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AN EXPERIMENTAL STUDY OF IMAGERY AND ITS RELATION TO ABILITIES AND INTERESTS

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Student subjects were assessed for four main types of imagery employed in carrying out short mental tasks, on the basis of their introspections. Some relation was found between these categories and regularity-irregularity of respiration, as claimed by Golla and Short; but no consistent relation was found with ordinary questionnaire self-reports nor with some of the alleged tests of imagery.

There was slight confirmation only of the supposed relevance of visual imagery to spatial ability. However, a number of associations at moderate to high levels of significance were found with (self-rating) tests of interests in different fields, and to a lesser extent with information about these fields.

I. Introduction

One of the areas in which individual differences were first studied was that of mental imagery, as a result of Galton's (1883) famous 'inquiries' with his 'breakfast-table questionary'. His finding that many scholars and scientists reported complete absence of visual imagery launched a long train of investigations into the functions of imagery in thinking. Bartlett (1927), for example, in a symposium in this *Journal*, held that imagery tends to appear when blockages occur in trains of thought, but that visual reproductions of experience are generally more distorted and condensed than verbalized memories. Many other writers supposed that individuals could be classified into imagery types—visiles, audiles, motiles, etc., or more simply into visualizers and verbalizers. It was assumed that these differences played an important part in the perception and retention of different kinds of information: that visualizers, for example, should be taught differently from verbalizers, and would be adept at different skills. Since, however, there seemed to be no reliable methods of establishing a person's type, and probably mixed types were commoner than pure ones, interest in this topic waned, and there has been little investigation in recent years.

Among the more systematic studies of introspective data were those of Betts, Carey and Burt. Betts (1909) expanded Galton's questionary so as to give a fair chance for images of every modality to be reported, and asked his subjects to grade each image on a 7-point scale from 'perfectly clear' to 'no image'. His results indicated that those who ranked their imagery high or low in one sense tended to do about the same in other senses; also that there was little or no relation between the use of visual imagery in various intellectual tasks and the subjects' abilities at these tasks.

Carey (1915) applied several of the alleged objective tests of imagery, but found these of little value. However, she claimed that reliable introspective reports could be obtained with school children, and noted that there was a tendency for negative correlations between strength of visual imagery and tests of higher mental processes, or *g*, suggesting that imagery might even be detrimental to academic studies. Again, in 1947, Brower found no relation between the reported intensities of images of

various modalities and the Otis intelligence test. That questionnaire techniques may be made to yield more meaningful results by applying such complex types of analysis as between-person correlations and factorization was shown by Burt in 1938. Twelve subjects were selected from an earlier study by Burt and Davies who had been found to possess exceptionally vivid images of one particular type, whether visual, auditory or motor—4 subjects for each type. These subjects were given a questionnaire which required them to grade the strength of their mental images of about a hundred different experiences. The 12 sets of gradings were intercorrelated and four factors were extracted. The first or general factor presumably indicates the tendency which all persons have to recollect certain experiences more vividly than others, regardless of their own particular imagery and of the imagery suggested by each experience. The three remaining factors evidently represented visual, auditory and motor types of persons.

A number of more objective tests have been proposed for the assessment of strength of imagery, though in no case is there any convincing evidence of validity. Useful summaries are available in Carey's (1915) article and Woodworth's (1938) text-book. These include the Letter Square, based on the ability to reproduce letters arranged in a square matrix in a different order from that in which they were learnt (cf. Myers, 1911). Similarly, Fernald (1912) supposed that visualizers would be better able to spell words backwards from their visual images than would verbalizers. In the testimony or Aussage test, visualization is supposed to be a help to fullness, though not to accuracy, of description. Kraepelin is credited with using tests of fluency of association with visual and auditory stimulus words. Bowers (1931) found a small but significant correlation between the ease of learning visual and kinaesthetic words and the clearness of imagery claimed for them, but no corresponding correlation for auditory words. Roe's (1951) well-known studies of scientists indicated that imagery is relevant to choice of vocation, the more theoretical being more inclined to be verbalizers than the more experimental workers. She claimed that verbalists gave a much larger total of responses to the Rorschach inkblot test than did visualists.

