	10	-01	01	00	04	-11	01	01	00	01	11	02	76	01	03	-03	08	-01	04	-12	01	10	04	-06	00	-07	-06
43	00	04	-10	02	02	02	-06	-02	15	-03	-06	04	04	01	-04	75	-03	-05	04	-04	-03	04	-07	-10	-02	-02	-07	-02	01	06
44	07	03	03	-02	-07	02	09	-03	05	06	05	04	-08	00	10	68	-02	10	02	-02	02	-11	06	06	-06	-20	07	09	05	-16
45	05	-03	-01	08	-05	-07	-16	04	-02	00	27	-04	-01	-13	01	-01	06	05	10	-02	-05	05	-08	-03	-26	-53	08	07	-02	09
46	02	-06	06	02	-05	00	-02	05	06	02	-04	12	-11	03	03	-12	08	11	02	07	-05	06	-16	04	-03	68	02	08	04	-08
47	01	-03	03	90	01	03	01	01	04	03	-07	09	-01	07	-05	00	-06	07	03	01	00	01	-03	-01	-02	-05	-10	-05	-02	11
48	04	08	-02	81	07	06	04	-03	-01	03	01	04	02	-01	-01	-02	-02	03	-04	06	04	03	00	-03	-10	-21	-04	-03	-01	03
49	01	07	-03	37	-02	02	03	07	-04	03	00	05	-04	04	-03	-01	04	-01	-02	00	02	-02	00	05	08	-04	-02	06	02	-01
50	07	-09	07	58	-07	-08	-04	-03	-02	-09	09	-03	-01	-07	02	10	-01	00	08	-07	00	02	00	24	-02	19	06	-07	12	-06
51	06	04	03	02	04	04	-04	01	-10	-01	02	64	09	-12	-02	15	02	-01	-06	02	09	05	10	-03	-07	10	-05	-06	-04	09
52	-03	02	-04	05	06	-01	06	-04	03	-01	-03	-02	02	-06	-03	08	01	92	-06	01	01	00	01	01	03	02	07	-01	-07	03
53	13	-10	-02	-01	-04	22	07	-05	16	02	04	13	-01	12	04	-08	06	-03	-02	-03	00	-01	-08	25	-08	-05	-07	06	04	01
54	07	03	0																											

TABLE 15

INTERCORRELATION MATRIX OF FACTORS.

FACTOR NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	-	20	18	46	52	26	31	33	27	08	21	25	-03	18	16	-06	00	-06	17	-15	09	10	-12	08	07	-17	15	12	29	-01
2		-	55	18	06	16	21	18	30	10	12	35	00	20	28	09	-01	-03	08	-10	14	-09	-04	12	06	-01	16	10	11	04
3			-	17	-02	10	24	18	21	-02	04	19	-18	18	19	11	05	00	12	-03	-01	01	-12	10	01	-11	08	03	10	00
4				-	15	26	34	26	26	01	31	14	-11	06	16	00	-09	-06	22	-10	03	12	-20	-04	-09	05	12	26	25	13
5					-	00	13	26	19	01	05	14	01	18	09	03	-05	-16	15	06	-15	22	-24	-03	12	-06	19	22	14	13
6						-	30	31	35	-05	35	23	-05	08	09	-05	02	01	19	-04	29	-13	00	15	-12	04	-05	-01	03	-11
7							-	40	48	00	28	57	-18	24	17	-06	06	-04	14	04	11	02	-09	07	-02	-06	01	02	22	-06
8								-	41	03	24	27	-11	21	07	07	06	-02	13	01	02	10	-12	-01	-05	-16	08	04	24	-07
9									-	10	33	34	-14	34	26	-07	06	-09	16	06	-01	09	-21	28	05	-08	09	11	10	00
10										-	10	09	05	-08	07	-09	01	07	13	07	-12	07	-11	10	02	-05	07	03	-09	11
11											-	08	-13	03	06	-05	04	-09	27	-12	04	00	-11	07	-11	11	11	07	07	07
12												-	-13	34	27	12	05	-07	05	11	25	07	-20	23	04	-23	-03	00	20	-16
13													-	-12	02	01	09	-11	02	-03	08	-04	00	-01	05	11	-01	-05	-18	01
14														-	37	08	09	-07	08	-08	-09	10	-07	03	12	-18	08	23	21	04
15															-	16	-06	-02	15	03	06	-06	-17	04	04	03	04	19	19	-03
16																-	-04	-03	05	03	07	00	-04	-01	00	08	-02	-06	08	06
17																	-	13	05	-14	04	06	-09	03	10	-07	-03	-05	-02	-05
18																		-	-03	10	-02	-06	15	-15	04	-04	-23	-12	04	-09
19																			-	16	00	-01	-10	10	12	-01	02	07	10	02
20																				-	-12	-17	01	08	17	-11	-10	-12	02	-19
21																					-	-26	08	18	-13	09	-12	-20	-05	-23
22																						-	-30	14	06	-10	11	18	00	16
23																							-	-16	-09	-16	17	-09	-10	-06
24																								-	07	-15	-06	-11	-13	-10
25																									-	-30	01	-02	01	-08
26																										-	-06	-02	-10	21
27																											-	35	01	13
28																												-	01	23
29																													-	-01
30																														-

GENERAL RESULTS OF FACTOR ANALYSIS:

Having reviewed and offered interpretations of the thirty extracted factors, there are several observations which can be made on the orthogonal results as a whole.

1. Hypothesis H_1 has been shown to be true. The creative thinking abilities of children in the age range 5-7 years - at least in the semantic-content area - appear to be very similar to those found in older subjects. The factor structure which has emerged, shows many of the same features or same types of features found in studies on adults and adolescents (Frick et al, 38; Guilford et al, 58; Guilford, 50; Guilford and Hoepfner, 55).

Although there are bound to be other modes of thinking involved, the main structure of creative thinking can be seen at this level. It appears to be an "oligarchic" type of structure, i.e. there are several "large" abilities covering different types of tests. There is certainly no basis for a "monarchic" view of creativity (i.e. one and only one ability or mode of thinking) or for an "anarchic" view (i.e. a different ability concerned with every test).

The factors show the behavioural capacities, the psychological processes used by individuals to deal effectively with the task at hand.

2. Factors are not decisively and clearly distinguishable from one another: several variables appear on more than one factor.

This could be because, at this age, different abilities are not yet clearly differentiated (as hypothesis H_1 states). This would be in line with McDougall's contention that new abilities are formed by gradual differentiation out of pre-existing abilities. However, there are other possible explanations for variables overlapping on several factors. The most likely explanation is that creativity is a very complex activity - a Mednick-type theory is just not enough. Creative thinking is very fluid and ever-changing. When a person is being creative, he indulges in many types of interdependent types of thinking. Thus, if he thinks up many ideas, it is highly likely that he

often alters categories of responses, shifts his view of the situation and adapts his strategy of responding so that some responses are unusual and novel. This is indicated in the correlations of the different types of variables with each other. Correlations of fluency with flexibility variables range from .71 to .91, correlations of fluency with originality variables range from .05 to .87 and correlations of flexibility with originality variables are in the range .50 to .77.

Fluency variables occur of flexibility factors, adaptive flexibility variables load on spontaneous flexibility and originality factors and spontaneous flexibility variables are found in originality factors. Detailed explanations of why these things happen, have been discussed in the factor interpretation sections. Factors may share similar variables for different reasons.

However, in most cases, the expected marker variables occur on their respective factors with high loadings and variables which "belong" to other factors occur with smaller loadings, i.e. the main loadings belong to the variables expected on the factor.

3. The importance of different perceptual approaches or perceptual styles in different creative abilities is obvious. So, too, are the indications of the influence of personality factors (which are linked, of course, to perceptual styles as well).

Most obvious is the ability to deal with ambiguous, vague, unstructured stimuli, play with them, explore their possibilities and come up with some original ideas. This idea has been mentioned over and over again by various people. It occurs in Rogers' "openness to experience" which is a lack of rigidity (cf. Guilford's "freedom from rigidity" factor) and an ability to tolerate ambiguity (cf. Guilford's and Hacker's "suspense of ambiguity"). A person with this attribute does not perceive things in predetermined ways nor does he distort perceptions in order to make them easier to deal with and more palatable (cf. Schachtel's autocentricity). Such a person does not avoid conflict and tension in order to avoid uncertainty. He accepts tension and is willing to let go of certainty (see Fromm's ideas given in Chapter II) in

favour of doubt - and a new, exciting, original view of his environment. He is willing to attend to vague feelings and do without "the established perceptual schemata" (Barron, 2). Relevant here, too, is Bruner's "deferral of completion" of a task. The creative individual does not select the easiest, obvious way out, he guards against premature closure and pays attention to the seemingly irrelevant. This "flexibility" in perception exists along with order and stability, however, because there must be anchorage points to keep "deformations" (or departures from "usual" perceptions) within recognisable bounds. In the words of a 15th century alchemist, "the work must be performed with true and not with fantastic imagination". This means that creative perception must still fit the requirements of the task at hand - it must be communicable and not bizarre. Nevertheless, the bounds within which flexible deformations can occur are very broad. The creative person takes advantage of this.

4. The results indicate that one has to be careful in constructing measures of creativity (and probably any other psychological phenomenon). Relatively small differences in test content or test instructions can bring different types of thinking into play. (e.g. Painting and Drawing variables do not always go together on factors - the only difference between the two activities in the use of colour).

5. Not all the factors are clearly identifiable. This is only to be expected when several factors have been hypothesised for the first time - it is difficult enough when they have appeared in previous studies. Many of the factors have to be tentatively interpreted - they will require more investigation before being acceptable as "real" factors. Factors must appear in more than one study to provide persuasive argument for their existence, otherwise they could be "error" factors, occurring in only one study.

For similar reasons, not all variables which occur in a particular factor can be adequately accounted for - their contributions to and roles in their respective factors can be clarified only after many analyses.

6. The hypothesised positions of the Torrance Tests of Creative Thinking on different factors are mainly correct. They have performed as expected except that Unusual Uses, Product Improvement and Ask and Guess sometimes have loadings on the concrete information type of factor whereas it was postulated they were conceptual information tests. It seems subjects tend to deal with these tests in a concrete manner. This is discussed in more detail under point (7).

Torrance's claim that his tests each measure distinct creative abilities appears to be true to a large extent. Each of the sub-tests (except for Product Improvement and Ask and Guess which appear together with high loadings) have high loadings on different factors. They do occur with other variables expected on each factor but one is always more highly loaded than the others.

7. There is much justification for accepting hypothesis H₁ (b) as correct in its main conception, though it has to be modified. This hypothesis stated that Guilford's semantic content area could be divided into two parallel content groups, one being semantic, concrete content and the other being semantic, conceptual content. Both types of content are meaningful - labels can be attached to them - but the former consists of pictorial information or stimuli and the latter of verbal information or stimuli. Torrance has named these areas non-verbal (or figural) and verbal. The concrete content area is not Guilford's figural content area, as mentioned in Chapter III.

The separation of these two content areas into parallel factors is not complete, but is evident enough to indicate the hypothesis is at least on the right track.

The modification of the hypothesis is as follows: the concrete and conceptual categories should not be taken to mean the type of information or stimuli of which tests are comprised, but the ways in which individuals tend to deal with a task. Thus the test stimuli or information may be given in concrete (pictorial) or conceptual (verbal) form: the way in which subjects deal with the stimuli is the important influence in deciding which factor the particular variable concerned should measure. In the main, the

concrete-information type of test is dealt with in a concrete type of thinking mode and the conceptual-information type of test is dealt with using a conceptual (abstract) type of thinking. However, some conceptual-information (purely verbal) tests can be pictorially represented - at least in imagination.

An inkling of this idea was actually stated in H₁(b) when the writer said that for semantic, conceptual content, "information is given in conceptual or abstract form and cannot be represented in concrete form or at least, is not handled concretely in a particular test".

8. Of the 14 hypothesised creativity factors, the first 10 are relatively clear and identifiable (fluency, spontaneous flexibility, adaptive flexibility, originality and elaboration).

The writer's contention that adaptive flexibility and originality both involve transformations, but that the latter is concerned especially with unusual transformations, appears to have found some support (see factors 1, 2, 4, 12).

Hypothesised factors 6(a) and 6(b) are not at all clear (see discussion under factors 8 and 17).

Hypothesised factor 7 has not appeared as a separate entity, i.e. "fluency in the use of materials". It is thought that the types of variables used to measure this possibly-existent ability, are inadequate, or else are not worthwhile methods of assessing products, at least with these relatively simple tests. Perhaps there are different abilities for each kind of material used and thus there are not enough representative variables of each kind to bring such factors out (if they exist).

9. H₂ also seems to have received some support, though not all the hypothesised factors have appeared. It would appear that "perceptual" factors (as defined by the writer) do exist.

H₂ Factor 1 is very clear and has been found in many studies (refer to discussion under factor 13).

H₂ Factor 2 - openness of perception - is not clear. The variables thought to measure H₂ factor 3 (form) have not appeared as a distinct factor. H₂ did mention that if a "form" factor was found, elaboration variables would probably have loadings on

it because form is likely to improve as embellishments and details are added to a picture. The reverse has occurred - the "form" variables have appeared on the elaboration factors.

H₂ Factor 4(a) (the only "perceptual elaboration" ability which could be measured for the purpose of factor analysis) appeared with strong support. As far as the writer knows, this is the first time such a factor has been postulated and found.

H₂ Factors 5(a) and 5(b) have appeared as a single bipolar factor ("preference for closed figures/dislike of open figures").

H₂ Factor 6 is not a distinct factor (preference for unusual angles of perception). The variables for this hypothesised factor have tended to load on most other factors, e.g. concrete originality conceptual adaptive flexibility, factor 7, concrete spontaneous flexibility, concrete adaptive flexibility, figural redefinition, and conceptual fluency, so it is difficult to judge their performance and roles in the different modes of thinking. The writer still thinks more research into this area would be valuable (see results of hypothesis H₃).

CORRELATIONS:

The significant correlations of variables with Age, Father's occupation, Birth order and Intelligence and the P levels of significance, are given in Table 16.

There seems to be no particular propensity for fluency and flexibility variables to correlate with the variables Age, Father's occupation and Birth order, more than with originality variables. The results show no definite pattern. If intelligence varies significantly with birth order (as Altus found) creative thinking abilities do not. The reasons for this could be that parents are often stricter on first-borns than they are on later sibs: first-borns are under more supervision and restraint and receive more attention from parents. Parents are experimenting in child-rearing for the first time with their eldest children and are, therefore, more concerned and anxious about them and their behaviour. While this stricter discipline and concern may ensure the child performs well at school and does as he is told, it could provide the wrong sort of atmosphere for the free-wheeling, independent,

TABLE 16

SIGNIFICANT CORRELATIONS BETWEEN SELECTED VARIABLES.

VARIABLE X	VARIABLE Y	CORRELATION COEFFICIENT	P LEVEL
AGE	Changing Figures	.32	.001
	Make a Figure: Av. No.	.36	.001
	Stories Originality	.47	<.001
	Toy Construction Form	.29	.005
FATHER'S OCCUPATION	Otis I.Q.	.33	.001
	Rorschach Fluency	.26	.01
	Rorschach Originality	.27	.02
	Circles Fluency	.24	.02
	Circles Originality	.26	.01
	Circles Elaboration	.30	.005
	Product Improvement Fl.	.25	.01
INTELLIGENCE	Rorschach Fluency	.50	<.001
	Torrance Form	.40	<.001
	Struc. Dr. Form	.37	<.001
	Product Improvement Fl.	.36	<.001
	Circles Fluency	.35	<.001
	Product Improvement Flex.	.33	.001
	Circles Elaboration	.32	.001
	Ask & Guess Flex.	.32	.001
	Ask & Guess Fluency	.31	.005
	Rorschach Originality	.29	.005
	Scribble Colour		
	Product Improvement Orig.	.28	.005
	Ask & Guess Originality	.27	.005
	Torrance 10	.27	.005
	Stories Fluency	.25	.01
	Circles Originality	.25	.01
	Torrance 11	.25	.01
	Struc. Dr. Originality	.24	.02
BIRTH ORDER	Sibling Number	.82	<.001

AVERAGES OF SIGNIFICANT CORRELATIONS OF CREATIVITY
VARIABLES WITH INTELLIGENCE:

<u>CREATIVITY VARIABLE</u>	<u>AVERAGE CORRELATION</u>
FORM	0.385
FLUENCY	0.354
FLEXIBILITY	0.325
ORIGINALITY	0.266

irrational type of thinking (and personality) necessary in creativity. However, there is no negative correlation of birth order with creativity variables either, thus there is no relationship at all between them - birth order plays no part in determining creative performance.

The older the child, the more original story themes he thinks up and the poorer his score of Changing Figures gets. This is an interesting and alarming result if we accept that Changing Figures is, in fact, a measure of "openness of perception". Openness of perception is an ability or a willingness to remain open to the environment and to accept new experiences. The opposite is remaining bound by past perceptions and a refusal to adapt in the face of unexpected, ambiguous stimuli. It appears that this ability decreases with age.

The significant correlation of Father's occupation and the Otis measure of intelligence is also of interest. It means that children in the higher social groups perform better on the Otis Intelligence Scale than children from lower social groups. The dependence of the one variable on the other is reflected in the number of common variables with which they both significantly correlate.

Level of intelligence is obviously quite important in Product Improvement, Circles and Ask and Guess and in achieving good form scores. The latter is interesting because in the standard Rorschach system, form level is considered an indication of a subject's level and type of intellectual functioning. These results offer some empirical support for this contention.

An indication of the differential roles intelligence plays in fluency, flexibility, form and originality is given at the bottom of Table 16. The order of variables from highest to lowest correlations is: form, fluency, flexibility and originality. The first has been discussed in the previous paragraph. The positions of the last three are as hypothesised in H₅. The basis of creativity - original thinking - depends the least of all the variables on general reasoning ability as measured by the Otis Scale. The more intelligent child is likely to have a greater

repertoire of possible responses because he possesses a wider range of information and can make greater use of it. This is in line with the many other findings mentioned in Chapter III under H 5 .

The serious limitations of I.Q. testing are indicated by these results. Reasoning and supplying correct information are but a small section of an individual's repertoire of thinking abilities.

There is no support at all for Schulman's findings that openness of perception is a condition for creativity. Table 17 shows the correlations of all the Torrance Tests' variables with Enclosed Areas and Changing Figures. The only two variables correlating with Enclosed Areas at the 5% level of significance are the Ask and Guess and Product Improvement fluency variables.

Variables other than the Torrance Tests which correlate significantly with Schulman's two tests at the 5% level or less show no particular pattern of dependence or interrelationship. Enclosed Areas correlates with all the painting variables except Painting (originality). From the nature of the starred variables in Table 17, if Enclosed Areas is a measure of openness of perception, that attribute would seem to be important in elaborating, in producing good form and in perceiving overlapping hidden figures. It seems to be a perceptual attribute which is of little importance as a condition for creative thinking.

Considering Changing Figures, if it measures openness of perception, then that attribute seems important in thinking up original story themes in response to pictures which have to be interpreted (the pictures are structured to different degrees).

These results are disappointing. However, Schulman used different measures of creativity (unconventionality, theme variability, form initiation, physical expansion and elaboration) and then added scores on all of them together in order to analyse his results. This is not a good idea because so many different abilities are involved. Perhaps a total creativity score on the Torrance Tests would show a relationship to openness of perception similar to Schulman's results. Schulman has oversimplified the

TABLE 17

CORRELATIONS OF THE ENCLOSED AREASAND CHANGING FIGURES TESTS WITH OTHER CREATIVITY VARIABLES

VARIABLE	ENCLOSED AREAS		CHANGING FIGURES	
	CORRELATION	P	CORRELATION	P
		COEFFICIENT LEVEL		COEFFICIENT LEVEL
Picture Construction Orig.	.05	>.10	.02	>>.10
Incomplete Pictures Fluency	.02	>.10	-.03	>>.10
Incomplete Pictures Flexibility	-.01	>.10	-.004	>>.10
Incomplete Pictures Originality	-.01	>.10	-.01	>.10
Circles Fluency	-.18	.10	-.03	>.10
Circles Flexibility	.12	>.10	-.02	>.10
Circles Originality	.09	>.10	-.10	>.10
Ask & Guess Fluency	.19	.05*	.004	>.10
Ask & Guess Flexibility	.16	.10	.05	>.10
Ask & Guess Originality	.14	>.10	-.04	>.10
Product Improvement Fluency	.19	.05*	.05	>.10
Product Improvement Flexibility	.15	>.10	-.06	>.10
Product Improvement Originality	.09	>.10	-.06	>.10
Unusual Uses Fluency	.08	>.10	-.04	>.10
Unusual Uses Flexibility	.08	>.10	-.02	>.10
Unusual Uses Originality	.01	>.10	-.05	>.10
Just Suppose Fluency	.12	>.10	-.03	>.10
Just Suppose Flexibility	.11	>.10	-.02	>.10
Just Suppose Originality	.09	>.10	-.05	>.10
<u>OTHER SIGNIFICANT CORRELATIONS:</u>				
Hidden Figures	.23	.02*	-	-
Line Meanings Form	.19	.05*	-	-
Line Meanings P.Q. 7	.20	.05*	-	-
Painting: Use of Colour	.19	.05*	-	-
Painting: Ability	.19	.05*	-	-
Painting: Detail	.20	.05*	-	-
Scribble Colour	.19	.05*	-	-
Structured Drawings Elaboration	.19	.05*	-	-
Structured Drawings Form	.29	.005*	-	-
Ask and Guess Fluency	.19	.05*	-	-
Make-a-Figure Originality	-	-	-.20	.05*
Make-a-Figure: Average No.	-	-	.46	.001*
Stories Originality	-	-	.32	.001*
Toy Construction Form	-	-	.19	.05*

picture by using composite measures and by assuming that both CFT and FEAT (Enclosed Areas) measure "openness of perception" whereas different abilities are involved - as indicated by the performance of the two tests in the factor analytic results.

WORD ASSOCIATIONS:

Examples of the graphs obtained from Quick Responses are shown in Fig. 19. Three example sets of response words to the words "black", "dance" and "clean" are listed along the X axis and their respective frequencies of occurrence along the Y axis.

The result is a typical decreasing exponential curve very similar to Mednick's theoretical curve for a single individual - a steep-sloped hierarchy of response words. The frequency counts decrease sharply and then level off asymptotically to the X axis.

A study of the types of words occurring with high and low frequencies within the group of 233 children, is instructive. Unfortunately, detailed responses could not be shown on the graphs.

The most common response is nearly always the VERB pertaining to the stimulus word (e.g. water-drink; house-live). The next most common responses are articles associated with the stimulus word (e.g. house-door; white-wall; black-crayon). Also quite common are rhyming words (e.g. child-mild; chair-where; clean - green), words beginning with the same letter (e.g. house-horse; bell-ball; apple-ant), synonyms (e.g. house-kia; child-baby; dance-ballet) and parts of the object given (e.g. child-hair; apple-juice; chair-leg).

Unusual responses are responses giving the function or characteristics of the stimulus word (e.g. white-get married; dance-make a noise), personal effects of meaning (e.g. house-earn a living; black-German and bombs), unusual objects or verbs (e.g. water-seal; black-Bible) and activities associated with the word (e.g. child-have fun; chair-musical).

Similarly-shaped association graphs were found for Instances. Examples of these are shown in Fig. 20. Note the same decreasing exponential curve of responses against frequencies.

The fact that one obtains this kind of curve for association-type tests does not necessarily give support to Mednick's associa-

tive theory. It has already been pointed out elsewhere in this chapter that his theory oversimplifies the structure and function of creative thinking. These graphs are included for interest. It would probably be worthwhile plotting association graphs for each individual and comparing the graphs for the highly creative subjects with those of the less creative ones. However, this was not the aim of this study and hence was not done.

COMPARISONS OF HIGH AND LOW CREATIVITY SUBJECTS:

"High" and "low" are used here with reference to totals on the non-verbal and verbal sections of the Torrance Tests of Creative Thinking.

There are eight creativity groups ranging from very low scores to very high scores. The eight groups with their score-intervals and the number of subjects falling in each group are shown in Table 18. Only fluency and originality variables for the verbal and non-verbal sections of the Torrance Tests are given.

RESULTS OF PERCEPTUAL QUALITIES:

The results obtained from comparing the performance of the members of six creativity groups (eight was too many - see Chapter IV) on the perceptual qualities listed under hypothesis H₃ in Chapter III, are given in Table 19. Only verbal and non-verbal originality score divisions are considered. The actual frequencies occurring in each group for Line Meanings, Torrance and Structured Drawings are given in Tables 20a and 20b. χ^2 values significant at the .05 level or less are marked *, i.e. the frequencies of occurrence of the perceptual qualities marked * differ significantly amongst the six creativity groups.

Considering

- 1) Division of creativity groups according to the Torrance tests of non-verbal originality, significant differences were found amongst the groups on Line Meanings P.Q. 1, 5, 8 and on Torrance P.Q. 1, 4, 7, 10, 11.

The patterns of differences amongst the groups can be seen from the means listed in Tables 20a and 20b and from the graphs shown in Figs: 21, 22, 23 and 24.