Still other writers have used tests of spatial ability or *k* factor, assuming that these depend on visual imagery—for example Clarke (1937) and Ormiston (1939). The introspections of El Koussy's (1935) subjects indeed suggested that subjects frequently resort to visualization, but hardly justify the inference that success at such tests can be used as a measure of strength of imagery. A more productive approach is that of Barratt (1953), whose subjects rated the strength and other attributes of their imagery when performing spatial and other types of tests. He was able to show that those who rated their visual imagery higher on the space tests did score more highly, whereas no such differences occurred on non-verbal reasoning tests.

Quite a different attack has been through the study of respiratory rhythms, which appear to vary with the type of mental imagery. It has long been observed that there are individual differences in regularity of respiration, and Angell & Thompson (1899) considered that this depends on the degree to which the subject is in a state of equilibrium, undisturbed by environmental changes. They found that the rhythm was generally regular also during voluntary attention, but that it became irregular when there was a tendency to verbalize, as when the subjects were asked to recall nonsense syllables.

Golla & Antonovitch (1929) examined the regularity of breathing of 67 normal subjects, claiming an association between visual imagery and regular breathing on the one hand, and auditory imagery (with a tendency to vocalize) and irregular breathing on the other. Their findings were confirmed by Wittkower (1934) and Paterson (1935), who also compared the breathing records of psychotic patients and normals. In 1943 Golla, Hutton & Walter investigated a further physiological concomitant of imagery, namely the electrical activity of the posterior areas of the brain, recorded by means of the electroencephalogram. They distinguished three main types of alpha records: (i) M (minus) type with alpha rhythms below 10μV., on which opening or closing the eyes or mental activity had no effect; (ii) R (responsive) type with alpha rhythms within the normal range of 10–50μV. when the eyes are closed; this was blocked or much attenuated with eyes open, and diminished if mental activity proceeded while the eyes are closed; (iii) P (persistent) type with alpha rhythms of normal amplitude, persisting relatively unchanged during opening of the eyes or mental activity. They claimed a high correlation between M type and visualizing, the P, and to a lesser extent, the R type being more inclined to auditory-kinaesthetic or verbal imagery.

Short (1953) adopted the above methods with certain modifications. Instead of recording the respiratory rhythms with a pneumograph and ink-tracing device, he placed a thermocouple over the nostrils to convert the breath temperature into electrical energy for recording with the EEG amplifier. Short examined epileptic and other patients at the Burden Neurological Institute, together with 75 normal subjects, mostly university students. On the basis of introspections while carrying out a series of mental tasks, he classified them into two main imagery types, visual and verbal-motor. The visualists breathed regularly and showed frequent blocking of alpha-rhythms, while the verbalists breathed irregularly and showed alpha-persistence. However when verbalists attempted a problem requiring predominantly visual images, then physiological changes characteristic of visualists were apt to occur.

The present investigation was planned, first, to repeat Short's work in part and to compare his method of classifying imagery with the traditional questionnaire and alleged objective tests, since we felt considerable doubts as to the possibilities of categorizing individuals into consistent types. Secondly, we wished to explore the associations, if any, between individual differences in imagery and abilities or interests.

II. The present investigation

Subjects. Graduate teachers under training for the Postgraduate Certificate Course in the Department of Education, Kings College, were chosen as a suitable group of subjects for several reasons. First, it seemed desirable to employ intelligent adults, since stress was to be laid on detailed introspective data. Secondly, it was desirable to have subjects possessing a wide range of fairly stable interests, and this was likely to be true of students in training as teachers of languages, history, science subjects, etc.

Since the collection of introspections and breathing records involved individual testing, it was not possible to use as large a number of subjects as one would wish. However 34 men and 36 women (aged 21–26) eventually completed all tests between

January and March 1955. Good rapport with the students was obtained by a preliminary meeting, at which the objects of the investigation were explained, also by securing the help of student representatives in planning individual sessions.

Methods: (*a*) *Introspections and breathing records.* Practical difficulties made it impossible to obtain EEG records, and the breathing records were obtained with quite simple devices: (i) a clockwork kymograph giving one revolution in 30–180 sec.; (ii) a rubber sack or pneumograph connected to: (iii) a Marey's tambour consisting of a shallow metal vessel enclosed by a thin rubber membrane, with a light lever resting on it; (iv) a stylus with an ink tracing capsule; (v) a Jacquet chronoscope.

After preliminary conversation and instructions, allowing about 4 min. for the subject's breathing to settle down, a 1-minute practice trial was carried out, consisting of the mental rehearsal of any story the subject could recollect and the calculation of a simple multiplication problem. The subject then relaxed with eyes closed for 5 min., and his normal respiratory curves were recorded for 2 min. Six tasks were then given in turn: a sum, recalling the story of Noah's ark, solving a 3-dimensional problem based on cubes, rehearsing the National Anthem, an argument and the Lord's Prayer. These lasted about 20 sec. each, 60 sec. for the cube problem. Each was followed by some 1½ min. of introspection on the mental processes used in carrying out the task, and a further 1 min. rest-pause before the next task. The total time per subject was about 30 min.

The remaining tests were given in two group sessions with the whole body of students, each session lasting about 2 hr. There was no time limit for the Questionnaire or for the Interests Survey.

(*b*) *Questionnaire.* This was based on a version devised by Prof. Burt. It asked for self-assessments of the vividness of visual, auditory or kinaesthetic imagery in 28 imaginary situations, and yielded three scores for the contrasted imagery types.

(*c*) *Fluency tests.* Subjects wrote down for 1½ min. each as many red objects, blue objects, harmonious or pleasant sounds, and harsh or unpleasant sounds as possible. These provided scores for visual and auditory 'fluency' and, when combined, a measure of verbal fluency. Since the mean correlation between two visual, or two auditory, lists was 0·599, and between a visual and an auditory list 0·502, it seems probable that scores depend much more on verbal ability than on the particular sense, or imagery, modality.

(*d*) *Rorschach test.* Following Roe (1951) and Golla *et al.* (1943), five plates from the Rorschach test (nos. 1, 3, 6, 8, 10) were shown on colour slides for 4 min. each, and subjects wrote any responses that occurred to them on duplicated outlines of the blots. These were not scored fully, but animal, non-animal and movement and total responses were counted; the proportion of non-animal to total responses appeared to be the most promising indicator of imagery type.

(*e*) *Ability tests.* The abilities thought to be most relevant were verbal and spatial, and the following tests were selected, most of which had been designed for use with high-grade personnel in the Royal Navy: (i) vocabulary test, SP 193–4 (10 min.); (ii) non-verbal *g* test, SP 192 (20 min.); (iii) copying (spatial) test, SP 97 (10 min.); (iv) paper formboard, SP 76 (10 min.); (v) English usage test (10 min.); (vi) examination marks in Principles of Education.

(*f*) *Interests survey and information tests.* An interests test was constructed along the lines of Strong's Vocational Interest Blank, with lists of occupations, school subjects, periodicals, leisure-time activities, etc., each item to be checked + +, +, 0, − or − − according to liking or disliking. The items were classified by content (not, as in the Strong Blank, by empirical group differences) to provide measures of the following interests: (i) artistic, subclassified into active and passive interests; (ii) business; (iii) mechanical-constructional (for men); (iv) domestic (for women); (v) gregarious-social; (vi) handicraft; (vii) literary, with active and passive subgroups; (viii) musical, active and passive; (ix) outdoor-athletic; (x) scientific; (xi) dramatic-theatrical; (xii) welfare-humanitarian.