TABLE 13

DIVISION OF TOPIRANCE TESTS INTO 8 GROUPS

GROUPS	1	2	3	4	5	6	7	8
SCORES: INTERVAL SIZE	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24
NON- VERBAL FLUENCY NO. IN GROUP	3	21	45	64	44	36	14	6
SCORES: INTERVAL SIZE	0- 6.75	7.00- 13.50	13.75 20.25	20.50- 27.00	27.25- 33.75	34.00- 40.50	40.75- 47.25	47.50- 53.75
NON- VERBAL CRIG. NO. IN GROUP	18	70	86	33	19	6	0	1
SCORES: INTERVAL SIZE	0-7	8-16	17-24	25-32	33-40	41-48	49-56	57-64
VERBAL FLUENCY NO. IN GROUP	20	66	71	42	21	11	0	2
SCORES: INTERVAL SIZE	0-6	7-12	13-18	19-24	25-30	31-36	37-42	43-48
VERBAL CRIG. NO. IN GROUP	32	79	40	14	6	1	7	1

TABLE 19

χ^2 VALUES INDICATING DIFFERENCES IN THE OCCURENCE OF DIFFERENT
PERCEPTUAL QUALITIES AMONGST 6 CREATIVITY GROUPS.

		DIVISION ACCORDING TO NON-VERBAL ORIGINALITY				DIVISION ACCORDING TO VERBAL ORIGINALITY			
VARIABLE		χ^2	df	P LEVEL	C	χ^2	df	P LEVEL	C
Line Meanings	P.Q. 1	20.87	10	.02*	.28	24.37	8	.01*	.32
Line Meanings	P.Q. 2	12.02	10	.30	.22	9.60	8	.30	.20
Line Meanings	P.Q. 3	9.30	10	.50	.20	5.64	12	.95	.14
Line Meanings	P.Q. 4	8.77	10	.70	.20	38.28	8	<.001*	.37
Line Meanings	P.Q. 5	11.30	4	.025*	.58	5.02	4	.25	.43
Line Meanings	P.Q. 6	12.63	15	.70	.22	5.03	8	.70	.14
Line Meanings	P.Q. 7	18.46	15	.30	.27	16.79	12	.20	.27
Line Meanings	P.Q. 8	10.51	4	.03*	.68	10.50	4	.03*	.68
Line Meanings	P.Q. 9	-	-	-	-	-	-	-	-
Line Meanings	P.Q.10	15.83	15	.50	.25	16.12	16	.50	.25
Line Meanings	P.Q.11	22.96	20	.25	.30	36.81	16	.01*	.37
Torrance	P.Q. 1	9.78	4	.05*	.61	9.78	4	.05*	.61
Torrance	P.Q. 4	9.78	4	.05*	.61	27.88	4	<.001*	.79
Torrance	P.Q. 7	23.47	10	.01*	.30	8.89	8	.50	.20
Torrance	P.Q.10	83.70	20	<.001*	.51	43.57	16	<.001*	.40
Torrance	P.Q.11	82.74	15	<.001*	.51	23.51	12	.05*	.30
Structured Dr.	P.Q. 1	-	-	-	-	-	-	-	-
Structured Dr.	P.Q. 7	15.60	10	.20	.25	20.42	8	.01*	.28
Structured Dr.	P.Q.10	16.02	15	.50	.25	9.81	12	.70	.20
Structured Dr.	P.Q.11	5.30	10	.90	.14	12.01	12	.50	.22

TABLE 20A

LINE MEANINGS: FREQUENCIES OF PERCEPTUAL QUALITIES OCCURRING
IN 6 CREATIVITY GROUPS.

<u>DIVISIONS ACCORDING TO</u> <u>NON-VERBAL ORIGINALITY</u>							<u>DIVISIONS ACCORDING TO</u> <u>VERBAL ORIGINALITY</u>						
<u>CREATIVITY GROUP NO.</u>							<u>CREATIVITY GROUP NO.</u>						
SCORE	1	2	3	4	5	6	SCORE	1	2	3	4	5	
PQ. 1 0	15	60	72	23	16	7	PQ. 1 0	70	65	39	10	10	
1	2	7	3	6	2	0	1	3	6	7	2	0	
2	1	3	6	4	1	0	2	4	8	2	2	0	
Means:	.33	.19	.28	.43	.25	0	Means:	.21	.35	.25	.43	0	
PQ. 2 0-1	11	39	47	14	10	4	PQ. 2 0-1	47	45	19	7	6	
2-3	5	23	20	11	3	3	2-3	27	18	19	5	3	
4-5	2	8	19	3	1	0	4-5	9	16	10	2	1	
Means:	1.38	1.4	2.0	1.9	1.4	1.7	Means:	1.5	1.8	2.1	1.6	.92	
PQ. 3 0-2	14	53	68	30	15	6	PQ. 3 0-2	6	66	39	11	9	
3-5	2	9	14	2	2	0	3-5	11	9	7	3	1	
6-8	2	3	4	1	3	0	6-8	5	4	2	0	0	
Means:	1.8	1.2	1.6	.70	2.2	5.2	Means:	1.5	1.5	1.3	1.1	1.4	
PQ. 4 0	16	57	53	26	15	5	PQ. 4 0	65	65	32	10	6	
1	2	10	22	5	2	2	1	15	12	14	0	1	
2	0	3	6	2	2	0	2	2	2	2	4	3	
Means:	.11	.23	.41	.33	.37	.59	Means:	.23	.21	.37	.64	1.1	
PQ. 5 1	0	6	12	5	5	-	PQ. 5 1	8	4	6	3	2	
Means:	0	.86	.14	.15	.13	-	Means:	.10	.06	.13	.21	.20	
PQ. 6 0-1	15	56	63	26	17	7	PQ. 6 0-1	66	64	38	12	9	
2-3	3	9	13	5	2	0	2-3	12	10	9	1	1	
4-5	0	5	5	2	0	0	4-5	4	5	1	1	0	
Means:	.45	.87	.85	.70	.54		Means:	.84	.73	.77	.79	.67	
PQ. 7 0-1	12	51	50	21	9	3	PQ. 7 0-1	62	44	28	6	6	
2-3	3	14	26	7	6	4	2-3	16	21	16	5	1	
4-5	2	4	9	4	3	0	4-5	2	11	3	2	3	
6-7	1	1	1	1	1	0	6-7	2	1	1	1	0	
Means:	1.5	1.1	1.6	1.4	2.0	1.3	Means:	.92	1.7	1.5	2.3	2.0	
PQ. 8 1	1	1	4	0	6	-	PQ. 8 1	3	3	0	0	6	
Means:	.06	.01	.05	0	.25		Means:	.04	.04	0	0	.63	
PQ. 9 1	1	0	2	0	0	-	PQ. 9 1	1	1	0	0	1	
Means:	.06	0	.03	0	0		Means:	.01	.01	0	0	.10	
PQ. 10 0-2	6	16	19	4	4	0	PQ. 10 0-2	16	20	8	2	2	
3-5	7	30	32	10	7	2	3-5	33	34	13	4	4	
6-8	4	16	21	11	5	4	6-8	24	16	15	3	3	
9-11	1	8	13	8	3	1	9-11	5	6	8	3	1	
Means:	4.0	4.9	5.1	6.5	4.3	6.5	Means:	4.9	4.7	6.3	6.8	4.3	
PQ. 11 0-3	1	0	1	2	0	0	PQ. 11 0-3	2	1	0	0	1	
4-7	6	24	17	3	6	1	0-4	30	20	8	3	1	
8-11	6	24	26	13	5	2	8-11	27	27	17	3	2	
12-15	2	13	26	6	4	2	12-15	17	24	10	5	2	
16-19	3	3	10	4	4	2	16-19	6	7	13	4	2	
Means:	9.3	9.7	12	10	11	12		95	10	12	13	13	

TABLE 2CB

STRUCTURED DRAWINGS: } FREQUENCIES OF PERCEPTUAL QUALITIES OCCURRING
 TORRANCE TESTS: } IN 6 CREATIVITY GROUPS

DIVISIONS ACCORDING TO NON-VERBAL ORIGINALITY							DIVISION ACCORDING TO VERBAL ORIGINALITY					
STRUCT. DR.	1	2	3	4	5	6	STRUCT. DR.	1	2	3	4	5
PQ. 1 1	0	6	3	0	0	0	PQ. 1 1	6	2	1	0	0
Means:	0	.09	.04	0	0	0	Means:	.07	.025	.03	0	0
PQ. 7 0	15	60	70	29	15	3	PQ. 7 0	72	68	35	9	3
1	3	9	13	4	5	3	1	9	9	12	3	4
2+	0	1	3	0	1	1	2+	1	2	1	2	0
Means:	.17	.16	.22	.09	.37	.92	Means:	.13	.17	.29	.57	.28
PQ. 10 2-3	0	7	4	0	1	0	PQ. 10 2-3	3	4	2	1	0
4-5	4	25	33	10	8	1	4-5	29	30	14	3	6
6-7	9	31	35	19	8	5	6-7	36	37	23	7	3
8-9	5	7	14	4	2	1	8-9	14	8	9	3	1
Means:	6.6	5.9	6.0	6.0	5.6	5.7	Means:	6.1	5.8	6.0	6.0	7.5
PQ. 11 6-8	7	23	28	8	5	3	PQ. 11 3-5	3	0	3	0	0
9-11	10	40	50	21	10	4	6-8	25	23	12	5	3
12-14	1	7	8	4	4	0	9-11	49	49	25	6	6
Means:	8.5	8.9	9.3	9.6	9.7	9.2	12-14	5	7	8	3	1
							Means	8.8	9.5	9.4	9.3	10
TORRANCE							TORRANCE					
PQ. 1 1	1	4	6	1	4	1	PQ. 1 1	6	4	4	1	2
Means:	.06	.06	.07	.03	.21	.14	Means:	.07	.05	.08	.07	.20
PQ. 4 1	1	4	6	4	1	1	PQ. 4 1	7	8	1	1	0
Means:	.06	.06	.07	.12	.05	.14	Means:	.09	.10	.03	.07	0
PQ. 7 0-1	17	58	61	22	11	4	PQ. 7 0-1	61	59	38	9	7
2-3	1	11	22	0	5	1	2-3	19	17	7	4	0
4-5	0	1	3	3	3	2	4-5	1	3	3	1	3
Means:	.33	.63	.02	.27	.58	.16	Means:	.80	.95	.96	.43	.63
PQ. 10 0-2	4	3	4	1	1	0	PQ. 10 0-2	10	2	1	0	0
3-5	7	33	16	0	1	1	3-5	36	17	10	2	1
6-8	7	27	37	10	7	2	6-8	29	32	19	5	4
9-11	0	5	24	9	2	2	9-11	6	19	12	4	1
12-14	0	2	5	5	8	2	12-14	0	9	6	3	3
Means:	4.7	5.7	7.4	8.2	9.8	7.5	Means:	5.4	7.6	7.9	9.1	8.3
PQ. 11 0-2	5	4	1	0	0	0	PQ. 11 0-2	7	2	1	0	0
3-5	12	28	23	8	1	1	3-5	29	22	13	6	2
6-8	1	34	49	15	7	0	6-8	34	39	25	4	4
9-11	0	4	13	10	11	6	9-11	12	16	9	4	5
Means:	3.4	5.6	6.8	7.4	9.0	10	Means:	6.0	6.7	6.77	5	9.3

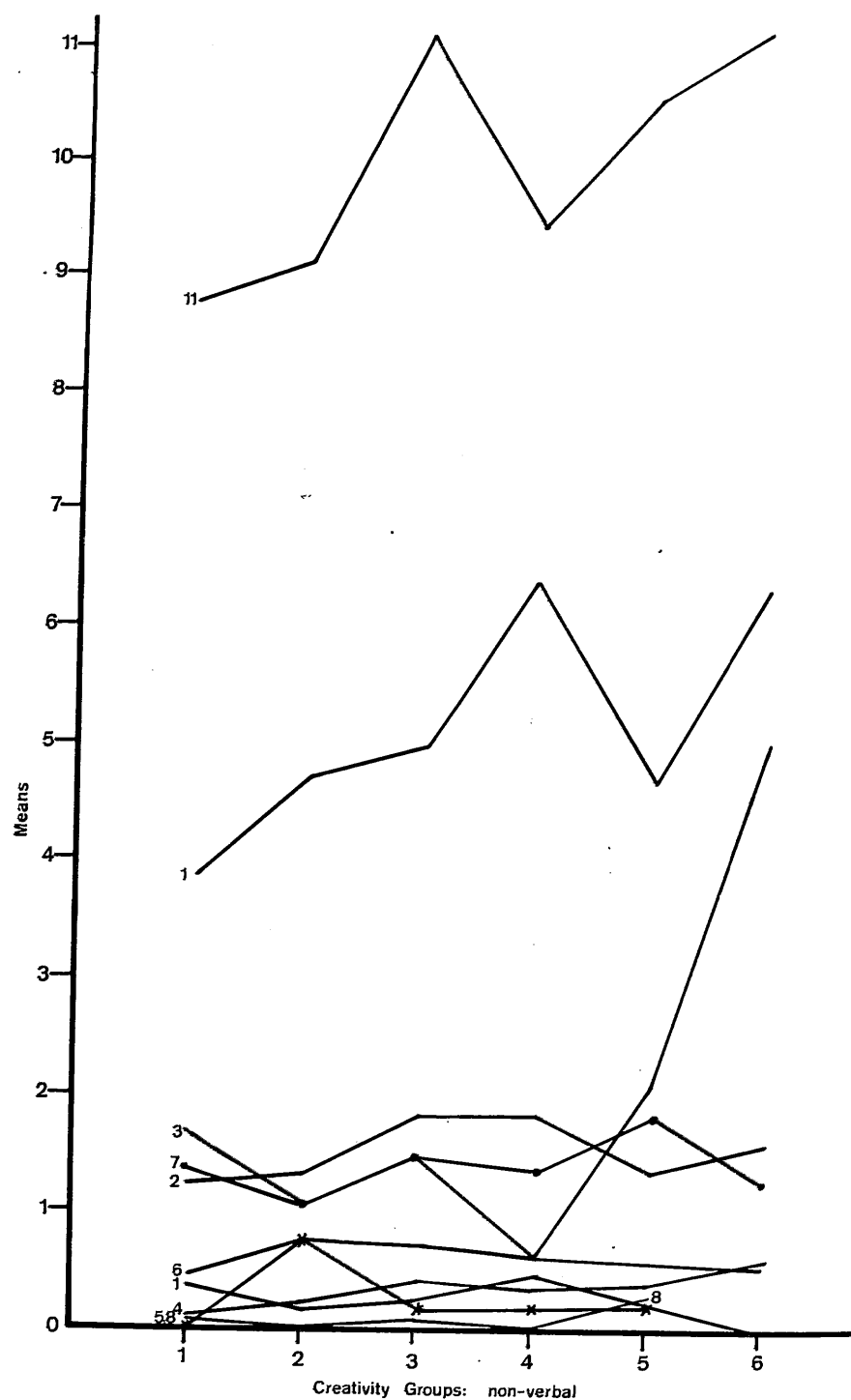


FIG.21: Graphs of the means of Perceptual Qualities of the Line Meanings test for 6 creativity groups (non-verbal).

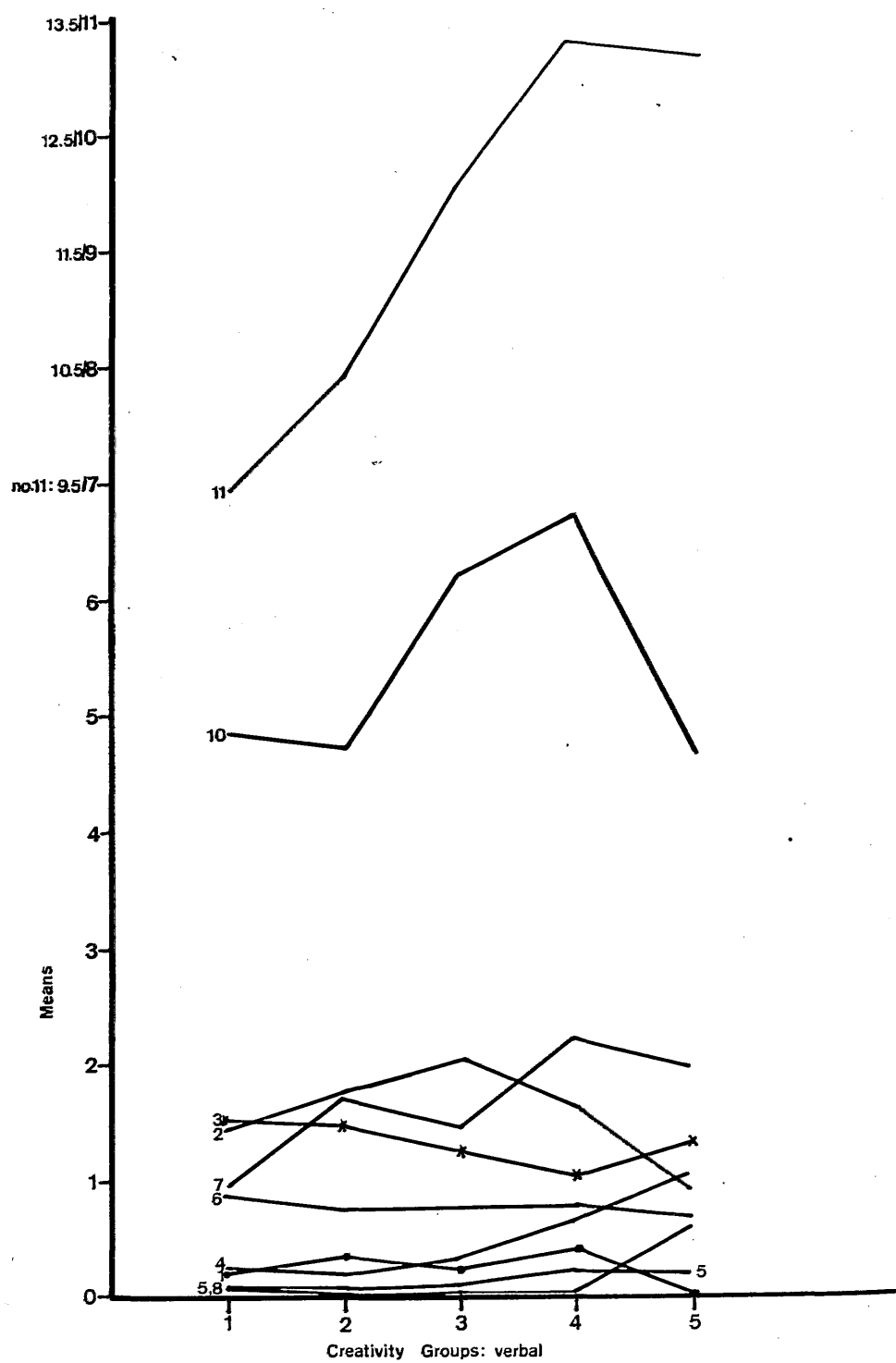


FIG.22: Graphs of the means of Perceptual Qualities of the Line Meanings test for 5 creativity groups (verbal).

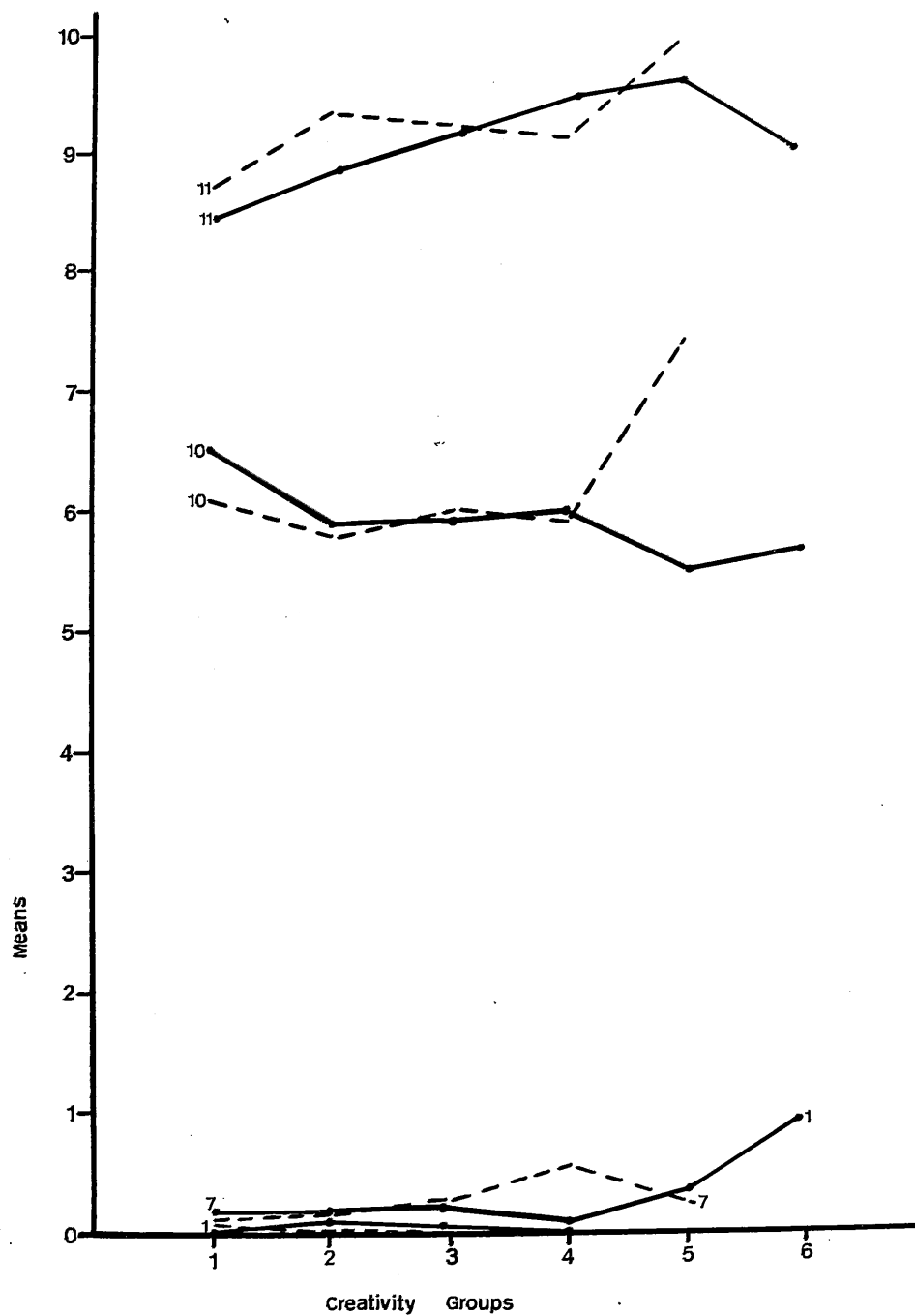


FIG. 23: Graphs of the means of the Perceptual Qualities of the Structured Drawings test for 6 creativity groups.

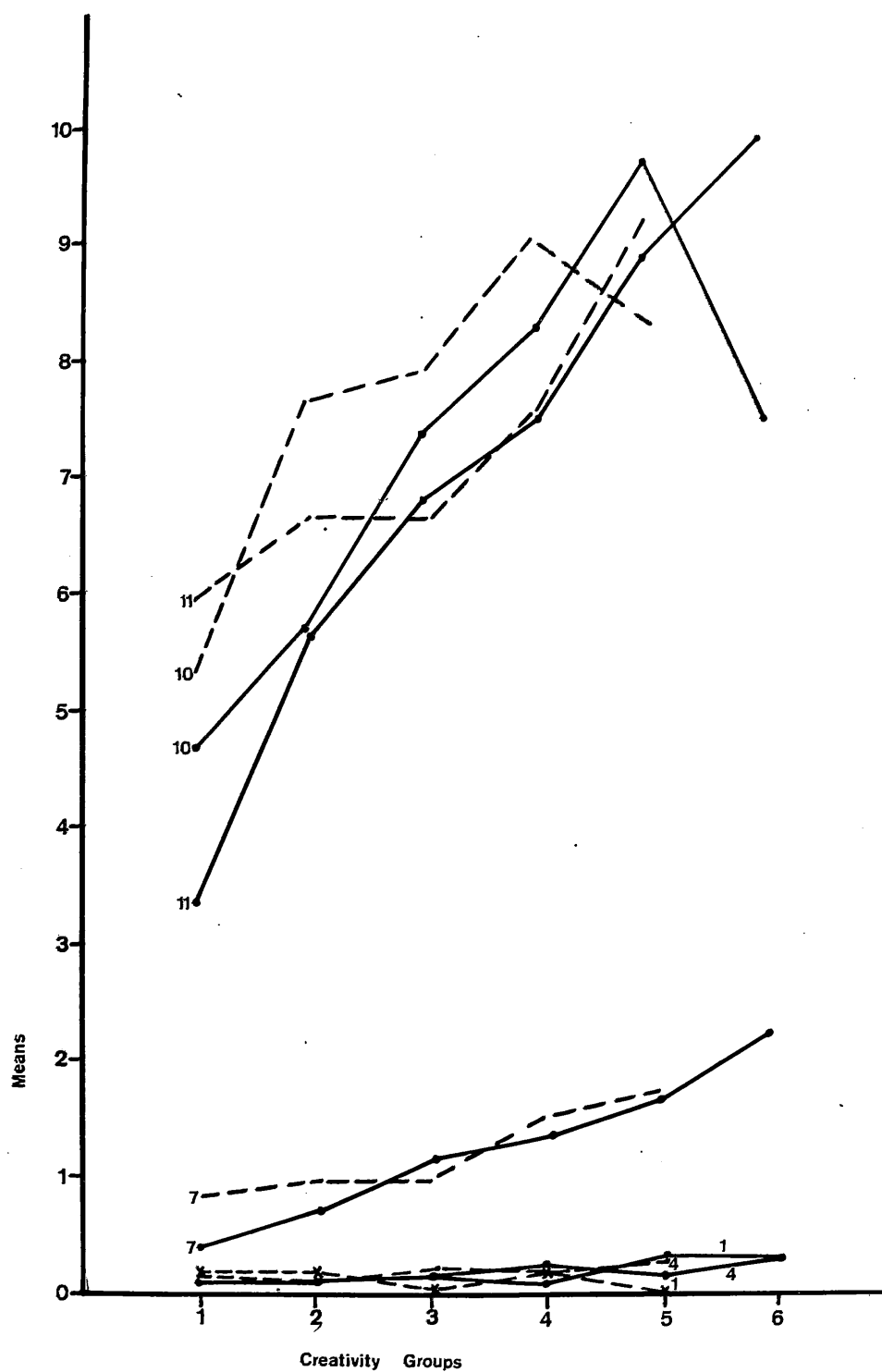


FIG. 24: Graphs of the means of the Perceptual Qualities of the Torrance non-verbal tests for 6 creativity groups.

It seems that the middle originality groups 3 and 4 produce most of the depth or three-dimensional responses to line drawings (P.Q. 1) - the pattern is not as hypothesised. For P.Q. 5 and 3 the pattern is difficult to see. The two extreme groups 1 and 5 seem to give more P.Q. 5 and 3 responses than the middle groups, perhaps for different reasons. For instance, P.Q. 5 is "rearrangement of stimulus lines". Perhaps both groups 2 and 5 found stimuli difficult to interpret and so altered their configurations, or perhaps group 2 found this so, but group 5 were not bound by what they were given: they were not afraid to alter their environment in order to perceive and interpret stimuli in a more satisfactory manner.

Groups 1 and 5 gave more back view responses (P.Q. 3) than the middle originality groups - this also does not fit the hypothesis.

In the Torrance tests, more original subjects tended to give more three-dimensional responses (P.Q. 1) than the less original subjects: a very similar pattern was found for P.Q. 4 (panoramic or vista responses, which also involve three dimensions), 7, 10 and 11. Thus more original subjects interpreted more views from above, the front and from the side than the less original subjects.

In view of the nature of Circles in the Torrance Tests, P.Q. 11 would be the more uncommon angle of viewing an object. It is not unusual to make a circle into a face or a ball (front-on viewing) but it is unusual to make a circle into a profile face or a fish because greater transformations and adaptations are involved. The two sections of the Torrance Tests used for the perceptual quality scoring (Incomplete Figures and Circles) should have been kept separate for this purpose. A viewing angle may be unusual for one type of test and not for another.

The results above do, however, indicate that original subjects tend to view objects from less common angles and introduce "extras" (three-dimensions, vistas) into their interpretations of pictures to a greater extent than non-original individuals.

There were no significant differences amongst the six groups on P.Q. 2 (incongruity), 3 (omissions of parts of stimuli) and 6

(repetitions of responses). The hypothesis that less creative subjects would use more of these types of responses had not been supported.

Considering

2) Division of creativity groups according to the Torrance Tests of verbal originality, differences were found on Line Meanings P.Q. 1, 4, 8, 11, Torrance P.Q. 1, 4, 10, 11 and Structured Drawings P.Q. 7.

Thus it seems that differential ability in non-verbal and verbal originality thinking is reflected to some extent in the interpretation of line drawings because there are no differences amongst the groups on P.Q. 5 or Torrance P.Q. 7 but there are on Line Meanings P.Q. 4, 11 and Structured Drawings P.Q. 7.

Again, for Line Meanings P.Q. 1, the middle groups give most instances of this type of response. The patterns for Line Meanings P.Q. 8, Torrance P.Q. 1, 10, 11 are similar to those found for the non-verbal division results - responses increase with increasing verbal originality (as hypothesised). The same occurs with Structured Drawings P.Q. 7 (view from above), which is as hypothesised since P.Q. 7 is unusual, and also for Line Meanings P.Q. 11 which is opposite to the hypothesis since P.Q. 11 is a common viewing angle. This might be expected, though, since we are dealing here with individuals who are original thinkers when dealing with verbal rather than with non-verbal information such as given in Line Meanings.

Results on Torrance P.Q. 4 (vista responses) are disappointing since the number of responses decrease with increasing originality. This is difficult to explain. For Line Meanings P.Q. 1, the result is similar to P.Q. 1 - it is the middle originality groups 3 and 4 that give most instances of this type of response.

From these results, it would seem that the viewing-angles P.Q. 7 and 10 and the Torrance depth response (P.Q. 1) are the best perceptual qualities on which to distinguish original thinkers.

RESULTS OF STORY CATEGORIES:

The results obtained from comparing the performance of the members of six creativity groups on the nine story categories

listed under hypothesis H_3 in Chapter III, are given in Table 21. The actual frequencies occurring in each group are given in Table 22.

χ^2 values significant at the .05 level or less are marked *, i.e. the frequencies of the story categories marked *, differ significantly amongst the six creativity groups.

Considering

1) Division of creativity groups according to the Torrance Tests of non-verbal originality, significant differences were found amongst the groups on categories E and J (.001 level of significance). Differences amongst the creativity groups were also found on categories A and D, but only at the .10 level of significance.

Category E is labelled "T.V. and fairy story-type story themes". The pattern of differences amongst the groups is rather indistinct. Most of these themes were found in originality groups 1 and 5, i.e. in one high and one low originality group. This is difficult to explain. Perhaps this type of story-assessing method is inadequate or perhaps this result would not be repeated in another experiment (this applies, of course, to the other results as well).

Category J is "use of discontinuous sentences". The result is distinct and in line with the hypothesis. The number of instances of this category decreases with increasing originality scores. More original individuals use this type of response much less seldom than less original subjects. Thus highly original subjects seem also to possess greater verbal ability (and thus greater fluency of ideas and prose-production) than relatively unoriginal subjects.

Although categories A and D show significant differences only at the 1% level, the results are worth studying. Category A is "themes of destruction", e.g. killing, earthquakes. It was hypothesised that the more creative the individual, the more he would use this type of theme. In actual fact, group 6 (high creativity) does have the highest occurrence of destruction themes, group 4 is next and then group 2. Thus the results are not clear; we cannot say Shapiro's and Getzels and Jackson's findings on the

TABLE 21

χ^2 VALUES INDICATING DIFFERENCES IN THE OCCURRENCE OF
DIFFERENT TYPES OF STORY RESPONSES AMONGST 6 CREATIVITY GROUPS

STORY CATEGORY	DIVISION ACCORDING TO NON-VERBAL ORIGINALITY					DIVISION ACCORDING TO VERBAL ORIGINALITY			
	χ^2 VALUE	df	P LEVEL	C		χ^2 VALUE	df	P LEVEL	C
A	24.21	15	.10	.30		20.70	12	.50	.28
B	6.36	4	.15	.57		24.50	4	.001*	.81
C	3.70	4	.40	.59		3.63	4	.50	.58
D	7.03	4	.10	.61		0.60	4	.95	.22
E	48.21	10	<.001*	.41		13.55	8	.10	.25
F	-	-	-	-		-	-	-	-
G	18.63	15	.30	.27		30.44	12	.01*	.35
H	14.97	15	.50	.25		7.76	12	.80	.17
J	20.35	4	.001*	.59		66.74	4	<.001*	.80

TABLE 22

STORY CATEGORY FREQUENCIES OCCURRING
IN 6 CREATIVITY GROUPS.

DIVISIONS ACCORDING TO NON-VERBAL ORIGINALITY								DIVISIONS ACCORDING TO VERBAL ORIGINALITY						
CREATIVITY GROUP NO.								CREATIVITY GROUP NO.						
	1	2	3	4	5	6		1	2	3	4	5		
CAT.A	0	10	33	45	15	10	5	CAT.A	0	15	34	21	12	4
	1	4	25	19	10	8	0		1	20	25	15	2	3
	2	3	9	19	5	1	0		2	14	11	11	0	1
	3	1	3	3	3	0	2		3	3	9	1	0	0
Means:		.78	.80	.78	.88	.55	1.0	Means:		.72	.96	.83	.14	.61
CAT.B	1	0	5	3	3	2		CAT.B	1	3	7	0	0	0
Means:		0	.071	.04	.09	.08		Means:		.04	.09	0	0	0
CAT.C	1	1	2	3	0	1		CAT.C	1	1	3	2	1	0
Means:		.06	.029	.035	0	.038		Means:		.012	.038	.041	.071	0
CAT.D	1	0	2	5	0	5		CAT.D	1	1	3	3	3	2
Means:		0	.029	.058	0	.195		Means:		.012	.038	.062	.214	.20
CAT.E	0	12	54	62	23	10	6	CAT.E	0	65	55	30	10	7
	1	4	12	21	9	7	0		1	14	19	15	4	1
	2	2	4	1	2	1	0		2	3	5	3	0	2
Means:		.45	.30	.31	.33	.58	.33	Means:		.26	.35	.44	.29	.50
CAT.F	1	0	0	1	0	0		CAT.F	1	1	0	0	0	0
Means:		0	0	.011	0	0		Means:		.012	0	0	0	0
CAT.G	0	5	36	48	20	9	4	CAT.G	0	31	43	29	10	7
	1	7	14	23	6	5	3		1	18	23	12	2	3
	2	6	8	8	5	4	0		2	15	10	5	1	0
	3	1	12	7	2	1	0		3	18	3	2	1	0
Means:		1.45	1.00	.73	.67	.84	.50	Means:		1.37	.65	.58	.50	.30
CAT.H	0	5	17	18	7	3	1	CAT.H	0	15	22	10	1	0
	1	5	30	38	16	5	3		1	40	32	17	5	4
	2	7	14	16	5	9	2		2	16	14	15	6	2
	3	1	9	14	5	2	1		3	11	11	6	2	1
Means:		1.22	1.23	1.35	1.18	1.53	1.42	Means:		1.28	.85	1.38	1.64	1.1
CAT.J	1	13	11	13	0	2		CAT.J	1	27	11	0	2	0
Means:		.72	.157	.15	0	.077		Means:		.33	.139	0	.143	0

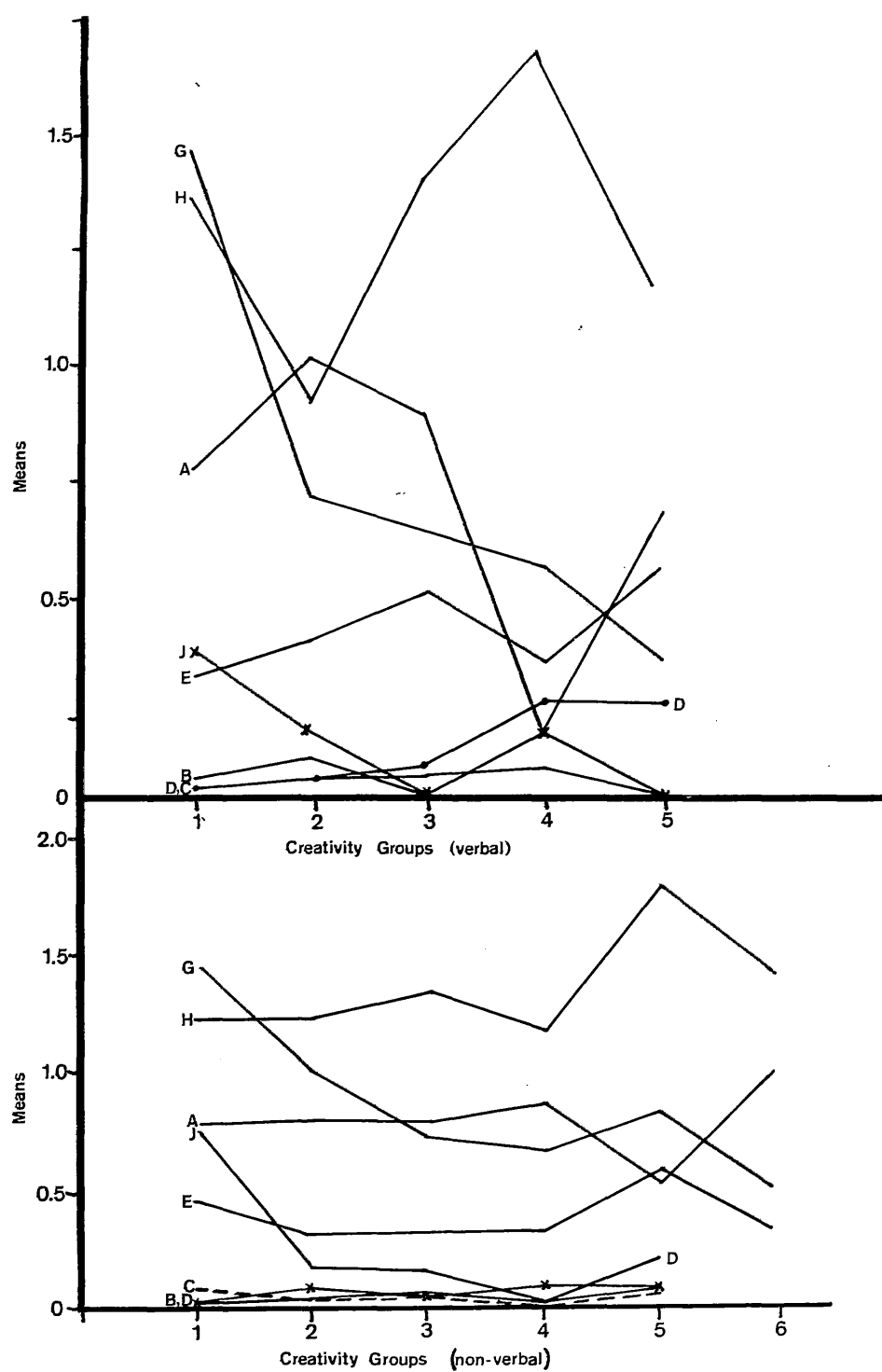


FIG. 25: Graphs of the means of the Story categories for 6 creativity groups.

creative person's use of fantasy and primary process have been substantiated unequivocally. The pattern for category D is more distinct, the occurrence of humour in story themes increasing with increasing originality (as was hypothesised). The similarity between original thinking and humour has been discussed in Chapters II and III. Both often involve the surprisingly apt juxtaposition of incongruous objects or situations. These results lend support to Getzels and Jackson's, Shapiro's and Barron's findings on the use of humour by more original people.

Considering

2) Division of creativity groups according to the Torrance tests of verbal originality, significant differences were found amongst the six creativity groups on categories B, G and J.

Category J results are similar to those discussed above for non-verbal originality groups.

Category B is labelled "irrelevancy in story themes". The results are quite clear. The number of irrelevant story themes decreases with increasing originality. This is as was hypothesised. The original thinker can coordinate his ideas to form a cohesive story theme relating all the aspects of a stimulus picture. He does not have to wander off into irrelevancies or "strain" the picture content to fit a familiar story.

Category G is Description, i.e. the story produced is nothing more than an inventory of the aspects of the stimulus picture. The distribution of frequencies is clear here as well. The occurrence of pure descriptions of the pictures decreases with increasing originality scores. The original thinker is at no loss for ideas, he does not have to or does not like to take the safe, uninteresting way out as much as his relatively unoriginal contemporaries.

STRUCTURE AND CREATIVITY:

The four sections of the Structured Drawings and Stories tests differed from one another in the amount of information with which they provided the subjects. Thus in Structured Drawings, the number of "clues" given to aid the subject in his interpretation of the line drawings increased through the four stages or sections.

In Stories, the number of clues decreased steadily, i.e. the pictures got progressively more vague and ambiguous.

The results of comparing the subjects' performances on these tests for originality, flexibility and form scores, are given in Table 23. The P levels marked * indicate the variables whose frequency distributions differ significantly at the .001 level amongst the four "degree of structure" categories. The column "C" contains the contingency coefficient for each variable. Table 24 gives the actual frequency counts at each degree of structure stage for all the variables and Fig. 26 shows graphically the distributions of means for the four degree of structure categories.

Only the variables Structured Drawings originality, flexibility and form show significant differences amongst the four structure categories. The two Stories variables have not behaved as hypothesised in H_4 - there are no significant differences in fluency or originality scores amongst the four pictures.

The pattern of means for Structured Drawings originality is exactly as predicted. As structure (or amount of information) increases, originality scores decrease (Hypothesis H_4 (a)). This has distinct implications for educational methods which will be discussed in Chapter VI. Too much information obviously restricts individuals - it decreases their chances of producing original responses.

The pattern for Structured Drawings flexibility is the exact opposite of that for the originality scores and is in line with the pattern predicted for less creative children. As the amount of information given in a stimulus increases, subjects are more flexible. Thus ambiguity and uncertainty restricts flexibility - individuals tend to stick to few categories of responses. The differences amongst the four series of pictures eventually forces the individual to be flexible - this is inherent in the test material since each series of drawings falls into a different flexibility category.

The form variable has not performed as expected. Form is best in category 4 (as was predicted) which is the most structured category, but it is next best in category 1 which is the least

TABLE 23

χ^2 VALUES INDICATING DIFFERENCES AMONGST
4 DIFFERENT DEGREE OF STRUCTURE CATEGORIES
FOR 5 VARIABLES OF THE STRUCTURED
DRAWINGS AND STORIES TESTS

VARIABLE	χ^2 VALUE	df	P LEVEL	C
Structured Drawings Originality	65.25	12	<.001*	.27
Structured Drawings Flexibility	82.56	9	<.001*	.28
Structured Drawings Form	32.38	9	<.001*	.17
Stories Fluency	4.23	9	.90	.07
Stories Originality	14.25	9	.10	.04

TABLE 24

STRUCTURED DRAWINGS AND STORY FREQUENCIES OCCURRING
IN 4 DIFFERENT DEGREE OF STRUCTURE CATEGORIES

<u>STRUCTURED DRAWINGS</u>					<u>STORIES</u>				
<u>SCORE GROUP DEGREE OF STRUCTURE</u>					<u>SCORE GROUP DEGREE OF STRUCTURE</u>				
<u>ORIGINALITY</u>	1	2	3	4	<u>FLUENCY</u>	1	2	3	4
0-1	94	115	164	173	0-29	153	153	150	159
2-3	89	75	52	48	30-59	62	67	66	56
4-5	38	35	11	11	60-89	14	10	13	16
6-7	10	7	4	1	90-119	3	3	4	2
8-9	2	1	2	0	Means:	202.7	190.1	242.1	200.3
Means:	15.5	13.0	9.6	5.8					
<u>FLEXIBILITY</u>					<u>ORIGINALITY</u>				
1	1	2	1	2	0-.5	173	194	192	171
2	33	12	8	4	1-1.5	42	27	27	41
3	91	60	44	31	2-2.5	14	8	8	16
4	108	159	180	196	3-3.5	4	3	6	5
Means:	24.5	25.0	25.8	28.0	Means:	4.67	2.79	3.00	4.43
<u>FORM</u>									
3-5	5	7	4	3					
6-8	41	49	36	22					
9-11	104	132	141	145					
12-14	80	45	52	63					
Means:	73.4	66.7	72.4	74.8					

structured category. It seems that lots of information helps produce good form because there is little or no ambiguity and little to add to the picture. A little information also helps produce good form probably because the individual can add to the picture as he likes. However, in the middle two categories (2 and 3) there is too much information to enable the subject to draw as he pleases and too little to provide him with most of the picture anyway.

The hypothesis that these relationships between creativity variables and the degree of structure of the stimulus material would hold for both concrete and conceptual tests has not been supported. Stories variables show no such relationships.

It might be that these patterns are different for low and high creativity groups. Differing amounts of information in stimuli may affect the performance of highly creative and less creative individuals differently.

Hence, Table 25 gives the χ^2 values obtained from comparing the performance of four creativity groups on the same variables discussed above. As usual, significant differences amongst the 4 structure categories are marked * (.05 level of significance or less).

Considering

1) Division of creativity groups according to the Torrance tests of non-verbal originality, significant differences were found amongst the four structure categories on the following variables:

Structured Drawings originality, for all creativity groups except group 4 (highly original group).

Structured Drawings flexibility for all four creativity groups.

Structured Drawings form only for creativity group 1 (low creativity).

Structured Drawings: Change number, for all creativity groups except group 4.

Stories fluency for creativity groups 1 and 4.

Table 26 gives the distributions of the means of these groups over the four degrees of structure categories. Graphical representations of these are shown in Fig. 26.

TABLE 25

χ^2 VALUES INDICATING DIFFERENCES AMONGST 4 DIFFERENT DEGREE
OF STRUCTURE CATEGORIES FOR 6 CREATIVITY GROUPS

VARIABLE	CREATIVITY GROUP	DIVISION ACCORDING TO NON-VERBAL ORIGINALITY				DIVISION ACCORDING TO VERBAL ORIGINALITY			
		χ^2 VALUE	df	P LEVEL	C	χ^2 VALUE	df	P LEVEL	C
Structured Dr. Orig.	1	39.27	9	<.001*	.32	70.40	9	<.001*	.32
	2	40.31	9	<.001*	.33	22.77	9	.01*	.33
	3	16.41	9	.05*	.33	6.16	6	.50	.32
	4	10.67	6	.10	.56	13.56	6	.05*	.50
Structured Dr. Flex.	1	33.33	6	<.001*	.30	55.84	6	<.001*	.45
	2	29.67	6	<.001*	.28	48.06	6	<.001*	.32
	3	16.17	6	.01*	.33	6.30	6	.50	.58
	4	18.90	6	.01*	.45	19.42	3	<.001*	.28
Structured Dr. Form	1	23.47	9	.01*	.25	53.60	9	<.001*	.28
	2	13.66	9	.20	.20	15.48	9	.10	.28
	3	9.41	6	.20	.27	27.72	9	.001*	.58
	4	7.42	6	.30	.27	4.58	6	.70	.10
Structured Dr. Change No.	1	63.84	9	<.001*	.39	118.6	9	<.001*	.40
	2	68.05	9	<.001*	.41	60.75	9	<.001*	.49
	3	26.53	9	.01*	.41	21.67	9	.01*	.53
	4	10.94	6	.10	.36	16.48	6	.01*	.54
Stories Fluency	1	45.34	6	<.001*	.33	57.39	6	<.001*	.28
	2	9.21	6	.20	.17	21.23	6	.01*	.32
	3	2.45	6	.90	.14	5.70	6	.50	.32
	4	31.19	6	<.001*	.43	23.31	6	<.001*	.57
Stories Originality	1	6.34	6	.50	.14	10.04	6	.10	.14
	2	4.35	6	.70	.10	8.22	6	.20	.20
	3	2.36	6	.90	.14	4.80	6	.70	.28
	4	9.38	6	.20	.28	12.54	6	.05*	.49

TABLE 26

MEANS OF 4 CREATIVITY GROUPS ON SELECTED VARIABLES ACCORDING
TO 4 DIFFERENT DEGREE OF STRUCTURE CATEGORIES

DIVISION ACCORDING TO NON-VERBAL ORIGINALITY STRUCTURED DRAWINGS ORIGINALITY					DIVISION ACCORDING TO VERBAL ORIGINALITY				
CREATIVITY GROUP NO.	DEGREE OF STRUCTURE				CREATIVITY GROUP NO.	DEGREE OF STRUCTURE			
	1	2	3	4		1	2	3	4
1: Means	2.13	1.24	0.61	0.82	1: Means	2.26	1.74	0.84	0.94
2: Means	2.26	1.87	1.09	0.90	2: Means	2.23	2.07	1.60	0.81
3: Means	2.46	2.42	1.48	1.21	3: Means	2.07	2.86	2.50	1.64
4: Means	2.18	1.91	1.94	0.68	4: Means	1.72	1.50	1.05	0.11
<u>FLEXIBILITY</u>									
1: Means	3.27	3.47	3.67	4.08	1: Means	3.32	3.58	3.71	3.77
2: Means	3.47	3.70	3.76	3.90	2: Means	3.31	3.83	3.71	3.86
3: Means	3.52	3.73	3.76	3.94	3: Means	3.64	3.50	3.87	3.93
4: Means	3.66	3.55	3.65	3.98	4: Means	3.28	4.44	3.67	4.67
<u>FORM</u>									
1: Means	9.8	9.2	10.0	9.8	1: Means	9.7	9.7	10.0	10.4
2: Means	10.1	10.2	10.4	10.6	2: Means	10.5	10.2	10.5	10.6
3: Means	11.4	10.6	10.7	10.8	3: Means	11.0	10.4	10.4	11.1
4: Means	10.8	10.4	10.5	11.3	4: Means	8.8	9.8	10.0	10.8
<u>CHANCE NUMBERS</u>									
1: Means	2.13	2.84	1.80	1.88	1: Means	2.00	2.11	2.03	2.33
2: Means	1.95	2.70	1.61	1.70	2: Means	2.66	2.79	3.00	2.44
3: Means	1.91	2.70	1.79	1.73	3: Means	1.64	1.98	2.00	1.94
4: Means	2.05	2.60	1.46	1.56	4: Means	1.74	1.98	1.64	1.28
<u>STORIES FLUENCY</u>									
1: Means	23.3	22.4	21.5	19.3	1: Means	25.2	31.1	42.0	36.3
2: Means	30.4	28.5	30.5	28.3	2: Means	24.2	31.6	44.6	39.5
3: Means	28.9	28.3	37.3	26.3	3: Means	24.7	35.8	55.7	38.0
4: Means	32.3	29.5	40.4	45.2	4: Means	22.5	32.3	38.6	40.1
<u>ORIGINALITY</u>									
1: Means	0.28	0.21	0.24	0.38	1: Means	0.33	0.69	0.68	1.08
2: Means	0.49	0.42	0.51	0.68	2: Means	0.26	0.50	0.79	0.78
3: Means	0.38	0.36	0.41	0.61	3: Means	0.26	0.58	0.96	0.73
4: Means	1.08	0.53	0.53	0.79	4: Means	0.47	0.89	0.71	1.31