In addition, a general knowledge test was constructed containing 12 corresponding sections (but not differentiating between active and passive artistic interests), each section with 10 to 16 multiple-choice items of information relevant to the interest. The total score on all sections of this test was taken as an additional measure of verbal ($g+v$) ability.

III. Analysis of results

Since some of the distributions of scores were skewed or irregular, they were all converted to a standard scale ranging from +5 to −5 for correlational purposes. In the case of interests and information tests, where significant sex differences were noted, the distributions were normalized separately, so that each sex obtained a mean of zero on each variable. No appreciable sex difference occurred in the imagery data.

Factorization of abilities. Table 1 shows the inter-correlations of eight ability tests. It will be seen that, in this highly selected student group, there is no trace of a general factor, and that the non-verbal test, designed as a measure of *g*, correlates strongly with the two spatial tests. A centroid factor analysis confirmed that the first three tests could be used as measures of spatial, and nos. 4, 7 and 8 as measures of verbal, abilities.

Table 1. *Inter-correlations of ability tests*

	1	2	3	4	5	6	7	8
1. Non-verbal *g*	—	0·532	0·669	−0·374	−0·014	−0·017	−0·335	−0·019
2. Paper formboard	—	—	0·655	−0·289	0·063	−0·151	−0·315	0·058
3. Copying (spatial)	—	—	—	−0·281	0·163	−0·046	−0·223	0·150
4. Vocabulary	—	—	—	—	0·130	0·144	0·504	0·567
5. English usage	—	—	—	—	—	−0·015	0·115	0·177
6. Verbal fluency	—	—	—	—	—	—	0·185	0·077
7. Examination marks	—	—	—	—	—	—	—	0·285
8. General knowledge	—	—	—	—	—	—	—	—

In an analysis of the reliability and consistency of the interests and information tests, the latter had been tried out on a sample of graduate teachers under training at Goldsmiths' College (14 men, 29 women). The mean reliability of the 12 subtests was 0·655. For the main group of subjects, the correlations between the two measures of each interest are shown in Table 2.

Considering that the tests were in an early stage of development, the amount of positive overlapping between these two approaches to interest measurement is fairly promising, though obviously rather irregular. We might, however, expect more consistent agreement between each student's pattern or profile of scores on the two

Table 2. *Correlations between interests survey and information subtests*

	Men	Women		Men	Women
Artistic	0·446	0·481	Literary	0·660	0·529
Business	0·285	0·123	Musical	0·649	0·197
Constructional	0·546	—	Outdoor	0·079	0·079
Domestic	—	0·083	Scientific	0·467	0·417
Gregarious	0·203	0·241	Theatrical	0·500	0·438
Handicraft	−0·099	0·262	Welfare	0·104	0·307

measures, and the following formula (based on a technique described by Allport & Vernon, 1931) was applied to the normalized scores:

$$R = \frac{\sum_{A}^{N}(X+Y)^2 - \frac{1}{n}[\Sigma(X_a+Y_a)^2+\ldots+\Sigma(X_N+Y_N)^2]}{\sum_{A}^{N}X^2+\sum_{A}^{N}Y^2-\frac{1}{n}[\Sigma X_A^2+\ldots+\Sigma X_N^2+\Sigma Y_A^2\ldots\Sigma Y_N^2]} - 1,$$

$A \ldots N$ = subjects; n = number of interest categories; X = score on each interest category; Y = score on each information subtest. The standard deviations for all scores are approximately 2 and the means zero.

The over-all correlations are still not very high, though better than the average coefficients for separate categories. It would appear that men show greater consistency between their interests and information than women do.