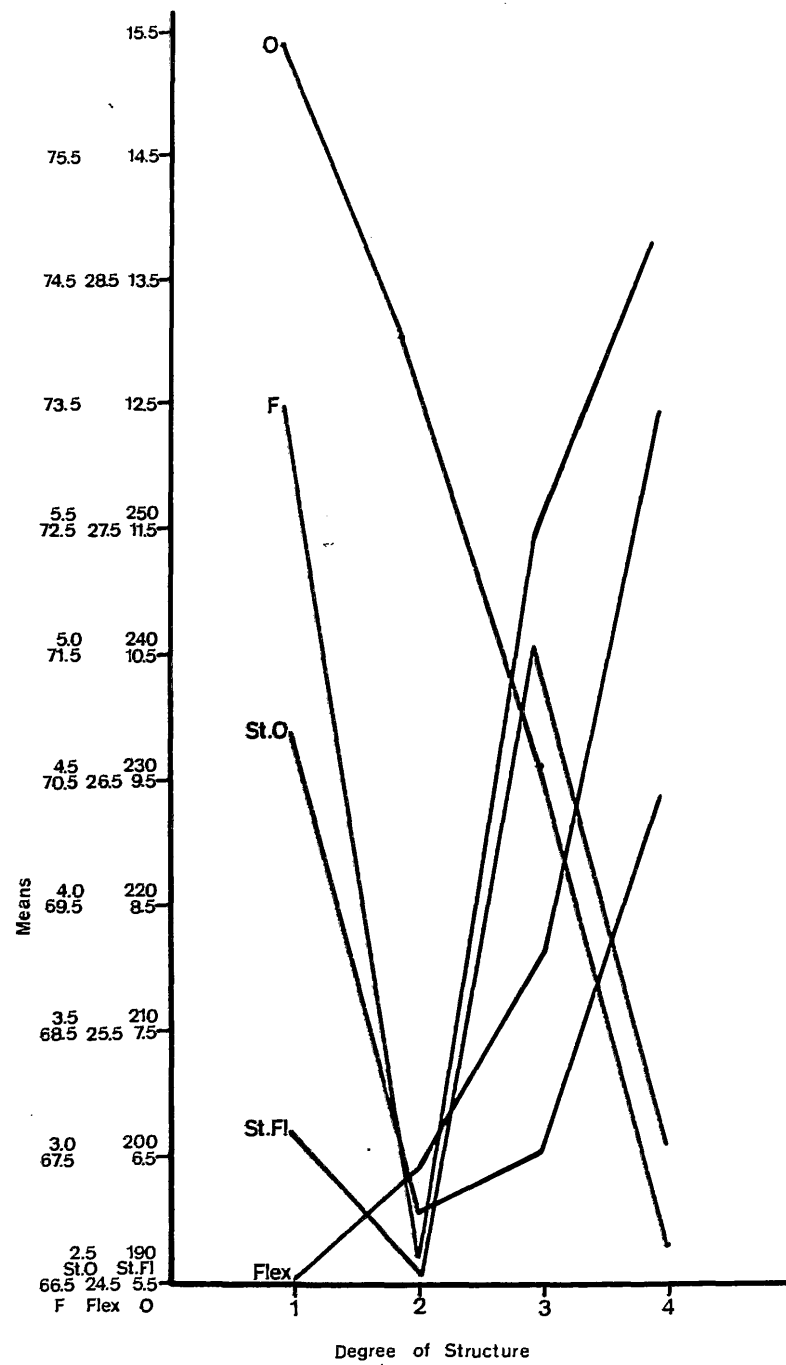


FIG. 26: Graphs of the distribution of Structured Drawings and Stories variables according to 4 degrees of structure categories.

The first three creativity groups show distributions of means identical to those for the sample as a whole on Structured Drawings originality. For creativity group 4, the differences aren't significant, though the distribution is somewhat similar. This could mean that highly original people are not affected by different degrees of structure in stimuli to the same extent as less creative people. They can maintain high originality scores in the face of changing stimuli.

The first three creativity groups show the same pattern of means as the sample as a whole on Structured Drawings flexibility. Group 4 (highly original) shows a slightly different distribution. They are least flexible in the two middle structure groups and most flexible when (a) the stimulus is highly structured (then they are forced to be flexible by the nature of the test material) and (b) when the stimulus is almost completely unstructured. Unlike the less creative subjects, they can be flexible even when dealing with very vague, ambiguous stimuli.

Again, the distributions for the variable "form", are not as hypothesised. Group 1 shows results similar to those obtained for the whole sample. The other creativity groups, though the differences aren't significant, show very much the same distributions. Thus performance on "form" is not affected by the level of a subject's creative ability.

The picture obtained from creativity group 1 on Stories fluency is exactly as hypothesised for low-creativity subjects. As the degree of structure in the pictures decreases, so, too, does the fluency scores. Thus uncreative individuals are able to produce fewer and fewer ideas in response to pictures that are more and more ambiguous. In the face of uncertainty, their fluency fails them.

The pattern for groups 2 and 3 is very indistinct and jumbled but for creativity group 4, the distribution of means is almost the reverse of that for group 1. In group 4, fluency increases with decreasing degree of structure. This was predicted. The more uncertain and ambiguous the situation, the "freer" the creative child is. He produces more and more ideas the less he

is given to work on. This, also, is of importance in its educational implications.

Stories originality showed no significant differences, unlike the predictions given under hypothesis H_4 (a). The distributions of means for the four creativity groups are jumbled. One cannot conclude that ability to think up original story themes is influenced by (a) the creative ability of the subject or (b) the amount of information given in the stimulus pictures. It might also be that differences in structure amongst the four pictures were not wide enough to result in different levels of performance.

The variable Structured Drawings: Change number is the last to be considered.

For the first three creativity groups, most of the "changes" occurred in the first two degrees of structure categories - as was hypothesised (H_4 (d)). "Change number" refers to the degree of structure category at which the subject "falls into the trap" and makes a line drawing into the final object intended. The longer a subject can restrain himself from doing this and, instead, thinks up original responses, the more creative (it was hypothesised) he is likely to be. The pattern is the same for group 4, though the differences are not significant.

Comparing all 7 creativity groups, group 7 (highly original subjects) certainly have the lowest "change number" mean (for both highly verbally and highly non-verbally original subjects) but after that the pattern is not clear. (see Table 27 and Fig. 27). Group 1, in both cases, does have high "change number" means, though. It seems that the prediction on change number scores holds for very low and very high originality subjects (groups 1 and 4) but not for the "inbetweens".

For the whole sample, most "changes" to the unoriginal, intended response occur in category 2, next most in category 1 and least in categories 3 and 4. It seems few subjects can resist the implications of the stimuli and thus succumb fairly early to giving the intended responses inherent in the test material.

TABLE 27

FREQUENCIES AND MEANS OF THE VARIABLE
"STRUCTURED DRAWINGS: CHANGE NUMBER" OVER
7 CREATIVITY GROUPS.

<u>NON-VERBAL</u>		<u>DEGREE OF STRUCTURE AT WHICH CHANGE OCCURS</u>					
CHANGE NO.		1	2	3	4	not at all	Mean
GROUP 1		13	40	13	2	4	8.89
2		79	121	47	17	11	8.12
3		125	139	50	15	14	7.96
4		36	66	18	6	4	8.13
5		17	37	18	3	1	8.52
6/7		11	11	5	1	0	7.25
TOTALS:		281	417	151	48	34	

<u>VERBAL</u>		<u>DEGREE OF STRUCTURE AT WHICH CHANGE OCCURS</u>					
CHANGE NO:		1	2	3	4	not at all	Mean
GROUP 1		100	142	60	17	8	2.04
2		110	142	56	7	11	1.98
3		42	98	26	7	11	2.17
4		17	22	10	4	3	2.18
5		5	10	9	3	0	2.17
6/7		7	6	0	3	0	1.94
TOTALS:		281	420	161	40	33	

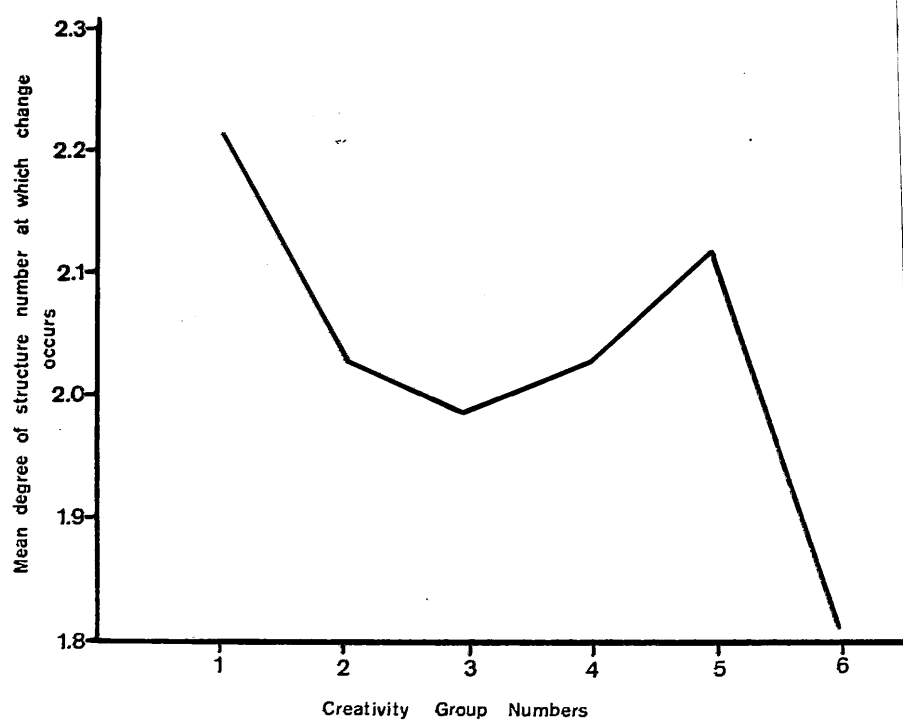


FIG.27: Graph of the distribution of variable "Structured Drawing — change number" over 7 creativity groups.

The Structured Drawings test, which was originated by the writer, has performed well and deserves further study and use on other subjects. The test would probably not be useful for adolescent or adult subjects because they might "see" the intention in the test, but it would be interesting to investigate this test and the implications of the children's performances on it.

Summaries of these results, evaluations of this study and its implications are set forward in Chapter VI.

CHAPTER VI.CONCLUSIONS.SUMMARY OF RESULTS:

The main aim of this study was the investigation of aspects of the structure and function of creative processes in the semantic-content area in young children. The results must mostly be considered tentative since it is the first time some of them have been hypothesised. However, the indications are clear that

many of the factors which were hypothesised, do exist. A brief summary of the results is as follows:

1. It is evident that one can obtain a factor structure for creative abilities in the semantic-content area for children in the age-range 5 to 7 years. The structure is similar in many respects to that obtained with adolescents and adults in other studies. The necessity for a multivariate view of creative processes is obvious - the results obtained from both orthogonal and oblique rotations of the factor matrix support this. It seems several "large" abilities are involved even within the relatively narrow area of a test battery of only semantic-content tests. This can be regarded as an oligarchic structure as opposed to an anarchic one (a different ability for every test) or a monarchic one (one all-pervading ability like the old monolithic view of intelligence).
2. The separation, within the semantic-content area, of "concrete semantic" and "conceptual semantic" factors has also been indicated. From the results, it is clear that it is not the type of information (content) a test deals with which determines whether it be concrete semantic or conceptual semantic, but the way in which the information is handled by the subjects. In the main, this does, in fact, mean concrete semantic content tests are handled in a concrete way and conceptual semantic content tests are handled in an abstract, conceptual way. ("The creative is shaped by the limits of the field into which it flows". (Hillman, 62).) However, there are exceptions.

The two modes of dealing with information can be defined as:
Concrete, semantic: the ability to deal with test stimuli in a concrete, representational way, i.e. the test stimuli are pictorially represented (even if only in the imagination) and meaningful labels are attached to them.

Conceptual semantic: the ability to deal with test stimuli in an abstract, conceptual way, also attaching meaningful labels to them. (This would probably be essential if using this type of thinking).

There is no reason to suspect that one type of thinking will result in more creative responses than the other (as Shapiro suggests). It could be that different individuals prefer to use, or are better at using different modes of thinking. These preferences, in turn, could be related to personality differences or to early child-training methods. Wallach & Kogan have performed some research along similar lines but a lot more needs to be done.

3. Ten out of fourteen of the postulated creativity factors were clearly identified.

These were:

- concrete semantic originality
- conceptual semantic originality
- concrete semantic spontaneous flexibility
- conceptual semantic spontaneous flexibility
- concrete semantic adaptive flexibility
- conceptual semantic adaptive flexibility
- concrete semantic fluency
- conceptual semantic fluency
- concrete semantic elaboration
- conceptual semantic elaboration (sensitivity to implications).

The concrete "free" originality factor seems to be concerned with elaborating rather than with producing unusual responses. There is not enough evidence to interpret the conceptual "free" originality factor, though it is indicated by the presence of two of its marker variables - Odd Animals. More research should be done on this type of test as, in the opinion of the writer, it definitely involves a distinct creative thinking ability. More tests of a similar nature involving a similar ability are required.

No "fluency in the use of materials" factor appeared at all.

4. Factors do overlap on occasions. This is due to the fact that similar variables load on different factors for different reasons.

Thus adaptive flexibility and originality variables load on both types of factors: fluency and flexibility, and fluency and originality variables do the same. Detailed reasons for this have been discussed, but in summary it can be said that (a) with an increase in the number of ideas being given, the individual is bound to change classes or responses (spontaneous flexibility), (b) the greater the number of ideas, the greater the possibility of an unusual response occurring, and (c) as an individual shifts and adapts his approach to a task (adaptive flexibility) the chances of arriving at an unusual transformation or adaptation.

5. As hypothesised, both adaptive flexibility and originality involve transformations, i.e. restructuring the test stimuli or situation in some way. The difference is that originality is the production of unusual transformations. Variables loading on both factors are similar because very often transformations are unusual. Perhaps, in scoring for "shifts" or changes in approaches, unusual shifts should be omitted in order to reduce the variance shared by the two factors. It could be said that transformation is the key word in creative thinking since transformations lie at the heart of originality.

6. Not all factors are identifiable, nor can the presence of all the variables in a particular factor be explained. This is to be expected. More research will be needed to arrive at a clearer picture of all the results obtained.

7. The Torrance Tests of Creative Thinking do, to a large extent, measure different abilities. In particular, Picture Construction seems to involve an ability distinct from others in other creative tasks. Only Ask and Guess and Product Improvement seem to occur together regularly on the same factors. That the Torrance Tests are complex activities (as Torrance says) is indicated by their involvement in all the fluency, flexibility and originality factors.

8. Most of the creativity tests performed well and as hoped. Figural Similarities, Block Sorting and Unusual Questions were the only ones that could not be used at all. The last is too difficult for children aged 5-7 years to understand the requirements. Subjects gave very few unusual responses to the first two - it is doubtful whether they are useful as creativity tests. Animal

Sorting seems more a measure of fluency of ideas than of spontaneous flexibility, although it was expected to be a measure of the latter process.

Mosaics, Toy Construction and Odd Animals all need further study. The last two, in particular, seem to be valuable measures, but they obviously involve abilities independent of the other creativity tests, i.e. it is highly probable that they represent other creative processes. This, indeed, makes them worth further investigation. Structured Drawings has given results beyond those hoped for. The ability to deal with stimuli which vary in the amount of perceptual cues they provide, seems independent of other creative abilities, though this also requires further investigation.

Form assessment and the amount of materials a subject employs in a creative task do not appear to be useful measures of any creative ability.

9. The hypothesised perceptual factors received mixed support. The redefinition factor found in many other studies also appeared here and is named "perceptual flexibility" because of its connections with flexibility in creative thinking. Perceptual flexibility involves redefinition of a stimulus to obtain (usually, but not always) one correct response: creative flexibility involves restructuring a stimulus to obtain many, often unusual responses.

The two perceptual factors clearly found were Preference for closed figures (a bipolar factor) and a perceptual elaboration factor representing an ability to introduce a third dimension (viz. movement), into static, visual stimuli.

No one particular factor which could be labelled "Preference for viewing stimuli from unusual angles" was found, though there are indications that such factors exist (factors 24,25,26). This deserves more attention.

The "openness of perception" factor is not clear and no claim can be made for such a factor on the basis of these results.

10. No distinct pattern of creativity or perceptual variables related to age or birth order occurs. The variables Father's Occupation and Otis I.Q. correlate significantly with many of the same variables - probably because they correlate signif-

icantly with each other. In general, the higher the intellectual level of the child the higher the rating of the father's occupation. Reasons for this have been discussed.

11. Some, but by no means all of the creativity variables correlate significantly with the variable Otis I.Q. Thus it cannot be said that creative performance and intelligence are unrelated, but neither do they involve the same ability or abilities. The relationship between them is complex, as Guilford intimates. Those who dogmatically claim that creativity is part of a general reasoning ability (as measured by standard intelligence tests) and those who just as dogmatically claim that neither abilities depend on each other at all, are both wrong.

The order of "amount of interrelationship" of intelligence with creativity variables is as follows (in decreasing order); form, fluency, flexibility and originality. This is as expected and has been explained in Chapter V.

12. The dependence of creative performance on an attribute Schulman has called "openness of perception" has not found any support in this study. This could be due to using different scoring systems instead of using overall estimates of creative performance, or differences in sample populations, or to inadequate measures of "openness of perception", or to the fact that no dependence exists. This warrants further research because from what we know about creative thinking, such a relationship is entirely credible.

13. High originality and low originality subjects did show significant difference in performance on some perceptual and creativity variables. This sometimes depended on whether they were highly original (or not) on non-verbal or verbal tests (as measured by the Torrance Tests of Creative Thinking).

In general, highly original subjects gave more depth and vista responses than low originality subjects (i.e. they interpreted visual stimuli in three-dimensions more than low originality subjects).

They also viewed and interpreted visual stimuli from more unusual angles, viz. from the back, front and from above (for Line Meanings test) and from the side and front (for the Torrance tests).

No differences were found on the number of omissions of parts of stimuli, incongruous responses and repetitions of responses given by low and high originality subjects.

Highly original subjects gave more story themes derived from T.V. shows and fairy stories, fewer discontinuous, disjointed story themes and fewer stories which were pure descriptions of the stimulus pictures. They also showed more themes of destruction and more humour in their stories, though these latter differences were significant only at the 10% level. Thus Shapiro's and Farron's findings were not unequivocally supported by these findings, though it must be noted that their findings were based on studies of specific populations. Wide ranges of intelligence, social background and creative abilities were not used.

14. The amount of information given on pictorial stimuli affects creative performance. Originality decreases, flexibility increases form decreases and then increases with increasing structure (or amount of information). These patterns are not true of the most original subjects where the differences are not significant. Highly original subjects appear to be able to maintain their originality and flexibility in the face of increasing numbers of cues forcing them not to be original.

When subjects deal verbally with a series of pictures with decreasing amounts of information, fluency decreases for low originality subjects but increases for highly original subjects. Originality of story theme is not affected.

Thus the amount of information given determines the object perceived. As more cues are added to a picture, the probability of obtaining alternative responses approaches zero. This is not significantly true of highly original individuals - they seem to be less "stimulus-bound" and operate more independently of their perceptual environments. They are less at the mercy of perceptual cues than are less original individuals. Uncertainty and ambiguity may actually suit them better than certainty which curtails their performance to some extent.

There are several observations to be made which are considered important.

Firstly, creativity belongs to everyone - it is not unique to one age, sex, level of intelligence or section of a population. We possess traits on a continuous scale, not on an all-or-nothing basis. There is no reason to suppose creative thinking abilities are any different. Secondly, a lack of rigidity, a willingness to adapt and consider something novel or different seems crucial in creative thinking. It lies behind all methods of assessing creative products, particularly flexibility and originality. It is the writer's belief that this type of thinking - tolerance of ambiguity, of change, of novelty - can be enhanced by the environment and perhaps even taught. Children could be encouraged to think in this way from a very early age, provided parents, teachers and peers value the same attitude and actively try to instil it into children. The writer was horrified by the admittedly small but significant number of 5,6 and 7 year olds who would not even consider the Just Suppose situation: "Suppose all the clouds had strings hanging down from them. What would happen?" Too many rejected the idea altogether and often vehemently. Creativity is only for prepared minds - we need to develop "prepared minds" in children.

Thirdly, "balance" is another key-word in creative thinking. Creative thinkers must maintain or learn to maintain a balance between reality and unreality, the rational and the irrational, the playful and serious, the adult and the childlike. The true creative thinker falls between the intellectual diehard who defends tradition and refuses to admit any other views and the iconoclast who destroys for the sake of destroying. The creative thinker must be revolutionary but not wholly destructive. He must be receptive, but also evaluative. He must accept many, often irrelevant perceptions (which are neglected by others) and yet not be overwhelmed by them.

EVALUATION:

As mentioned in previous chapters, any study has to curtail its area of interest, especially when conducted by a single individual. Hence there are many criticisms to be made of this

project - mostly due to omissions on the part of the writer. These do not detract from the overall results to any great extent, but it is well to note some of them.

1. This study has concentrated only on what Guilford has called the "semantic content" area, i.e. test information is meaningful in that verbal labels can be attached or are attached to it. Even--
tually, all the divergent production^{abilities} should be studied at this age level, though it will probably be necessary (in some cases) to construct special tests. Many of the present marker tests for divergent production factors are too difficult for 5,6 and 7 year olds to deal with adequately.
2. Many of the test variables used are not univocal. It is extremely difficult to construct univocal tests. One must consider whether it is desirable to do so, anyway. Is it not better to construct creative activities which are more like the true-to-life creative situation? It is likely that "pure" tests are too pure and stringent. The writer favours the Torrance approach to measuring creative thinking in which complex tasks are used, but assessed in many different ways.
3. It goes almost without saying that even if this is done, one is probably missing out on a great deal simply because one cannot know every valuable and significant method of assessment. Just as with all other statistical procedures, factor analytical discoveries are limited by (a) the test battery, (b) the method of assessment and (c) the people tested. However, we can be guided by what we know of the modes of thinking of well-known creative thinkers. Even, then, how can we be sure our methods are measuring something similar? This is where the study of criteria is important. Many criteria will be needed - it is very unlikely that one criterion will be enough to predict creative potential.
4. Scoring, especially for originality, is quite subjective. There seems to be no way round this problem, the very nature of creative thinking prohibits the use of completely objective methods of assessment. We can come ~~quite~~ close to being sure of standard scoring methods, though, by the use of the statistical-rarity assessment to begin with and the opinions of different raters

after the initial score grouping has been done.

5. Factor analysis is obviously a useful tool. It can help describe the structure of complex phenomena. We can go as far as linking factor analysis with psychological theory and say a factor is also a function. Factor analysis is one way of arriving at and describing psychological functions. But factor analysis cannot bear the whole burden. To begin with, it does not tell us how the factors occur. It is relatively unconcerned with how the subjects got the way they are. Different factors, different types of creative thinking could be determined by heredity, by environmental influences in the home or in different societies or cultures, or by a combination of both. The latter is most likely - the feud between nature and nurture is out of date and far too narrow a view of any psychological phenomenon.

6. The methods of investigation used in this study represent just one approach to the problem of creative thinking. This approach shuts out other possible approaches to a large extent. In particular, personality differences which may be important in different "perceptual approaches" and preference in modes of thinking, should be considered. There is a tremendous scope for further extended research. This study has served to indicate some worthwhile areas.

7. More detailed criticisms of the methods of this study are:

- (a) More marker variables are needed to be able to identify some of the factors which have occurred.
- (b) Further investigation is needed to establish the "reality" of some of the factors, especially the newly hypothesised ones. Factors have to appear in more than one study before they can be considered to "exist".
- (c) More subjects in the sample would increase the plausibility of the findings. This is however, true of any study where only a sample can be studied and the size of the sample used here was adequate.
- (d) The ranges of originality weightings could be increased. Score ranges of, say, 0 to 10 rather than 0 to 2, 0 to 3 or 0 to 5 would serve to differentiate responses more. Finer discriminations in scoring methods would be beneficial.