Table 3. *Correlations between interests and information tests*

	Mean of separate coefficients	Pattern coefficients
Men	0·349	0·480
Women	0·231	0·274

In scoring the breathing records, the distances between successive crests were measured in millimetres, both for all the rest periods combined and for all the task periods combined. From these measurements the length of each subject's median breath, together with his 90th and 10th percentiles were calculated. The two latter quantities provided a measure of the range or degree of irregularity of breathing span under rest, or under task, conditions. Since, however, a considerable correlation was observed between median and range (i.e. slower breathers tended to exhibit more variability), a correction was applied, based on the regression of range on median.

The correlation between the regularity scores at rest and during tasks was 0·240, which is significant only at the 5% level, suggesting that the characteristics of breathing vary considerably with the situation. However, the two measures were averaged in exploring the relations between the questionnaire and objective tests of imagery, shown in Table 4.

There is some confirmation for Short's claim that visualizers breathe more regularly ($r+0{\cdot}378$), and possibly for a relation between Rorschach non-animal responses and kinaesthetic imagery. But the remaining coefficients negate any consistent relationship between different types of assessment. Thus the auditory questionnaire bears no relation to auditory fluency, nor the kinaesthetic questionnaire to breathing

Table 4. *Correlations between measures of imagery*

	1	2	3	4	5	6	7
1. Questionnaire: visual	—	0·368	−0·292	0·229	0·088	0·101	0·378
2. Questionnaire: auditory	—	—	−0·003	0·136	−0·024	0·031	0·167
3. Questionnaire: kinaesthetic	—	—	—	0·130	0·055	0·334	0·004
4. Visual fluency	—	—	—	—	0·624	0·410	0·106
5. Auditory fluency	—	—	—	—	—	0·394	0·048
6. Rorschach non-animal	—	—	—	—	—	—	0·218
7. Breathing regularity	—	—	—	—	—	—	—

irregularity; and the Rorschach score overlaps more closely with both measures of fluency.

Short has commented on the extreme difficulties of classifying introspections regarding imagery. We did not attempt to impose any *a priori* categories on our records, but first classified under some eight headings which seemed to emerge from the material itself. The numbers of remarks by each subject falling under these headings were totalled and tetrachoric intercorrelations were calculated between the headings to see how far they overlapped. In this way, four reasonably distinct categories were reached, defined as follows:

I. *Visual-passive*, including reports such as 'pictured to myself', 'imagining myself seeing', and images of scenes, objects, people, etc., *not* in motion. In view of the positive correlation of this category with regular breathing, a small weighting was also given to the latter variable in totalling the scores.

II. *Auditory-passive*, including reports such as 'conscious of, or hearing one's self-produced speech', and audition of sounds, music or speech from other persons or things. A small weighting was also given to auditory scores in the questionnaire.

III. *Visual-active against Verbal.* These two subcategories were so highly correlated inversely, that it seemed preferable to accept them as a bipolar factor. Visual-active includes reports on self-activity, e.g. 'I was looking at the screen in a theatre', 'I looked at the cube and divided it in pieces', also moving scenes such as 'animals going in two by two'. Verbal was restricted to such statements as 'I said to myself', but excluded awareness of mouth or throat movements. The Rorschach score was also given a small, arbitrary weighting, since it showed some correlations with the introspective totals (cf. Chowdhury, 1956).

IV. *Kinaesthetic*, i.e. consciousness of movements or contractions of the tongue, eye muscles, hands, etc. Irregular breathing was also taken into account.

Finally the highest 15 students and the lowest 15 on each of these 'types' were picked out, and their scores on the various tests employed in the investigation were compared. Tables 5–8 list any group differences between highs and lows that reached various levels of significance, using the two-tailed t-test. t's which are asterisked are to some extent inflated, since these variables were actually included in determining the imagery-type scores.

There is a definite relation between this type of visual imagery and regular breathing, though less close than that found by Short. However, the written questionnaire responses not only fail to correspond with the introspective records, but tend to contradict them. Though there is no consistent tendency for these visualizers to score above average on spatial tests, they are weak in vocabulary and slightly

superior on a non-verbal '*g*' test. Mechanical-constructional information and scientific interests show a more positive relation, and artistic, handicraft, theatrical interests and information slight negative relations.

Table 5. *Concomitants of high or low visual-passive imagery*

Highs superior on	*t*	*P*	Lows superior on	*t*	*P*
Regular breathing*	5·22	0·001	Vocabulary	2·62	0·05
Mechanical-constructional information	3·96	0·001	Theatrical information	2·16	0·05
Scientific interests	2·76	0·05	Visual imagery (questionnaire)	1·96	0·10
Business interests	1·95	0·10			
Non-verbal '*g*'	1·92	0·10	Artistic information	1·82	0·10
Domestic information	1·88	0·10	Domestic interests	1·74	0·10
			Handicraft interests	1·72	0·10
			Artistic interests	1·54	0·20
			Gregarious interests	1·52	0·20
			Theatrical interests	1·49	0·20

Table 6. *Concomitants of high or low auditory-passive imagery*

Highs superior on	*t*	*P*	Lows superior on	*t*	*P*
Auditory imagery (questionnaire)*	4·05	0·01	Regular breathing	1·56	0·20
Literary information	2·25	0·05	Visual fluency	1·40	0·20
English usage	1·97	0·10	Auditory fluency	1·39	0·20
Literary-active interests	1·80	0·10	Welfare interests	1·32	0·20
Mechanical-constructional interests	1·65	0·20			
Principles of education	1·61	0·20			
Visual imagery (questionnaire)	1·57	0·20			
Theatrical information	1·53	0·20			
Musical information	1·36	0·20			
Rorschach animal responses	1·34	0·20			

Table 7. *Concomitants of high visual-active against verbal imagery*

High visual-active superior on	*t*	*P*	High verbal superior on	*t*	*P*
Rorschach non-animal responses*	3·57	0·001	Outdoor activities	1·57	0·20
Welfare interests	2·86	0·01	Business information	1·41	0·20
Kinaesthetic imagery (questionnaire)	2·21	0·05			
Rorschach animal responses	2·05	0·05			
Mechanical-constructional interests	1·86	0·10			
Literary-passive interests	1·35	0·20			

Table 8. *Concomitants of high or low kinaesthetic imagery*

Highs superior on	*t*	*P*	Lows superior on	*t*	*P*
Irregular breathing*	4·07	0·001	Scientific interests	1·26	0·03
Domestic interests	3·73	0·001	Business interests	1·33	0·02
Handicraft interests	3·69	0·001			
Visual imagery (questionnaire)	2·17	0·05			
Artistic-active interests	2·08	0·05			
Artistic interests	1·95	0·10			

* These *t*-values are inflated. See text.

The auditory group is rather consistently, though to a small extent, superior on several tests of '*v*' factor, literary information and interest. There is also some relation to musical information and interest, though not at an acceptable level of significance.

The visual-active, as contrasted with the verbal, type shows few significant relationships, except possibly with certain interests and, unexpectedly, with kinaesthetic

questionnaire responses. However, as posited, there is a closer relation with Rorschach non-animal than with animal responses.

The kinaesthetic type shows irregular breathing, but claims strong visual rather than kinaesthetic imagery in the questionnaire. These subjects appear to be definitely above average in handicraft and active artistic interests, and (among women) in domestic activities; but there is no indication of any relation to athletic inclinations.

In conclusion: a greater number of relationships, at moderate to good levels of significance, have been established between the introspective imagery categories and measures (self-ratings) of interests than with either information or ability tests, or other measures alleged to be diagnostic of imagery. However there is certainly room for further work in reaching a more adequate classification and assessment of introspections about imagery. We should suggest that more extensive records should be collected in a variety of situations in order to explore the consistency with which subjects employ different modalities (thus the discrepancy between our introspective and questionnaire data needs to be resolved). It should then be possible to select representatives of relatively extreme (though not, of course, of pure) imagery types and to study their patterns of interests with more reliable tests.

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