(e) One obviously has to be careful when constructing tests. Even what one imagines are slight differences between test content or test instructions or testing methods, can introduce a new ability or mode of thinking, e.g. Drawing and Tainting variables separated to quite a large extent though the only difference between them was the use of colour in the latter.

(f) The concept of ideational fluency as being the number of relevant ideas an individual can think up within a specific time limit seems wrong to the writer. Creative thinking must be as free and uncoerced as possible. Time is not an important factor in assessing creativity. Thus the writer sees ideational fluency as being the number of relevant ideas an individual can think up altogether. Ideally, subjects should be encouraged to continue giving responses until they run out of ideas. There are, of course, drawbacks attached to this view, especially when older children and adults are being tested because they are likely to give many responses (their store of information is greater). However, it worked well with the age range 5-7 years.

(g) In theory, oblique rotation results are likely to be more valuable than orthogonal rotation results. Unfortunately, there are many problems and uncertainties associated with the use of oblique rotations of factor matrices - those have been discussed elsewhere. Detailed interpretations of these results must await further investigation of the implications of oblique rotations.

(h) There may well be other factors to be discovered within this study, but they may not be represented well enough to be identified. With this in mind, it would have been valuable to compare the results obtained using other values of m , the number of factors. Only two values (18 and 30) were compared here. Using other m 's would, however, be a very lengthy and costly procedure.

IMPLICATIONS FOR RESEARCH:

The possibilities here are endless. Here are just some of the many interesting aspects which could be investigated:

(1) Replication studies of the newly-hypothesised factors found in this study.

- (2) More detailed investigation of the perceptual processes of creative individuals, viz. angles from which interpretations of stimuli are made, introduction of three-dimensional effects, colour and movement.
- (3) More detailed investigation of the amount of information given in test content and its effect on creative processes.
- (4) Factor analytic studies of other divergent-production factors, especially the behavioural content area. This could possibly be studied through the media of free play activities, acting and miming.
- (5) Investigation of the differential roles other SI abilities play in creative processes. This would include those abilities at present measured by the traditional intelligence tests.
- (6) More detailed investigation of the phenomenon of invention in language usage such as one obtains in the young child who is learning to talk. How is this related to creative potential? There are bound to be more successful ways of studying this than the Odd Animals test constructed by the writer, but this could be a beginning.
- (7) Further investigation of free model-making activities such as the writer's Toy Construction test. This seems to involve modes of creative thinking that are different from those used in paper-and-pencil types of tests.
- (8) Longitudinal studies to trace the development of creative thinking processes as the child grows up. Such studies will also help in setting up external criteria and selecting the best "intermediate" criteria from which to predict different kinds of creative abilities.
- (9) Genetic/environmental studies of creativity aimed at sorting out the differential roles each type of influence plays in the development of creativity.
- (10) Studies of creative thinking as evidenced by even younger children would be very difficult, but very interesting. Special methods of assessment will be necessary.
- (11) Investigation of different cognitive and perceptual approaches to thinking should be done in more detail. People with different

approaches probably require different methods of teaching. This could also be investigated.

(12) What personality attributes are associated with different creative abilities and different modes of thinking? Guilford, Barron and others have made a start on this: much more remains to be done.

IMPLICATIONS FOR EDUCATION:

Studies such as this one are of little value if they have no practical applications and cannot guide us in rearing and educating children and helping adults to attain self-fulfilment.

Rogers sees creativity in this light. He is not the only one - many others see the development and use of creative abilities as vital not only to society and our culture, but to the individual himself if he is to survive in our increasing complex, automated and potentially soul-destroying world ("Soul" used here in the Jungian sense).

Schools have a wonderful opportunity to enhance and advance creative thinking if they are willing to adopt the "creative attitude" and try something new. However, it is not up to the schools alone - this applies in the home, in institutions of higher learning and in all branches of commercial and industrial enterprise as well.

Torrance (120) has set forward three ideas that have come out of his studies of creativity and its application in education:

(1) The concept of the mind has been expanded; educators are becoming aware of the limitations of standard teaching methods and content. A large portion of a person's abilities are being almost totally neglected or even negatively affected. The findings of this study and other studies support this view. In fact, none of the modes of thinking described here are taught or encouraged in schools and yet education should exercise all types of intellectual functioning.

(2) Learning creatively can often be more economical and more effective than learning by authority. This will probably be true for some individuals and not for others. From this we can learn what it means to individualise education.

(3) Creative development is not just a matter of chance but can be aided by such methods as creative problem-solving, brainstorming, synectics and bionics. We cannot accept that the developmental stages in creativity (as found by Torrance) are unchangeable. Some children don't experience discontinuities in their creative development - the curves differ amongst cultures. The assumption is that the behaviours underlying creative processes are basic to learning and therefore may be facilitated by teaching. Thus it is theoretically possible to maximise the environmental conditions conducive to creative thinking in the home, in educational institutions, in industry and in commerce. Creativity is important in eminent individuals in every field, but also to those in more commonplace occupations.

Creativity is important for personality development and in information - acquisition, in the application of knowledge and in vocational success. Teachers are sometimes too eager to transmit accepted knowledge and cut off a child's own ideas and yet creation is often the rediscovery of what others have done before: creative products that are common knowledge to us, may be novel to the child. A teacher should, therefore, not be too critical of a child's ideas: at present there is too much emphasis on "correct" thinking and too little on original thinking. "Imagination is more important than knowledge" (Einstein).

Considering only educational institutions for the moment, what is the status of creativity within them? We have to conclude that for many, many years education has aimed at stockpiling information in pupils and at developing skills (i.e. using the stored information in the "correct" way). Now what about the evaluation of information and the discovery of information for oneself? Present educational methods produce, at best, critics rather than inventors, poets, artists and musicians. Children who have not given in to conformity measures are the lucky ones. They are hampered by the environment, but manage to select worthwhile ideas and concepts.

J. Ciardi has written:

"But where, in what curriculum ever, has there been, or can there be a course in inventiveness - which is to say in creativityCreativity cannot spring from the untaught".

Education has become too much of a tool evaluated in terms of how it will aid in the attainment of vocational goals and not as an end in itself; job opportunities are forever fixed by earlier school performances. This has introduced a false set of values and neglected the innermost needs of the individual. Pupils must be encouraged to learn for the sake of learning and not just to get through an examination, one step nearer the school-leaving level. There is a danger that creativity will suffer the same fate - we must value it for itself and not come to see it merely as another marketable product.

Sir Ronald Gould, General Secretary of the British National Union of teachers, has emphasised that children don't need the "repetitive" type of education that teaches them to do an immediate job. He has said, "we ought to be educating for adaptability - an education which enables them to apply their brains and knowledge to new situations as they arise".

Children should not be allowed to be passive spectators, accepting what the teacher says, learning it by heart and cooing it out of the end of a pen regularly at the end of each year. The "all-eyes-front" technique of learning must be abandoned: children should be encouraged to think critically and constructively and taught how to use their creative gifts. Children need to learn by discovery and experimentation. The evidence of this study is that too much structuring of activities inhibits original thinking. The more information a child is given, the less he is able to think out (or up) for himself and the poorer his original thinking becomes.

It is important to prepare children in specialised areas as well as giving a broad, general education. It is impossible to produce a "balanced, well-rounded" individual. Furthermore, there is a strong case for not developing diversity in all individuals. Years of psychological research as well as many more

years of nothing more than common sense, makes it obvious that not all people are good at or interested in all subjects and skills. Educational methods have largely ignored the implications of this well-known fact, perhaps because educators have been led astray by misinterpretation of the phrase "all people are equal". Equality today too often means "sameness".

We need a change in many areas - changes in children, parents and teachers. And education is certainly not independent of the general national and social atmosphere: we need changes there, too. It will not be easy to introduce these changes. A survey undertaken by Columbia University, U.S.A., showed that it takes fifteen years for a new teaching concept to reach 3% of the nation's (America's) schools and fifty years to reach them all. The huge inertia which accompanies even the slightest change, is more than disheartening - it seems almost futile to try to overcome this and yet it must be done. There is a vicious circle operating here: it must be broken. The types of attitudes which attune people to change and adaptation can be taught as an accompaniment to teaching creatively. Yet we need these attitudes to be able to introduce creative teaching. Furthermore, the personality characteristics of highly creative people leave no doubt that they need a different type of education. But creative education is not only for the highly creative, as Torrance's work on discontinuities in creative performance shows. "The nourishment and exercise of the imagination is the root of true literacy in all from the backward child to the genius". (D. Holbrook - "English for the Rejected"). This is true of all fields of study.

How can teaching methods be altered? A great deal has been surmised about this problem, but just some of the main ideas will be discussed.

Firstly, to cater for highly creative individuals, there are three possible approaches:

1. Acceleration. This has been practised for years. A child who is not challenged enough by the level of the work his age-mates are doing, can be moved up one or more grades. While it is true that not everyone should be forced to "absorb the standard academic

diet in yearly steps", (Henry, 60), there are several drawbacks associated with acceleration. Children need time to think and explore, but in accelerating them, too often their time is completely organised for them with either work or play activities. Accelerated children will be "out of step" developmentally with other children in their classes. They will not be as advanced physically or as emotionally mature. The possible resultant problems are obviously numerous.

2. Enrichment. This could work well, although it would involve quite a bit of organisation and would be difficult for teachers, especially if classes were large.

Children do extra courses and independent research, but in the same classes as less capable children. They do the same work but in much greater depth.

3. Special Grouping. There are two possibilities here:

- (i) Children are streamed in ordinary schools according to their abilities and interests in different subjects. This is being tried in South Africa and, so far, seems successful.
- (ii) Special schools for the more able scholars are run. This means an advanced student learns with other students of roughly equal ability. He is thus not bored or frustrated, but continually challenged in his work. The whole school situation is geared to his needs.

Objections to this system have been that (a) it is too expensive and (b) these children will be "out-of-touch" with the average scholar and will come to think of themselves as "better" than anyone else. This last criticism seems to be no more than sour grapes and the all-too-common distrust and dislike of anyone who is gifted in any way. It can be applied equally to the situation in ordinary schools.

These three ways of altering teaching methods are but the beginning of the changes that could (and must) be involved in teaching creatively.

The heaviest burden falls, of course, on the teachers. Teachers must value creativity and high standards of work, they must accept each child as worthwhile and not be too critical of

him and his ideas. Standards of performance should be set for each child individually according to his potential and not according to the time available, or the teacher's interests. Too often teachers guard knowledge and dispense it in small doses to everyone from the same container. Teachers must emphasise independent thought rather than rote learning and maintain an atmosphere which permits children to express their own ideas. Teachers will have to be specially trained - creatively trained to use their knowledge creatively and to value this kind of approach. This means they themselves must remain open to new experiences and ideas: the unimaginative teacher will take the easy way out, the imaginative one can set the stage for productive thinking.

We especially need a change of heart towards highly creative children: we must not expect too much of them (or too little!), we must not set them on pedestals, we must not neglect their needs or think they're "odd" or a nuisance. Creative children face rejection by friends, parents and teachers and the frustration of restraints, boredom and misunderstanding more than any other type of child. We have many special opportunities and much sympathy for the mentally handicapped and for children with special educational problems - what about the other end of the scale? Gifted children (and this does not mean only highly intelligent children) are just as worthy of special attention. Any effort put into special educational methods for them will be amply rewarded.

Other changes are indicated. One must avoid excess orderliness and the frenzied following of timetables: there is little value in segmenting the day into equal periods and breaking off in the middle of one subject just because a bell has rung. Its only value is ease of organisation. The ideal would be a flexible syllabus without formal subject boundaries.

Beautifully-presented, all-inclusive cook-books of information are another danger. O. Handlin has said, "The assumption of the text book is that learning consists of remembering and the function of the book is to supply material to be remembered". The result is endless imitation.

If students are to continue to learn for examinations and if we want to exercise and measure all types of the more valuable intellectual abilities, then examinations must be redesigned accordingly.

There is too great a gap between students and trained people. Students should come into contact with outstanding, eminent minds.

Sex differences should not be ignored. The sexes have much in common in their methods of and abilities to learn, but not all. Again, "equality" does not mean "sameness".

Lowenfeld (76) has said, "probably the best preparation for creating is creating itself". Children must be given the opportunity and encouragement to exercise this power in art, poetry, prose, music, movement and scientific experimentation. The child who says, "I can't", has had his learning disrupted in some way. Children are taught to conform - group activities and interests are emphasised - yet they must be given time to make choices, use their imaginations, be independent and explore their worlds with their senses. This is hardly a new idea: Plato wrote, "Avoid compulsion and let your children's lessons take the form of play".

All this does not mean all self-disciplining methods and training in basic skills should be disregarded: creative potential must be channelled and guided, but not too formally or rigidly. The advocate of the so-called "permissive" teaching wants to subordinate formal teaching to creative thinking - this would be inimical to both. A balance will have to be found and maintained. To do this, we must distinguish between (a) I.Q. test-type abilities and other intellectual abilities, (the results of this study and other studies have shown that this can be done) (b) independence and rebelliousness, (c) the group and the individual, (d) evaluation and censorship and (e) indecisiveness and tolerance of uncertainty. In introducing new methods, we cannot afford to throw out everything else. Educators must (a) train logical, rational thinking and (b) foster freedom and independent, creative thought. Independence, dissatisfaction and curiosity can remain forever undisciplined and uncontrolled, but too often the opposite occurs - submission, premature closure and imitation. Torrance has stated, "A more creative

kind of education is advocacy not of "fancy frills", but of new ways of achieving education's most cherished goals".

The writer sees the essence of creative teaching in developing a particular attitude of mind. In all his learning, a child develops the capacity to attend, select and perceive rapidly and accurately. As educational methods emphasise rational answers, intelligent reasoning and the regurgitation of "correct" information, children too often give up questioning. They learn the correct answers and "correct" perceptions so that their approach to learning situations is "merely a quick registration of its familiar features according to ready labels" (Schulman, 107). As his perceptual development progresses, the child builds up assumptions about the world which represent the "weighted average" of his past experiences. Thus past experience and motivation determine what and how an individual perceives. Too often this means that the person's environment is "levelled off" so that he neglects to register anything that is unexpected or unusual. Such people get stuck or einge-stellt, sticking to what is expected as long as possible (Bruner and Postman, 11).

This is enhanced by the fact that too much is taught (and learnt) as though it was irrefutably true and complete. There is no room for doubt or ambiguity and no room for wondering. "I don't know" implies loss of face. But knowledge is not "out there", it is gained (or should be gained) as people explore their environments. Thus it is vitally important that people value their own ideas and perceptions and yet remain receptive to new experiences. In this way they are not rendered insensitive to new idea and possibilities.

This can be possible only if the easy, safe, impertinent certainties are rejected. People must be ready for, and open to the unpredictable, the unexpected and the unprecedented. They must be able to say, "It isn't safe to know", instead of, "It isn't safe not to know". They must develop an ability to accept conflict and complexity and the tension that accompanies them. This is the opposite of most educational practices where conflict is minimised. Conflicts need not be harmful, they can be a

source of curiosity and challenge: experience without conflict and doubt is a superficial kind of experience. In removing conflict, doubt and fear, Jonathan Miller says, "we have gone some way to removing, perhaps, the essential features of the creative imagination which in fact rests ultimately on the sense of dread, the sense of mystery, the sense of the uncanny". (The Listener, 63, 21/8, 1970).

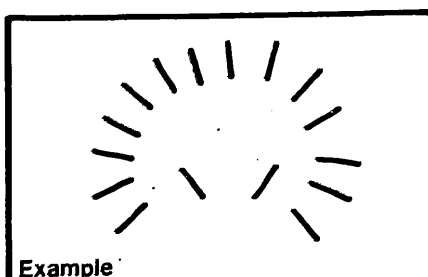
Bertrand Russell, in his "History of Western Philosophy", has written: "Uncertainty, in the presence of vivid hopes and fears, is painful, but must be endured if we wish to live without the support of comforting fairy tales.....To teach how to live without certainty, and yet without being paralysed by hesitation, is perhaps the chief thing that philosophy, in our age, can still do for those who study it".

We must educate for uncertainty.

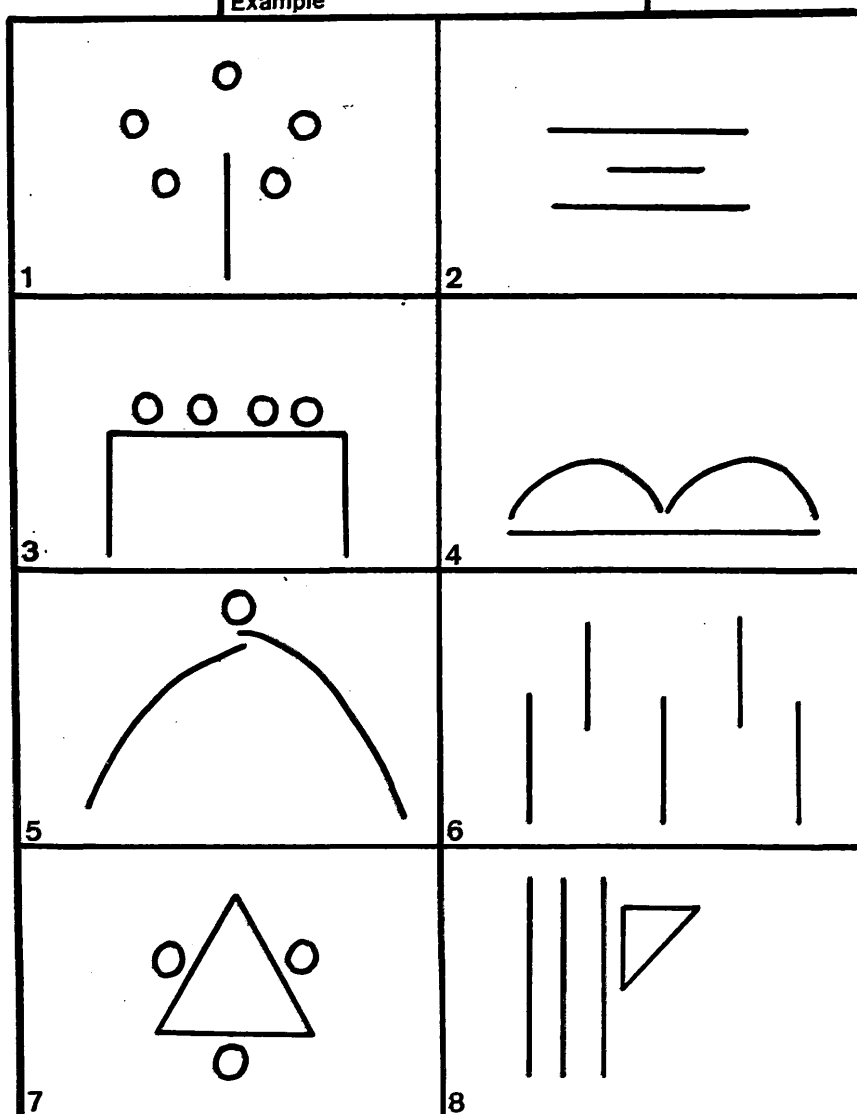
APPENDIX A.TEST MATERIAL.

Tests not included in this appendix (e.g. the Torrance Tests of Creative Thinking) are described in detail in Chapter IV, as well as verbal instructions for all the tests and activities. The appendix includes tests which were dropped from the final set of variables used in the analysis of the results

LINE MEANINGS

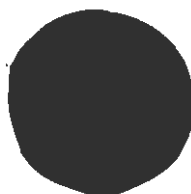


Example



MAKE-A-FIGURE.

The four pieces of cardboard from which the subjects could make any number of objects they wished, were shaped as follows:



INSTANCES.

The 5 items or categories for which the subjects were required to give instances, were:

1. What things move on wheels?
2. What things are round?
3. What things make a noise?
4. What things are white?
5. What things are sharp and silver?

PICTURE PREFERENCEPAIR 1.

A.



B.

PAIR 2.

A.



B.



QUICK RESPONSES.

The 10 words for which the subjects are required to give word associations, were:

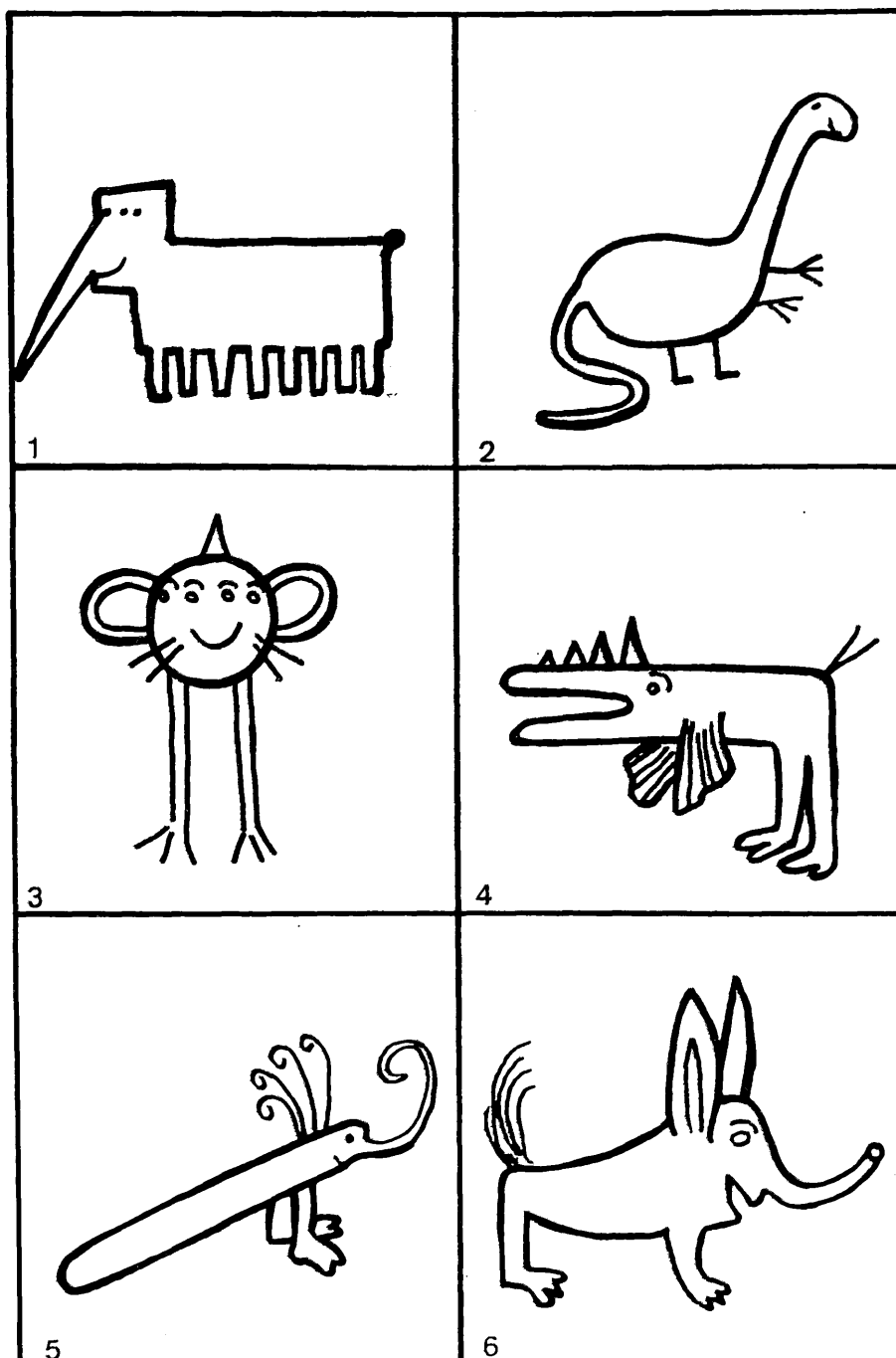
1. house
2. white
3. water
4. apple
5. dance
6. child
7. black
8. bell
9. chair
10. clean

ANIMAL SORTING.

The toy animals the subjects were given to sort into groups, were:

1. calf (lying down)
2. cock
3. cow
4. crocodile
5. dog
6. duck
7. elephant
8. gibbon monkey
9. goat
10. gorilla
11. hen
12. lion
13. hippopotamus
14. horse (lying down)
15. horse (standing)
16. horse (standing)
17. kangaroo (large)
18. kangaroo (small)
19. leopard
20. lion
21. lion cub (sitting)
22. monkey
23. ostrich
24. panda
25. pelican
26. penguin
27. pig (big)
28. pig (small)
29. polar bear
30. reindeer
31. robin
32. sable
33. seal
34. sheep
35. tiger
36. turkey

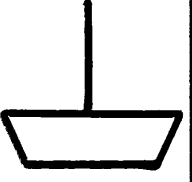
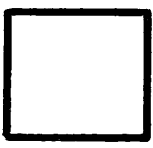
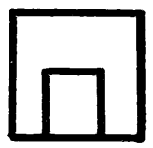
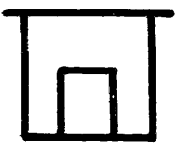
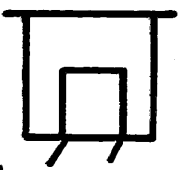
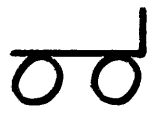
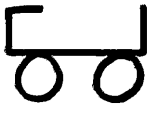
ODD ANIMALS



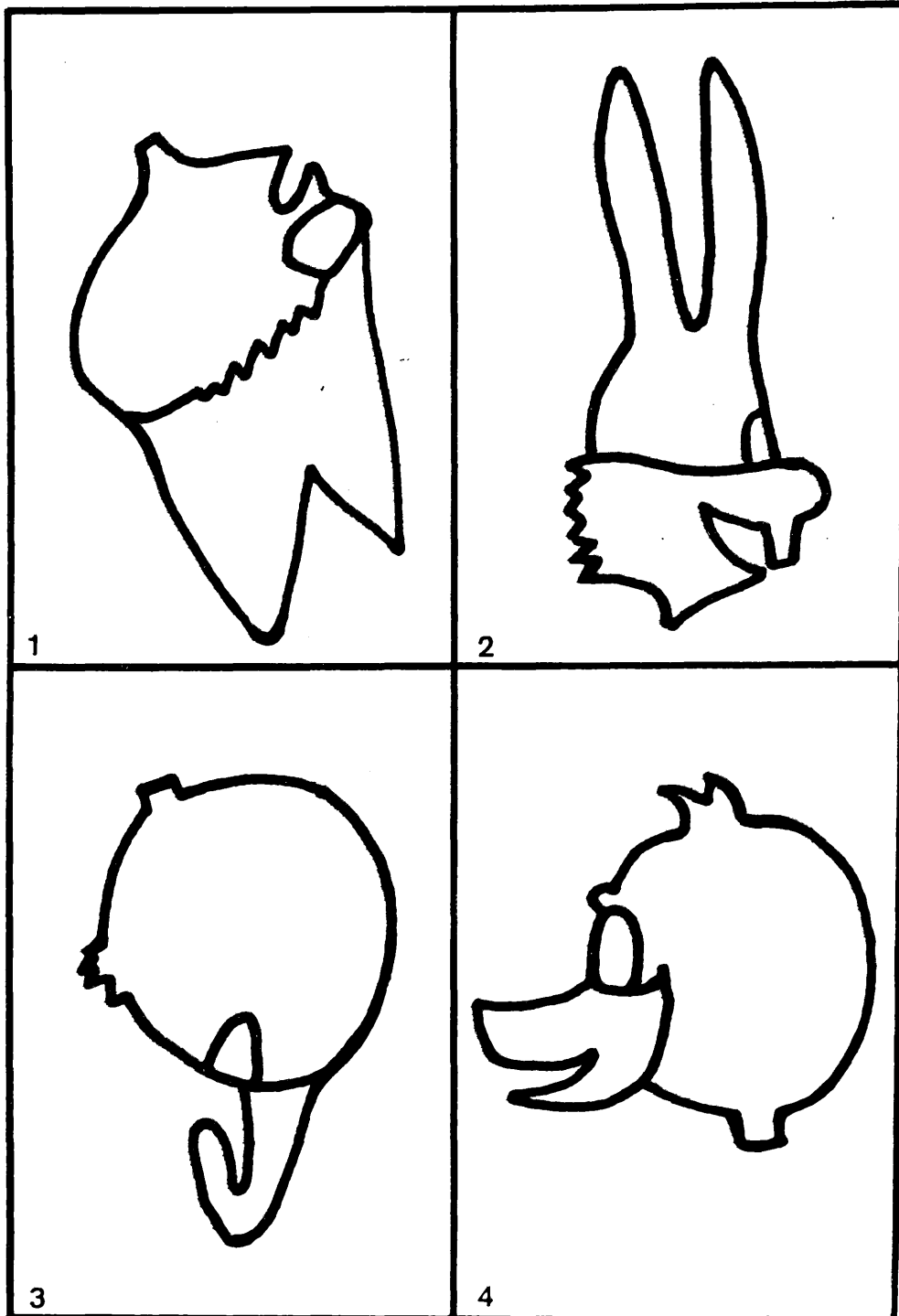
STORIES



STRUCTURED DRAWINGS

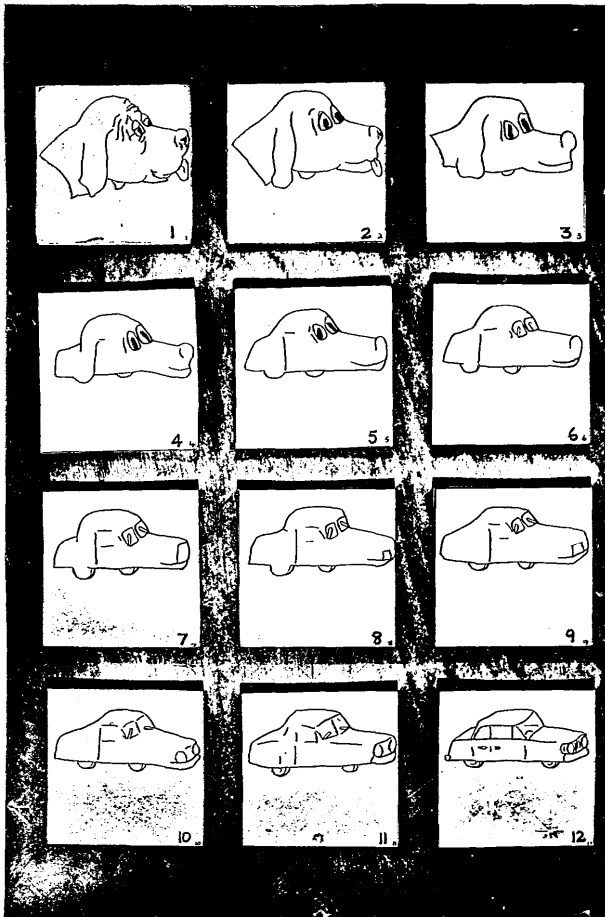
Series 1: BOAT  1	 2	 3	 4
Series 2: PLANE  1	 2	 3	 4
Series 3: HOUSE  1	 2	 3	 4
Series 4: CAR or TRAIN  1	 2	 3	 4

ENCLOSED AREAS

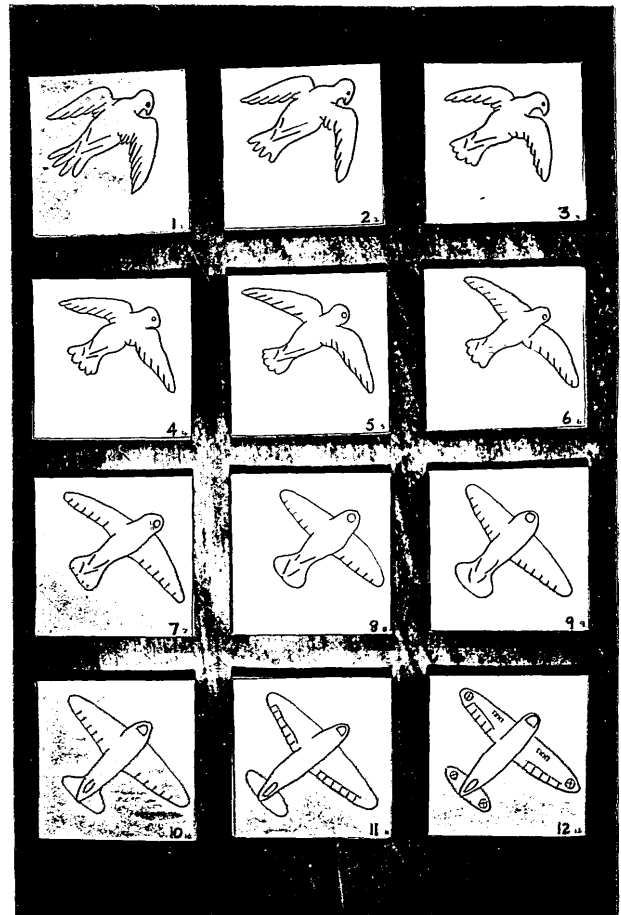


CHANGING FIGURES

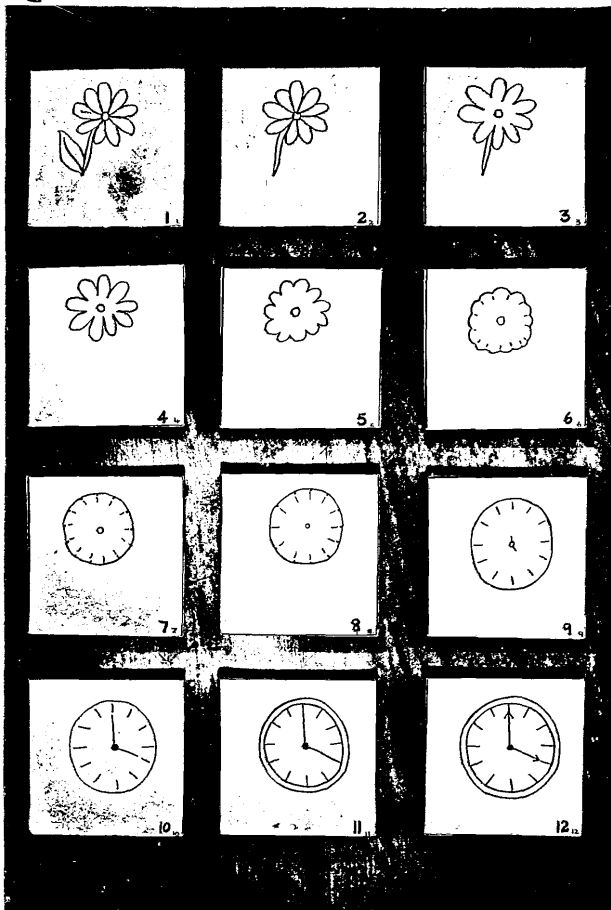
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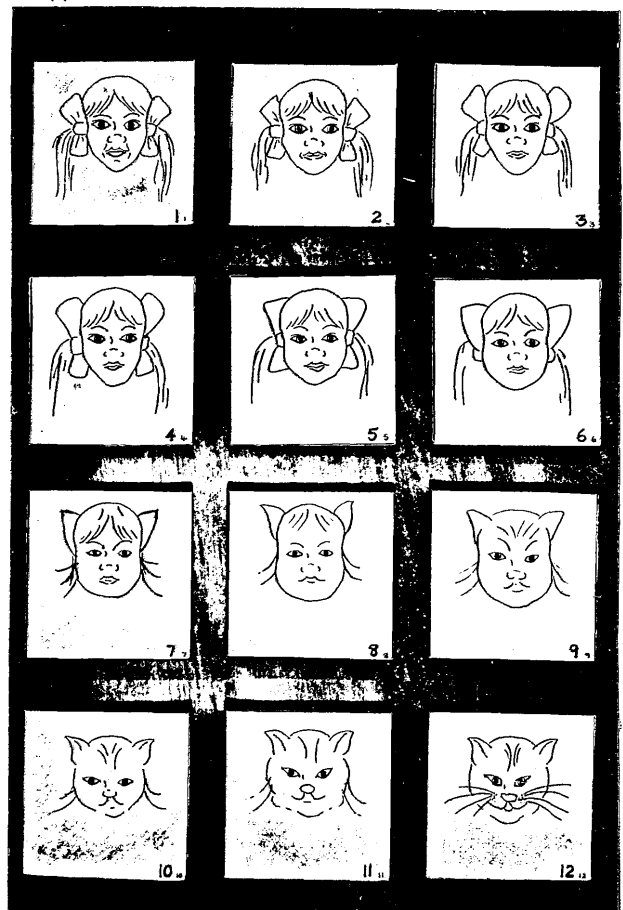
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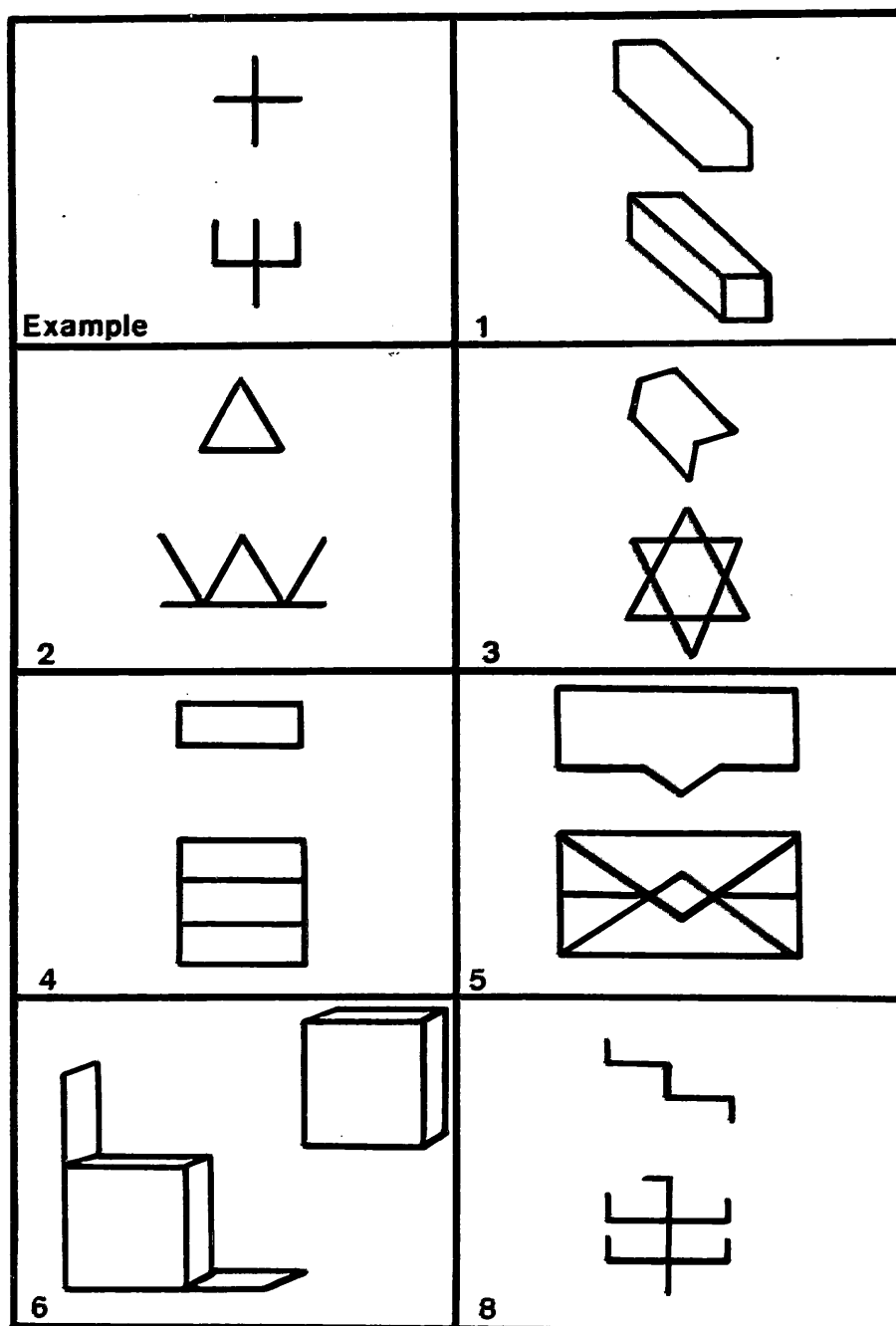
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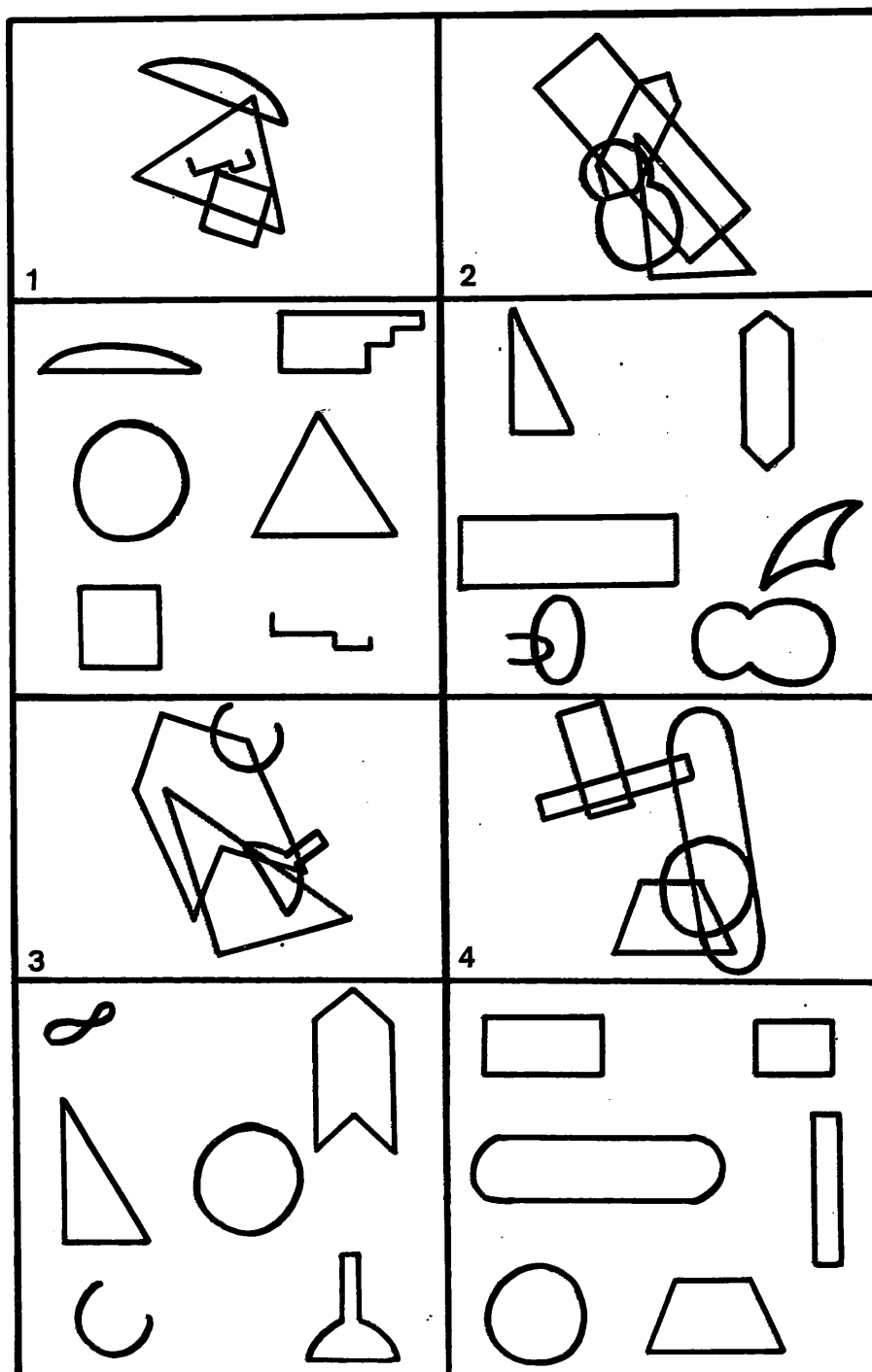
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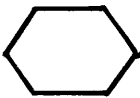
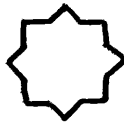
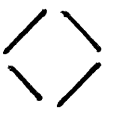
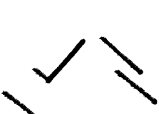
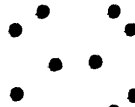
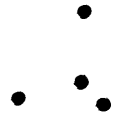
EMBEDDED FIGURES



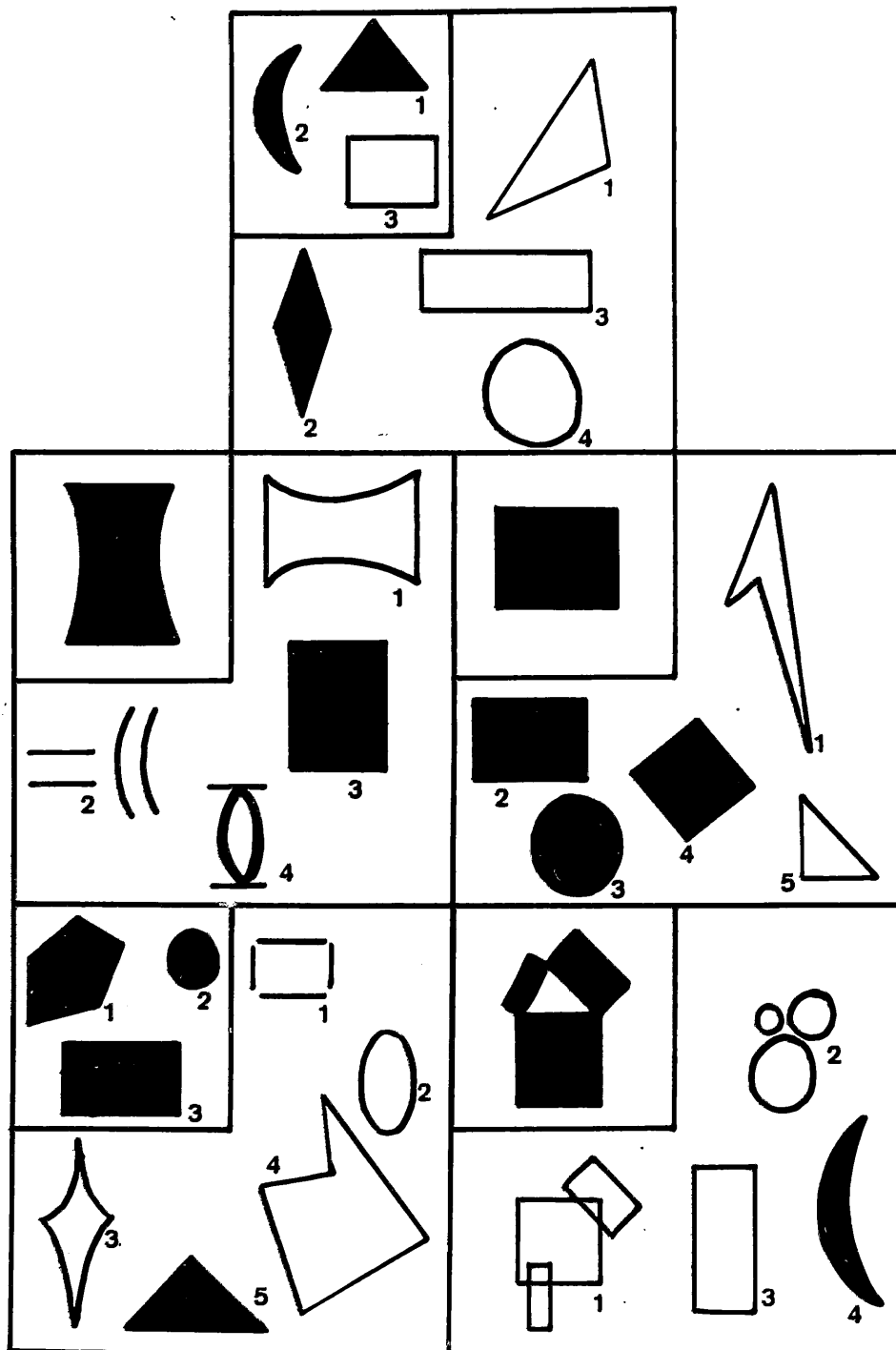
HIDDEN FIGURES



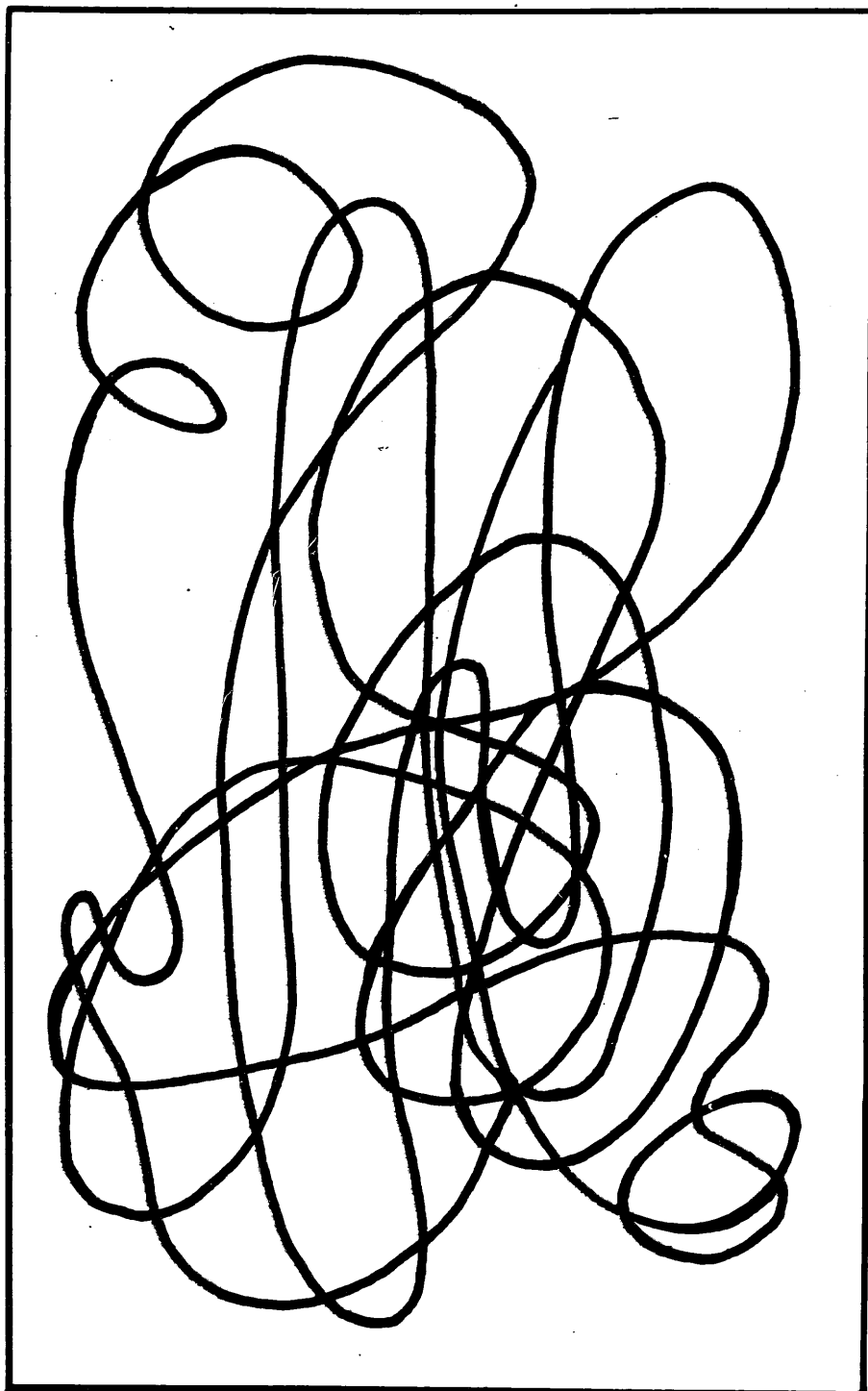
GOOD FIGURES

CAT. 1 closed, symmetrical				
				
CAT. 2 closed, assymetrical				
				
CAT. 3 open, symmetrical				
				
CAT. 4 open, assymetrical				
				
CAT. 5 symmetrical dots				
CAT. 6 assymetrical dots				

FIGURAL SIMILARITIES



SCRIBBLE COLOUR



QUESTIONNAIRE FOR TEACHERS:

Name of Pupil:

Age:

Class:

Residential Address:

Father's Occupation:

Mother's Occupation:

Number of Brothers and Sisters:

Birth Order (1st, 2nd, or 3rd child etc.):

Defects (if any):

Please rate the child on the following question. The rating scale is from 1 to 4, e. g., a rating of 1 would mean "very unoriginal" and a rating of 4 would mean "very original". Draw a circle round the rating you choose.

Originality can be defined as "the ability to produce unusual novel or new ideas in art, in play, or in almost any activity". The very original child has many "out-of-the-ordinary" ideas. To what extent would you say this particular child is original or shows originality?

RATINGS: 1 2 3 4

Thank you for your co-operation.

APPENDIX B.

SCORING GUIDES.

These guides serve only as examples of the scoring methods used because the full guides with all the responses included are too extensive. The flexibility categories are, however, given in full.

Examples of the scoring methods used for the Torrance Tests of Creative Thinking were given in Chapter IV: refer to the scoring guides published by the Personnel Press Co. for detailed marking systems for the Non-verbal and Verbal Torrance Tests.

All the guides to originality scores included in this appendix (except the Quick Responses test) follow the same system as the Torrance tests, responses being divided into groups according to the percentage of individuals giving each particular response.

<u>% of Subjects</u> <u>giving the response</u>	<u>No. of Subjects</u> <u>giving the response</u>	<u>Weighted</u> <u>Orig. Score</u>
5% or more	12+	0
3% to 4.99%	7-11	1
1% to 2.99%	3-6	2
1%	1 or 2	3

As explained in Chapter IV, responses falling in particular originality score groups by virtue of the number of people who gave them, need not have received the appropriate weighted originality score - the actual score obtained depended on the "creative strength" of the response and its relevance to the particular task considered. The statistical frequency of the response is a necessary, but not a sufficient condition for a response to obtain a particular score for originality.

LINE MEANINGS.ORIGINALITY SCORING.

Card No.	O Score	1	2	3	4
1.	tree balls & stick line & spots	(25) bubble pipe (30) sucker (1)	(9) balls & (7) golf club hammer path & pole	(4) frying pan (4) parachuters & (3) road (2) teaspoon	(1) (1) (1)
2.	door pattern road	(33) gate (2) race track (60) boat	(8) drawer (3) river (7) sledge	(4) car elevator (3) mouth & tongue (3) sand & crack	(1) (1) (1)
3.	balls & table car square with spots	(21) coal truck (36) trolley (1) T.V.	(7) battery (10) bubbles & bath (7) oven	(5) cliff & boulders (2) tennis (3) wash line & pegs	(1) (2) (1)
4.	B eyes hills	(40) hills & road (16) ice-creams (12) sand heaps	(8) caves (7) haystacks (2) umbrellas	(2) frog jumps (4) Loch Ness Monster (4) pimples	(1) (1) (1)
5.	castle rain steps	(13) bullets (21) spears (30) trees	(10) cake (8) grass (10) nails	(~) fish swimming (4) cracks in the ground (3) money boxes	(1) (1) (2)
6.	ball & hill cake & cherry rock	(49) bell (15) cup (6) snowman	(6) igloo (8) necklace (3) tea-cosy	(4) fish mouth & bubble (3) pliers (4) snooker game	(1) (1) (1)
7.	face hat triangle & snow	(21) rocket (17) balls & hat (1) clown	(11) chimney (9) kite (4) rocket & stars	(2) level measure (2) pudding & tickeys (3) snooker	(1) (1) (1)
8.	boat & sea railway pattern	(52) flag (22) car & road (4) roof & arrows	(8) chair (6) mast & sail (1) P	(3) cable car (4) curtain & toes (2) iron & ironing board	(1) (1) (1)

FLEXIBILITY CATEGORY NUMBERS:

1. Accessories:	glasses, necklace.
2. Animals:	dog, horse.
3. Animals (parts of):	tail, paw.
4. Buildings:	castle, jail.
5. Buildings (parts of):	steps, door.
6. Celestial Bodies:	sun, planet.
7. Clothing:	shoes, hat.
8. Constructions:	bridge, tunnel.
9. Containers:	bottle, case.
10. Design:	pattern, line.
11. Eating Utensils:	knife, spoon.
12. Entertainment:	circus.
13. Fantasy:	fairy, giant head.
14. Fruit:	apples, berries.
15. Food:	cake, ice-cream.
16. Furniture:	bed, table.
17. Geography:	hill, island.
18. Household Items:	light, keyhole.
19. Household Tools:	needle, scissors.
20. Human:	man, girl.
21. Human (parts of):	eyes, hair.
22. Insects:	bee, mosquito.
23. Letters:	M, I, P, O.
24. Machines:	T.V., washing machine.
25. Musical Instrument:	drum, guitar.
26. Natural Phenomena:	fire, rain.
27. Optical Instruments:	binoculars.
28. Plants:	tree, flower.
29. Raw Materials:	wood, metal.
30. Recreation:	balls, trampoline.
31. School Equipment:	ruler, book.
32. Shelters:	kennel, antholes.
33. Signs:	robot, road sign.
34. Stationery:	postcard, paper.
35. Sweets:	candy floss, toffee apple.
36. Symbols:	flag, badge.
37. Symbols (math.):	equals, plus.
38. Tools:	saw, drill.
39. Toys:	golliwog, doll.
40. Transport - Air:	plane, rocket.
41. Transport - Land:	car, train.
42. Transport - Water:	boat, raft.
43. Transport Ways:	road, rails.
44. Water:	sea, dam.
45. Weapons:	gun, arrow.
46. Writing Utensils:	pen, crayon.

FLUENCY SCORING:

Fluency score is the number of relevant responses given in the whole test. Repetitions are not counted.

LINE MEANINGS.FORM SCORING:

CARD NO.	0	1	2	3
1	bed box car E	arrow chopper fence spear	apple clock dots & 1 notice	candle flower sucker tree
2	arrow clock face web	bone car chair roof	bed top drum fence river	board drawer lines road
3	book door monkey	bed bicycle mat rocket	bridge oven robot table	cake caravan radio wagon
4	box door face tin	balloons cart pool river	bread bridge collar M	bird hills igloos jellies
5	axe bucket paper sky	box fire mat missile	boat ladder people rulers	castle ll, ll, 1 fence grass
6	animal book coat plate	bear car circle flower	bird cup ditch drain	hat lid man pudding
7	box curtain knife	arrow biscuit fort jet	bell cheese kite lamp	billiards face hat pattern
8	planet tricycle tunnel	balcony fish jet window	cable car chair P spade	bed boat chopper flag

MAKE-A-FIGURE.ORIGINALITY SCORING:O SCORE:

0	1	2	3
arrow (41)	bird (7)	bird house (3)	camera (2)
bat (41)	bus stop (3)	chair (3)	can opener (1)
clown (32)	church (8)	helicopter (3)	funnel (1)
house (149)	coach (2)	seal & ball (5)	hole (1)
man (99)	"I" (9)	trampoline (3)	paint brush (1)
plane (56)	van (2)	windmill (3)	teapot (1)
robot (22)	door (7)	top (1)	toadstool (1)
tree (28)		scales (5)	water-pump (1)

FLEXIBILITY CATEGORY NUMBERS:

1. Accessories:	watch, ring.
2. Animals:	dog, bird.
3. Buildings:	house, church.
4. Construction:	stile, gate.
5. Containers:	box, bottle.
6. Decorations:	
7. Design:	circle, square.
8. Fireworks:	squib, cracker.
9. Food:	cheese, bread.
10. Fruit:	apple, grape.
11. Furniture:	bed, table.
12. Accessories (Garden):	wheelbarrow, mower.
13. Household Articles:	broom, can opener.
14. Houses (parts of):	door, light.
15. Human:	lady, man.
16. Human (parts of):	arm, eye.
17. Insects:	mosquito, fly.
18. Instruments:	drum, guitar.
19. Letters:	A, O, P, K.
20. Machines:	grader, pump.
21. Nature:	sky, ground.
22. Plants:	acorn, toadstool.
23. Signs:	bus stop, robot.
24. Sweets:	lollipop, candy floss.
25. Symbols:	cross, plus.
26. Tools:	axe, chopper.
27. Toys:	block, top.
28. Transport:	car, plane.
29. Weapons:	arrow, cannon.

FLUENCY SCORING:

Number of relevant responses: exact repetitions are not counted.

RORSCHACH INKBLOTS.ORIGINALITY SCORE:

O SCORE:	0	1	2	3
Card				
No.				
1.	bat (40) cloud (25) face (15) plane (15)	bridge (10) crab (9) house (7) mask (8)	crown (5) island (7) leaves (3) men flying (3)	bellows (1) ice (1) sea & oil (1) watermark (1)
2.	blood (16) butterfly (32) elephants (13) fire (33)	cat's head (9) clouds (8) rockets (11) tunnel (7)	bombed place (3) burst tomato (3) hole (3) socks (4)	battle (1) clothes (1) bruises (1) candle in the dark (1) drought area (1)
3.	animals (32) butterfly (14) lizards (7) tree (15)	boat (7) face (8) inside (7) a man (8) map (8)	badge (4) fountain (3) heart (3) sea (3)	icing (1) marshmallow (1) pipe (1) with water (1) volcano (1)
4.	bird (21) crabs (54) rabbit (35) spiders (89)	bone (7) mice (8) rocks (9) spider (10) web (10)	fireworks (3) pliers (5) seasand (4) stars (4)	acids burning (1) ground (1) bottle (1) opener (1) cowboy legs (1) injection (1) needle & arm (1)

FLEXIBILITY CATEGORY NUMBERS:

1. Art:	church picture.
2. Accessories:	necklace, brooch.
3. Animals:	crab, fox.
4. Animals (part of):	feet, paw.
5. Animal Shelters:	nest, kennel.
6. Biology:	vein, lungs.
7. Buildings:	flat, roof.
8. Celestial Bodies:	star, sun.
9. Clothes:	dress, coat.
10. Construction:	tunnel, bridge.
11. Containers:	glass, cup.
12. Designs:	triangle, dots.
13. Fantasy:	devil, Batman.
14. Food:	ice-cream, vegetables.
15. Furniture:	chair, table.
16. Geography:	volcano, island.
17. Home Tools:	scissors, hooks.
18. Household Items:	broom, curtain.
19. Humans:	chest, arm.
20. Humans (parts of):	baby, man.
21. Insects:	ant, spider.
22. Letters:	A.
23. Machines:	T.V.
24. Minerals:	diamond, stones.
25. Monuments:	statue.
26. Nature:	cloud, ice.
27. Plants:	flower, bush.
28. Recreation:	fishing rod.
29. Symbols:	crown, badge.
30. Tools:	chopper, drill.
31. Toys:	ball, balloon.
32. Transport - Air:	jet, spaceship.
33. Transport - Land:	car, train.
34. Transport - Sea:	canoe, boat.
35. Water:	lake, river.
36. Weapons:	arrow, gun.
37. Weather:	rain, sunshine.
38. Writing Utensils:	ink, pencils.
39. Roadways:	path, road.

FLUENCY SCORING:

Total number of responses given.

INSTANCES.ORIGINALITY SCORING:

No.		O SCORE	
1.	bicycle	(127)	bulldozer (7)
			animal. (4)
			cages (1)
move	car	(220)	fire-engine (7)
on	plane	(53)	grader (3)
wheels	wheelbarrow	(23)	piano (5)
2.	ball	(15)	crane (2)
round	clock	(19)	gates (1)
	lights	(26)	grass spray (1)
			dog collar (1)
			phone dial (2)
			mealie (1)
			stalk
	wheels	(127)	plate (7)
3.	dog	(46)	wooden leg (3)
			bee (8)
			baby (5)
			coathanger (1)
			squeak
make	lorry	(35)	cutting (1)
			bread
a	screaming	(16)	gun (9)
noise	wind	(13)	fireworks (3)
4.	crayon	(19)	thunder (3)
white	paper	(135)	shell (1)
	shirt	(23)	fibres glass (1)
	all	(45)	ghost (1)
			mist (1)
5.	fork	(32)	piano keys (1)
sharp	knife	(179)	compass (1)
and	razor blade	(23)	money (8)
silver	tin	(15)	crown point (1)
			mirror (2)
			scrowdriver (1)

FLEXIBILITY CATEGORY NUMBER:1 - WHEELS:

1.	Air Transport:	jet, glider.
2.	Furniture (Baby's):	cot, pram.
3.	Furniture (Hospital):	wheelchair.
4.	Furniture (House):	piano, trolley.
5.	Garden Items:	gates, spray.
6.	Games:	roller skates.
7.	Rail Transport:	diccel coach.
8.	Road Transport (Animal):	wagon, chariot.
9.	Road Transport (Army):	tank, cannon.
10.	Road Transport (With Cars):	caravans, trailer.
11.	Road Transport (Business):	petrol lorry, watercart.
12.	Road Transport (2 Wheels):	barrow, ice cream cart.
13.	Road Transport:	car, van.
14.	Road Transport (Racing):	drag, go-kart.
15.	Road Transport (Roads):	grader, tractor.
16.	Road Transport (2 Wheels):	scooter, bicycle.
17.	Road Transport (Special):	bus, fire engine.
18.	Tools:	painter's brush.
19.	Toy Transport:	pedal car, dinky.
20.	Toys:	animal, space explorer.

2 - ROUND:

1. Animal:	face, body.
2. Balls:	soccer, wool.
3. Building:	hut.
4. Clothing:	bonnet, cap.
5. Containers:	tin, jar.
6. Covers:	lid, cork.
7. Design:	circle, dot.
8. Food:	cake, sweets.
9. Fruit:	apple.
10. Fun Fair:	roundabout.
11. Furniture:	stool, table.
12. Garden:	hose, flowerpot.
13. Geographic:	hole, stones.
14. Hardware:	screws, pipe.
15. Heavenly Bodies:	moon, planet.
16. Household Articles:	ashtray, clock.
17. Household Items:	plug, tap.
18. Houses (parts of):	window.
19. Human:	finger, eye.
20. Instrument:	drum, trumpet.
21. Kitchen Articles:	teapot, frying-pan.
22. Letters:	O, B.
23. Numbers:	O.
24. Ornaments:	watch, ring.
25. Paper:	roll of paper.
26. Plants:	tree, flower.
27. Tableware:	plate, glass.
28. Toys:	balloon, marble.
29. Transport:	flying saucer, boat.
30. Wheels:	plane, piano.
31. Writing Utensils:	pen, crayon.

3 - NOISE:

1. Animal:	frog, seal.
2. Animal (Other):	drinking.
3. Bells:	bell, doorbell.
4. Birds:	eagle, owl.
5. Breaking:	house, plate.
6. Clashing:	tin and stone.
7. Dropping:	plate, brick.
8. Electrical Gadgets:	radio, T.V.
9. Falling:	brick, book.
10. Food:	eating, cutting bread.
11. Household Items:	clock, kettle.
12. Household Items (Moving):	chair, door.
13. Human:	talking, shouting.
14. Human (Other):	clapping, running.
15. Insects:	cricket, bee.
16. Machines:	pump, lawnmower.
17. Musical:	clappers, band.
18. Nature:	wind, thunder.
19. Road Machines:	cement mixer, grader.
20. Shutting:	box, door.
21. Squeaking:	chair, shoes.
22. Tableware:	cup and saucer.
23. Tools:	hammer, saw.
24. Toys:	doll, rattle.
25. Toys (Playing):	catapult, ball.
26. Transport:	car, jet.
27. Transport (Special):	fire engine.
28. Water:	dive, splash.
29. Weapons:	bombs, gun.

4 - WHITE:

1. Accessories:	glasses, badge.
2. Animals:	cat, fur.
3. Buildings:	castle, shop.
4. Celestial Objects:	moon, star.
5. Clothing:	buttons, socks.
6. Containers:	box.
7. Food:	egg, salt.
8. Furniture:	chair, table.
9. House (parts of):	door, ceiling:
10. Household Articles:	knob, light.
11. Humans:	people, hair.
12. Insects:	beetles, ants.
13. Linens:	sheet, towel.
14. Nature:	ice, smoke.
15. Paper Products:	parcel, book.
16. Plants:	flowers, roots.
17. Sewing:	wool, cotton.
18. Tableware:	dish, jug.
19. Toys:	kite, block.
20. Transport:	cart, ambulance.
21. Writing Utensils:	chalk, crayon.

5 - SHARP AND SILVER:

1. Accessories:	brooch, badge.
2. Aircraft:	propeller, rocket point.
3. Buildings:	steeple, spire.
4. Clothing:	crown point, shoes.
5. Containers:	case, clasp, tin.
6. Eating Utensils:	knife, fork.
7. Garden Utensils:	axe, spade.
8. Household Articles:	ashtray, bell.
9. Household Items:	key, tap.
10. Instruments:	compass point, clock point.
11. Machines:	lawnmower, blades.
12. Metals:	iron, rock.
13. Office Equipment:	drawing pin, sharpener.
14. Sewing Utensils:	pin, scissors.
15. Hardware:	pipe, nails.
16. Tools:	pliers, drill.
17. Toys:	flying saucer.
18. Transport:	boat point, bumper.
19. Weapons:	dagger, spear.
20. Writing Utensils:	pen, pencil.

FLUENCY SCORING:

The fluency score is the total number of relevant responses for all 5 categories: repetitions are not counted.

QUICK RESPONSES."REMOTENESS" SCORING, "R":

	1	2	3
"R"	HOUSE	WHITE	WATER
0	high, horse.	why, white.	bought, caught.
1	live, door.	black, paint.	drink, tap.
2	chimney, paint.	cat, car.	swim, blue.
3	family, grass.	hand, draw.	boats, kettle.
4	shed, caravan.	rod, picture.	hosepipe, play.
5	fire, neighbour.	candle, reindeer.	drain, mud.
6	high tea, earn a living.	different.	melon, windmill.

	4	5	6
"R"	APPLE	DANCE	CHILD
0	ant, acorn.	day, dartboard.	chair.
1	eat, fruit.	branch, dancing.	baby, children.
2	banana, tree.	feet, grown-up.	big, play.
3	juice, sour.	can't, pretty.	body, growing.
4	flower, pie.	fun, happiness.	name, family.
5	circle, pip.	drink, stop.	noise, come here.
6	coat, knife.	silk, make angry.	dog, teddy.

	7	8
"R"	BLACK	BELL
0	back, box.	ball, build.
1	paint, white.	ring, bells.
2	blue, cat.	play, school.
3	carpet, table.	house, table.
4	clock, flower.	band, metal.
5	mud, rat.	paper, rope.
6	i can't see, Germans.	death, money.

	9	10
"R"	CHAIR	CLEAN
0	church.	key, ting-a-ling.
1	sit, table.	wash, dirty.
2	desk, house.	broom, tidy.
3	children, wood.	door, knee.
4	old, material.	good, help.
5	tea, rest.	eating, smell.
6	be careful, key,	horrible, visitors.

BLOCK SORTING.ORIGINALITY SCORING:O SCORE:

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
shape & size e.g. small & square (200)	size e.g. big (2)	colour combinations e.g. red & blue (1)	5-sided (1) 8-sided (1)
shape (100) e.g. square		number of sides e.g. 9-sided (2)	fat (1)
colour e.g. blue (100)		shape and colour e.g. green & square (3)	flat (1) can rock (1) wooden (1)
4-sided (28)			

FLEXIBILITY CATEGORY NUMBERS:

- | | |
|----------------------|----------------------|
| 1. Colour: | red, green. |
| 2. Shape: | round, rectangular. |
| 3. Shape and Colour: | square and blue. |
| 4. Shape and Size: | hexagonal and small. |
| 5. Sides: | 4-sided, 3-sided. |
| 6. Size: | big, small. |

FLUENCY SCORING:

Total number of groups thought of by the subject.

ANIMAL SORTING.ORIGINALITY SCORING:

O SCORE: 1		2	3	4
bears	(116)	big	(6)	climb (4)
cat family	(132)	black	(12)	fat (3)
cows	(132)	grey	(10)	game reserve (2)
bucks	(80)	same size	(6)	give milk (5)
farm birds	(43)	small	(4)	hooves (3)
monkey	(174)	wild	(5)	teeth (1)
				birds that (2)
				can't fly
				carry people (1)
				circus (1)
				eat people (2)
				pull carts (1)
				messy (1)

FLEXIBILITY CATEGORY NUMBERS:

- | | |
|-----------------------------------|-------------------------|
| 1. Animals, same type: | camels, kangaroos. |
| 2. Body (parts of): | horns, wings. |
| 3. Characteristics (physical): | sitting, same size. |
| 4. Characteristics (personality): | tame, dangerous. |
| 5. Colour: | white, brown. |
| 6. Family: | mammals, cat family. |
| 7. Living Habits: | jump, eat people. |
| 8. Habitat: | sea, trees. |
| 9. Uses: | hold balls, pull carts. |
| 10. Material: | plastic, steel. |

FLUENCY SCORING:

Total number of groups thought of by the subject.

MOSAICS.ORIGINALITY SCORING:BLACK AND WHITE SQUARES:

O	SCORE:	1	2	3	4		
blocks	(1)	bricks	(1)	bird	(1)	crossword	(1)
carpet	(2)	castl.	(2)	chessboard	(2)	cloud & moon	(1)
floor	(13)	face	(4)	draughtboard	(3)	lights &	(1)
tiles						darkness	
house	(26)	stairs	(4)	T.V.	(1)		

COLOURED SQUARES:O SCORE:

	1	2	3	4
blocks	(4)	bricks (4)	crocodile & (1)	lighthouse (1)
			water	& water
floor	(6)	face (1)	fire place (1)	Guy Fawkes (1)
man	(5)	flower (1)	garden (1)	snakes & (1)
				ladders
wall	(9)	road (3)		

NUMBER OF PIECES:

The number of squares used for the black and white mosaics and coloured mosaics are counted.

ODD ANIMALS.ORIGINALITY SCORING AND FLEXIBILITY CATEGORIES.CATEGORY:

<u>A. NAME OF ANIMALS:</u>		<u>O SCORE</u>
1. Known Animal Names:	e.g. elephant, cow, ant.	0
2. Anthropomorphism & Pet Names:	e.g. Lucy, Mr. Elephant, Bonzo.	1
3. Known Fantasy Names:	e.g. Mickey Mouse, Spock, Popeye.	2
4. Description:	e.g. Mr. Long Legs, Flapperpoint, Who Mouse	3
5. Fantasy Names:	e.g. Sponk, Badu, Gamo.	4

B. DIET:

1. Expected from animal's name:	e.g. grass, leaves, fish.	0
2. Human Food:	e.g. sweets, sandwiches, peas and meat.	1
3. Unexpected, unusual:	e.g. electricity, pegs, clouds, nails.	2

C. HABITAT:

1. Expected from animal's name or from some animal:	e.g. trees, bush, forest.	0
2. Human dwelling:	e.g. house, castle.	1
3. Unexpected, unusual:	e.g. Mercury, a suitcase, very old shoes.	2

TOY CONSTRUCTION.ORIGINALITY SCORING:

0 SCORE: 0		1	2	3			
plane	(19)	arch	(2)	airport	(2)	anemometer	(1)
bridge	(15)	boat	(7)	customs barrier	(2)	atom bomb	(2)
cannons	(18)	fishing rod	(10)	Guy Fawkes	(1)	orange juice	(1)
design	(3)	lights	(6)	mine	(4)	machine	
guns	(18)	tent	(1)	radio	(2)	sewerage	(1)
trees	(13)	tower	(10)	spaceship	(1)		
				and man			
ball	(3)	washline	(4)	weights	(1)		

FLEXIBILITY CATEGORY NUMBERS:

1. Accessories:	bangle, necklace.
2. Air Transport:	jet, spaceship.
3. Animals:	cat, snail.
4. Buildings:	fort, palace.
5. Buildings (parts of):	roof, pole.
6. Constructions:	bridge, arch.
7. Containers:	glass, box.
8. Design:	pattern.
9. Enterprises:	airport, dairy.
10. Fantasy:	Darlek, robot.
11. Furniture:	bed, chair.
12. Gadgets:	radio, T.V.
13. Geography:	hill, rock.
14. Household Items:	light, bell.
15. Humans:	baby, lady.
16. Insects:	spider, caterpillar.
17. Machines:	orange juice machine.
18. Plants:	tree, flower.
19. Recreation:	hurdle, fishing rod.
20. Road Transport:	lorry, cart.
21. Tools:	hammer.
22. Toys:	ball, game.
23. Water Transport:	ship, submarine.
24. Weapons:	bow and arrow, cannons.

NUMBER OF ARTICLES:

The total number of articles used are counted, e.g. 1 block,
2 bits of plasticine, string, 2 hairpins, 1 bead = 7 articles.

STRUCTURED DRAWINGS.ORIGINALITY SCORING:SERIES 1 - BOAT.

O SCORE: 0 1 2 3

PAGE

1	boat	(58)	box	(3)	flowerpot	(2)	bar & acrobat	(1)
	house	(36)	plane	(6)	raft	(1)	blade	(1)
2	boat	(125)	house	(1)	helicopter	(1)	pudding	(1)
	bath	(12)	box	(2)	spaceship	(1)	trampoline	(1)
3	boat	(130)	bath	(7)	crown	(1)	wall	(1)
	pattern	(1)	house	(7)	face	(1)	bar of chocolate	(1)
4	boat	(209)	bath	(1)	ice-cream	(1)	birdcage	(1)
	motorboat	(1)	house	(2)	tree	(1)	broom	(1)

SERIES 2 - PLANE.

1	box	(12)	car	(7)	equals	(3)	hammock	(1)
	plane	(17)	train	(8)	ladder	(5)	teeth	(1)
2	pattern	(1)	house	(6)	bottle	(4)	pill	(1)
	plane	(89)	magnet	(8)	sausage	(2)	test tube	(1)
3	plane	(155)	car	(3)	bed	(4)	escalators	(1)
	square	(1)	boat	(6)	fish	(3)	drill	(1)
4	plane	(170)	car	(5)	bag	(1)	paper punch	(1)
	stripes	(1)	helicopter	(6)	submarine	(5)	washing machine	(1)

STRUCTURED DRAWINGS.SERIES 3 - HOUSE.

<u>PAGE</u>	<u>0</u>	<u>1</u>	<u>2</u>	<u>3</u>
1	house (89) T.V. (15)	picture (8) clock (3)	gate (1) parcel (4)	gunsights (1) hypnotiser (1)
2	house (109) box (1)	fire (7) hotel (1)	shelf (1) coffin (1)	goals (1) tunnels (1)
3	house (167) flat (4)	office (1) station (3)	fire (5) steps (1)	goals (1) mousetrap (1)
4	house (164) shed (1)	shop (2) hospital (1)	fire (2) passage (1)	phone (1) candle (1)

SERIES 4 - CAR/TRAIN.PAGE

1	car (48) glass (22)	train (8) cart (4)	mats (1) pram (3)	butterfly (1) scissors (1)
2	car (49) train (14)	eyes (2) trolley (5)	people (1) wheel - (1) barrow	cabbages (1) in garden log trap (1)
3	car (68) train (11)	house (8) trolley (3)	mirrors (1) bomb (2)	water (1) pump coal (1) machine
4	car (91) train (45)	go-kart (3) trolley (4)	cot (2) mirrors (1)	power (1) station

FLEXIBILITY CATEGORY NUMBERS - for all 4 Series:

1. Accessories:	ring, brooch.
2. Animal:	dog, horse.
3. Animal (parts of):	paw.
4. Animal Enclosures:	bird cage, kennel.
5. Buildings:	castle, hut.
6. Buildings (parts of):	porch, window.
7. Clothing:	hat, umbrella.
8. Construction:	bridge, tunnel.
9. Containers:	pot, bottle.
10. Design:	pattern.
11. Fantasy:	giant, house-eater.
12. Food:	sausage, cake.
13. Furniture:	throne, table.
14. Games:	number game.
15. Garden Utensils:	flowerpot, roller.
16. Geography:	field, cave.
17. Household Items:	light.
18. Human:	man, nurse.
19. Human (parts of):	face, foot.
20. Insects:	butterfly.
21. Machines:	T.V., washing machine.
22. Medical:	pill, thermometer.
23. Musical Instruments:	trumpet, drum.
24. Nature:	fire, cloud.
25. Numbers:	one.
26. Optical Instruments:	binoculars.
27. Plants:	stalk, tree.
28. Playground:	slide, seesaw.
29. School Equipment:	ruler, lines.
30. Symbols:	flag, crown.
31. Symbols (Maths):	plus, times.
32. Tableware:	fork, cup.
33. Tools:	chopper, drill.
34. Toys:	ball.
35. Transport - Air:	rocket, jet.
36. Transport - Land:	car, cart.
37. Transport - Sea:	canoe, boat.
38. Weapons:	gun, bow and arrow.
39. Writing Utensils:	pencil, crayon.
40. Celestial Bodies:	sun, star.

ELABORATION SCORING:

One point is given for each detail added to the stimulus figure or to the space surrounding it. This includes shading, decorations, additional objects and each detail added, though repetitions of details are not counted separately, i.e. if insect legs are added to a stimulus line, that would be one elaboration point, not one point for each leg.

PERCEPTUAL QUALITIES.CODE NUMBERSNAME

1	3-dimensional, depth responses.
2	Incongruity: bizarre juxtapositions of objects.
3	Omissions: interpretation of only part of a
4	Panorama, stimulus.
4	Panorama, vista responses.
5	Rearrangement of stimulus lines.
6	Repetition of responses.
7	View from above.
8	View from the back.
9	View from underneath.
10	View from the front.
11	View from the side.
12	Movement responses: e.g. dancing, jumping.

STORIES CATEGORIES.CATEGORYNAME

A	Destruction: killing.
B	Irrelevant: not close to picture.
C	Incoherent: story does not follow.
D	Humour.
E	"T.V." type and fairy stories.
F	Failure to produce any story at all.
G	Description of picture.
H	Violence: fighting, breaking.
J	Discontinuity: one and two-word sentences.

GOOD FIGURES CATEGORIES.CATEGORYNAME

1	closed, symmetrical figures.
2	closed, asymmetrical figures.
3	open, symmetrical figures.
4	open, asymmetrical figures.
5	symmetrical dot figures.
6	asymmetrical dot figures.

OCCUPATIONS.

<u>RANK</u>	<u>GROUP</u>	<u>EXAMPLES</u>
7	Executives, professional services.	doctors, lawyers, business owners, engineers, accountants.
6	Small business operators and professional services.	lecturers, sub-accountants, farmers.
5	Store and factory managers, officials, professional services.	teachers, army officers, missionaries.
4	Technicians, highly skilled workers.	technical assistants, train drivers.
3	Salesmen, skilled workers.	foremen, hairdressers.
2	Clerical workers, skilled workers.	army personnel, artisans.
1	Factory workers, semi-skilled.	shedman, shunters.
0	Labourers, unskilled.	platelayers.

APPENDIX C.
COMPUTER SPECIFICATIONS.

All specifications refer to the computer ICL 1301 with extended drum storage.

1. PROGRAM NAME. Data Counting.

Purpose: To check the number of scores punched for each of M sets of data.

Main Procedures: Enter the M sets of data with a 9999 card following each of the M sets.

1. Processing Requirements:

There are 2 different forms of processing. For small M, the data are counted for one set and the total, N, is displayed in B register when a 9999 card is encountered. For large M, the totals for all M sets are printed out in the format: Data set number and total.

2. Controls: The computer comes to a 1156 stop at every 9999 card and can be made to carry on to the next set of data simply by restarting with the "start" button.

General: Time per variable, for N scores ~ 10 sec.
There is one chapter.

2. PROGRAM NAME: Normality of Distribution.

Purpose: To calculate the χ^2 values for M sets of N scores in order to test whether the scores of each of the sets are normally distributed.

Start Procedures: Read in:
X: the maximum score in a set of scores
Y: the minimum score in a set of scores
N: the number of groups into which the scores are to be classified.

Main Procedures: Enter the scores for the M sets.

1. Processing Requirements:

For each set of scores the program counts the frequencies of the scores falling in each group or score-interval. The frequencies expected from a normally-distributed set of scores are calculated and then the χ^2 value for testing for normality of distribution, according to the formula

$$\chi^2 = \sum_i \left(\frac{f_o - f_e}{f_e} \right)^2$$

where f_e = expected frequency and
 f_o = obtained frequency of scores for each of N groups.

In addition, the mean and standard deviation for each set of scores are calculated from the formulae

$$\bar{X} = \frac{\sum X}{n} \quad \text{for the mean and}$$

$$s = \sqrt{\frac{\sum x^2}{n}} \quad \text{for the standard deviation}$$

where X is a score, $x = X - \bar{X}$ and n is the number of scores in one set of data.

The following information is printed out under appropriate labels:

- (1) the maximum score occurring in a set of scores
- (2) the minimum score occurring in a set of scores
- (3) the number of groups or score-intervals
- (4) the mean, $\bar{X}$, of a set of scores
- (5) the standard deviation, s , of a set of scores
- (6) the χ^2 value for a set of scores.

2. Controls: Chapter 0 guides the transference of scores to and from drum storage to the I.A.S. (Immediate Access Store) which can deal with (100-M-2) scores at one time in this program.

General: The time taken for running the program for $M = 128$, is approximately $2\frac{1}{2}$ hours.
 There are three chapters.

3. PROGRAM NAME: Linearity of Regression.

Purpose: To calculate the F values of M pairs of sets of data, X and Y , in order to test the linearity of regression of X on Y and Y on X .

Start Procedure: Read in:

- M : the number of data sets (this is automatically reduced by 1 every time one run has been completed).
 N : the number of scores in each set of data.

Main Procedures: Enter the M sets of data.

(1) Processing Requirements:

The program classifies each set of scores, X and Y , into G groups and calculates the value of F from the formula

$$F = \frac{(n^2 - r^2)}{1 - \eta^2} \times \frac{N - G}{G - 2}$$

where η = correlation ratio
 r = correlation coefficient between X and Y
 G = number of arrays or groups
 N = number of pairs of scores.

For significance of curvilinearity, considering the regression of Y on X,

$$F = \frac{S_d^2}{S_w^2}$$

where S_d^2 = sum of squares of deviations of array (group) means from the regression line. The d.f. here = $G-2$
 and S_w^2 = sum of squares based on within-array variation.
 The d.f. here = $N-G$.

The results are printed out under headings:
 Variable numbers, F Value, N1 and N2,
 where N1 = degrees of freedom, $G-2$
 and N2 = degrees of freedom, $N-G$
 F values for the regression of X on Y and Y on X, are calculated.

2. Controls: Nil.

General: There are 5 chapters.
 This is a very long procedure if M is large.
 Estimated time for M = 128 is > 100 hours.

4. PROGRAM NAME: Reliability.

Purpose: To calculate the split-half reliability coefficients of M sets of data.

Main Procedures: Read in the N pairs of scores on alternate items X and Y for each set of data.

1. Processing Requirements:

The program calculates the correlation coefficients for each set of paired scores, from the Pearson Product - Moment formula

$$r_{1/2} = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}}$$

where $r_{1/2}$ = split-half reliability coefficient
 $x = X - \bar{X}$, $y = Y - \bar{Y}$ for X and Y which are corresponding scores on alternate items for one test and $\bar{X}$ and $\bar{Y}$ are the means of the 2 sets of paired scores.

The Spearman-Brown extension formula for a half-length test is then used to obtain the estimated reliability coefficient of the whole test, i.e.

$$r' = \frac{2r_{1/2}}{r_{1/2} + 1}$$

2. Controls: Stop 1156 after M sets of data are inserted to allow re-organisation of data cards for calculating interscorer reliabilities.

General: There are 4 chapters.
Estimated time of running program for M = 45, is 1 hour.

5. PROGRAM NAME: Intercorrelation Matrix.

Purpose: To calculate the correlation coefficients, r, between every possible pair of M sets of data.

Start Procedures: Extend drum scores for large M.

Main Procedures: Read in the M sets of data using packed storage facilities.

1. Processing Requirements:

Every pair of variables or sets of data, X and Y, are considered in order 1 and 2, 1 and 3, - - - - 1 and M, 2 and 3, - - - - 2 and M, etc. Correlation coefficients, r, are calculated for each pair from the Pearson Product-Moment formula

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}}$$

where $x = X - \bar{X}$, $y = Y - \bar{Y}$ and $\bar{X}$ and $\bar{Y}$ are the means of the X and Y variables.

The $M(M+1)$ coefficients are printed out one under the other with the value of X printed on the left side and a space left each time X changes its value. Unities are printed for the self-correlation values. At the same time, the matrix is punched out onto cards by rows for use in program 6. Since the matrix is symmetric, only the upper half is punched and printed.

2. Controls: Nil.

General: There are 3 chapters.
For M = 90, this program takes 7 hours 4 mins. to complete.

6. PROGRAM NAME: Matrix Inversion.

Purpose: To invert an M x N matrix, R.

Main Procedures: Read in the data cards obtained from program 4 - an M^2 matrix.

1. Processing Requirements:

This is a standard program: number 300. An additional section guided the punching of the M diagonal elements onto cards.

The M^2 elements of the inverted matrix R^{-1} are printed out in blocks, 5 blocks or columns across one page with the M number printed at the top of each column. The values of the M diagonal elements were punched onto cards for use in program 7.

2. Controls: Nil.

General: Time taken to run the program for $M = 90$, is 1 hour 40 mins.

7. PROGRAM NAME: SMC Calculator.

Purpose: To calculate the SMC's (Squared Multiple Correlations) for the intercorrelation matrix R, to use as estimates of communalities.

Main Procedures: Read in the data cards from program 5 with the M diagonal elements, r_{jj} of the inverted matrix, R^{-1} .

1. Processing Requirements:

For each of the M diagonal elements, the SMC value is calculated from the formula

$$SMC_j = 1 - \frac{1}{r_{jj}}$$

where r_{jj} is the jth element of the inverse matrix corresponding to variable z_j , $j = 1, 2, \dots, M$.

These SMC's are printed out in rows and punched onto cards at the same time for use in program 8.

2. Controls: Nil.

General: There is one chapter.
Time taken to run the program for $M = 90$, is 1 hour 40 mins.

8. PROGRAM NAME: Repunching intercorrelation matrix.

Purpose: To replace the unities in the original intercorrelation matrix R, with corresponding SMC values.

Main Procedures: Read in the upper half of the symmetric intercorrelation matrix R, and the SMC values punched out in program 6.

1. Processing Requirements:

Each unity value is replaced by the appropriate SMC_j value, where j = variable number: j = 1 to M. The reduced correlation matrix (i.e. with SMC's as estimates of communalities) is printed out with spaces between each of the M sets of correlation coefficients. The reduced matrix is also punched out by rows onto cards for use in program 9.

2. Controls: Nil.

General: Estimated time taken = 10 minutes.
There is one chapter.

9. PROGRAM NAME: LO3.

Purpose: To calculate the eigenvalues and eigenvectors of a real symmetric matrix by Jacobi's Method.

Start Procedures: This a machine-code program
Read in
N: the order of the matrix
Z: the accuracy required
Y: zero to suppress the calculation of the eigenvectors. Positive to allow the calculation of the eigenvectors.
T: zero if the lower matrix is to be read. Positive if the upper matrix is to be read.

Main Procedures: Read in the upper or lower matrix punched by rows. Here the data cards were obtained from program 7.

1. Processing Requirements:

Eigenvalues and eigenvectors are calculated by the method of systematically reducing each off-diagonal elements of the matrix to zero (within the allowed error Z).

The print-out consists of

- (1) interrogation printing of a measure of the convergence of iteration. This can be suppressed by setting MI 25,
- (2) each eigenvalue and its number followed by its associated eigenvectors. These values can also be punched out for use in program 10. Punching can be suppressed by setting MI 24,
- (3) the upper matrix is re-calculated and printed if Y > 0. This is a measure of the accuracy of the results and can be suppressed by setting MI 22.

To obtain an intermediate print-out (i.e. before a particular iteration has been completed) MI 23 can be set. The program can then be restarted by starting to 111155, unsetting MI 23 and starting.

2. Controls: To stop the program temporarily, TEA statements are incorporated into it. Set MI 27 to obey TEA No. 1 at any stage. Restart using Initial Orders with MI 25 and 22 (Compiler No. 1).

For a long break in running the program, the second TEA statement can be used. MI 23 is set to obtain an intermediate print-out and punched results - this stops at 111152. Set MI 27, start to 111155. Unset MI 23, start to 111150. The computer can then be switched off.

Drum storage is required from machine-code word 6201 onwards for N^2 words if $Y = 0$, or for $2N^2$ words if $Y > 0$, i.e. if $Y = 0$, $N \leq 133$ and if $Y > 0$ then $N \leq 94$.

Z can be altered during the running of the program by setting a new Z value into A register.

General: To reduce the off-diagonal elements to $< 5 \times 10^{-3}$ (i.e. $Z = 5 \times 10^{-3}$), this program takes approximately 77 hours 15 minutes.

10. PROGRAM NAME: L02

Purpose: To check the values of the eigenvalues and eigenvectors obtained from program 9.

Start Procedures: Read in
 N: the order of the matrix
 Y: any positive number
 Z: no significance
 T: zero if the lower matrix is to be read.
 Positive if the upper matrix is to be read. For $N \leq 94$, use Compiler No. 1 in extended store mode. For $N \leq 52$, Compiler No. 1 or No. 2 can be used.

Main Procedures: Read in the $\frac{1}{2}(N^2+M)$ numbers that represent the matrix and the M sets of $M+1$ numbers, being
 (1) the eigenvalue
 (2) the M elements of the eigenvector.

The program is designed to use the input and output data of program 9 directly.

1. Processing Requirements:

The program generates the M^2 matrix A. For every eigenvalue, λ , and associated eigenvector, α , the computer calculates

- (i) $A\alpha = \bar{y}$ and prints $\bar{y}$ as calculated vector
- (ii) $\lambda\alpha - \bar{y}$ and prints the result, which should be zero ideally.

The results printed consist of

- (1) the eigenvalue
- (2) a matrix row
- (3) the eigenvectors
- (4) the result of the matrix x eigenvectors (i)
- (5) the difference between (3) and (4), i.e. (ii)

2. Controls: Nil.

General: There are 2 chapters.
Time of run for N = 90, is 3 hours 35 minutes.

11. PROGRAM NAME: Drum punch-out.

Purpose: To punch-out the entire drum contents onto cards.

Main Procedures:

1. Processing Requirements:

Since Program LO3 was a very long program and since the computer had to be shut down and moved in the middle of the LO3 run, it was necessary to store all the contents of the drum on cards which could be fed into the computer after it had been moved and set up again and the program allowed to continue running from where it had had to be interrupted.

This is a machine-code program which causes all the drum stores to be punched out at 300 words in 10 minutes.

Reloading was done by loading the punched-out data with MI 20 (to zeroize drum stores) and then starting as from a TEA statement after which LO3 continues. Order of sets of cards does not matter.

12. PROGRAM NAME: Factor Loadings.

Purpose: To select M eigenvalues $\geq$ a set value Z, and to calculate the factor loadings for each factor M. To calculate the percentage contribution of each eigenvalue to the total sum of the communalities of all the factors.

Start Procedures: Read in
M: the number of factors
N: the number of variables
X: the total communality (sum of eigenvalues) for M variables.

Main Procedures: Then follow the eigenvalues and their associated vectors as punched in program 9.

Processing Requirements: Each eigenvalue is checked to see if its value is $\geq$ the set value, Z , (which is the value of the M th largest eigenvalue). If it is $< Z$, that eigenvalue and its vectors are disregarded and the next eigenvalue is checked. If it is $\geq Z$, factor loadings are calculated from the formula

$$a_{ij} = \alpha_{ij} / \sqrt{\lambda_j}$$

where λ_j = eigenvalue of factor (eigenvalue) number j and α_{ij} = the i th associated eigenvector.

These are printed out in one column. At the bottom of the column, the eigenvalue and the percentage contribution of that eigenvalue are printed

$$\text{percentage contribution} = \frac{\lambda_i}{\sum_{j=1}^m h_j^2} \times 100\%$$

where the symbols have the usual meanings.

2. Controls: There is 1 chapter.
Estimated time for $M = 30$ and $N = 90$, is
35 minutes.

13. PROGRAM NAME: Matrix Rotation - Varimax.

Purpose: To rotate an $M \times N$ matrix of factor loadings orthogonally.

Main Procedures: Read in the $M \times N$ factor loadings obtained from program 12.

1. Processing Requirements:

This is a standard N.I.P.R. program. Factors are rotated orthogonally two at a time and the complete cycle of $M(M-1)/2$ pairings of factors repeated until the varimax criterion, V , no longer increases. The varimax criterion is

$$V = n \sum_{p=1}^m \sum_{j=1}^n (b_{jp} / h_j)^4 - \sum_{p=1}^m \left(\sum_{j=1}^n b_{jp}^2 / h_j^2 \right)^2$$

which is to be maximised.

Results are printed out in columns with the respective factor number at the head of each column and the new loadings - to 4 decimal places - listed under each other. A communalities check is also printed, the values of the difference between each of the new and the old communalities being given.

2. Controls: Tolerance for variances was set at 1×10^{-4} and the variances had to agree within the allowed limit once.

14. PROGRAM NAME: Matrix Rotation - Promax

Purpose: To rotate an $M \times N$ matrix of factor loadings obliquely.

Main Procedures: Read in the $M \times N$ factor loadings obtained from program 13.

1. Processing Requirements:

This is a standard N.I.P.R. program.

Factors are rotated obliquely and results printed out as in program 13. In addition, the factor correlation matrix is printed out in numbered columns with unities in the diagonals.

General: The time taken to rotate a 90×30 matrix to within the required degree of accuracy both orthogonally and obliquely (i.e. programs 13 and 14) was 22 minutes 34.9 seconds.

15. PROGRAM NAME: Division of Data (Torrance).

Purpose: To divide the total scores on the variables "fluency", "flexibility" and "originality" on the verbal and non-verbal sections of the Torrance Tests of Creative Thinking, into 8 equal groups.

Start Procedures: Read in
 X: the minimum value of the set of scores to be classified
 Y: the maximum value of the same set of scores.

Main Procedures: Read in the N scores on the variable whose scores are to be classified.

1. Processing Requirements:

The 8 equal score intervals for the variable are computed, then each of the N scores are checked and classified into one of the 8 groups.

The print-out consists of the 8 groups listed across the page and the individual numbers of the subjects falling in a particular group listed under that group number. In addition, the same numbers are punched out onto cards, each group beginning a new card, for use in program 16.

2. Controls: Nil.

End Procedures:

A running count of the total number of individuals in each group is made and listed under the group together with the score-interval at the end of one set of scores. The procedure is repeated until all variables have been classified.

General: There are 5 chapters.
 Time per variable = 7 minutes.

16. PROGRAM NAME: Division of Data.

Purpose: To divide selected sets of data into the
 8 groups listed by program 15.

Start Procedures: Read in the numbers of the individuals
 falling in each group, i.e. the cards
 punched out by the program 15.

Main Procedures: Read in the N individual scores on the
 variable to be divided into 8 groups
 according to the particular Terrance Test
 division of groups being used.

1. Processing Requirements:

The program checks the number of each individual score as it is read in, finds the appropriate Terrance Test group into which the individual falls (from the data obtained from program 15) and prints out his score on the variable concerned under the correct group number. Thus the print-out consists of a heading showing which Terrance Test variable's groups are being used as a basis for dividing up the selected variables' scores, the number of the variable being classified, the 8 group numbers and the individual scores falling in each group.

2. Controls: After each set of scores, the computer comes
 to a 1155 stop and can be restarted to
 read the next set of scores.

End Procedures:

The program keeps a running total of the scores in each of the 8 groups and prints out the mean for each group at the end of the classification of one variable.

General: Classification of one variable takes about
 4 minutes.
 There is one chapter.

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