

## IV.—RESEARCH.

### MENTAL ASSOCIATION INVESTIGATED BY EXPERIMENT.

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Mental Association has always interested students of psychology. The importance of studying the train of ideas is everywhere admitted, and by the English school association has been put forward as an explanation of mental phenomena. We may, therefore, be glad that it has recently been found possible to investigate the subject by scientific experiment. During the past ten years such research has been undertaken both in England and in Germany,<sup>1</sup> and of this our present work is a continuation.

#### 1. METHODS OF EXPERIMENT.

Most of our experiments were made in a way so simple that they may be repeated by anyone. A spoken or printed word was given to an observer (or 'subject'), who was required to say or write as quickly as possible what it suggested. The experiment thus began with the perceiving and ended with the expressing of a word. The intervening mental process is an association, the name being here taken in a wide signification. We used 20 nouns (given in Table V.) with about 500 observers, and 250 or more words with 6 observers. We thus have a large mass of material which we shall consider in regard to (1) the time taken up in the process and (2) the nature of the association.

The time it takes for one idea to suggest another is of scientific and practical interest. It was also of advantage in a first series of experiments to get the observer to give the associated idea as quickly as possible in order to obtain uniformity. Three methods were used to measure the times. (a) In the first series of experiments, made by C. at Leipsic (1885) with the help of Dr. Berger, apparatus<sup>2</sup> was employed which made it possible to measure to the thousandth of a second the time of each association. Such elaborate methods could not, however, be conveniently used with a large number of persons, nor was it necessary to measure so exactly the time. (b) We therefore (1885-8) prepared lists

<sup>1</sup> Galton, *Inquiries into Human Faculty*, 182 ff., and *Brain*, 1879, 149 ff.; op. MIND iv. 551. Wundt, *Physiologische Psychologie*, 3rd ed., 812 ff., 884 ff. Trautscholdt, *Philosophische Studien*, i. 218 ff. Kraepelin, *Tageblatt der Naturforscherversammlung zu Strassburg*, 1885. Cattell, MIND xii. 68 ff.; *Phil. Stud.*, iv. 241 ff. For an account of theories concerning the "Association of Ideas," with references, see Croom Robertson in *Encyc. Britannica*, 9th ed., ii. 780 ff.

<sup>2</sup> For description, see Cattell, MIND xi. 220 ff.

containing 10 words, and the observer seeing the words in order said what each of them suggested, the total time for the 10 processes being taken. The average time of association could thus be obtained with sufficient accuracy, but not the time for the separate processes. We were able, however, to get the times for different classes of associations by using lists made up of concrete nouns, abstract nouns, verbs, &c. (c) In a third series of experiments, made mostly by B. (1887-8), a method was used that admitted of a number of persons being tested simultaneously. A word was distinctly spoken, and the observers were required to write in the order suggested as many words as they could until they were stopped after 20 secs. In this case the number of ideas suggested was complicated by the need of writing them down, but the results seem to show that the number of ideas was limited, not by the rate of writing, but by the rate of thought.

While three different methods were used to measure the times, the process of association in the several sets only differed in so far as in the first two sets the starting-word was read and the suggested word spoken, whereas in the third set the former was heard and the latter written. In this third series of experiments we have the train of ideas for 20 secs., and this is in some ways more interesting than the first idea suggested. This latter, however, presents the simpler problem, and gives as much material as can be conveniently considered in the present paper. We may at some future time have experiments on the train of ideas, and we hope that others will also undertake research in this direction.

## 2. THE TIME TAKEN UP IN MENTAL ASSOCIATION.

The times we obtained in our experiments do not give merely the duration of the process of association, but include the time required to perceive the original words, and to say or write the suggested ideas. The time, if any, taken up with intermediate ideas which are not expressed in definite words must be considered as part of the association-time. In the cases where the duration of a series of processes was measured, it is not possible to eliminate with any exactness the perception-and-movement-times. This is due to the overlapping of the processes; an association may be going on while the foregoing idea is being expressed or the following word is being perceived. Experiments, however, show<sup>1</sup> that it takes on the average about  $\frac{1}{4}$  sec. to see and name a word; so if this interval be subtracted from the whole time we get approximately the duration of the association. In comparing the time required by different persons and classes of persons the whole interval may be used, the perception-and-movement-time being short as compared with the association-time, and in a general way proportionate to it.

<sup>1</sup> Cattell, *MIND* xi. 63 ff.; 580 ff.

(a) In the first series of experiments, it was possible to eliminate the perception-and-movement-time, and thus to determine with great accuracy the association-time. This is given in thousandths of a second in the following Table. There is also given after the average time the mean variation of the different measurements. 52 words of each class were used, German for Dr. Berger, English for C.

TABLE I. *Time of Association.*

	Concrete Nouns.	Less Concrete. <sup>1</sup>	Abstract Nouns.	Verbs.
Bg. ...	361 (73)	540 (168)	633 (188)	538 (184)
C. ...	380 (108)	384 (108)	508 (171)	465 (144)

The time of association was thus in the neighbourhood of  $\frac{1}{4}$  sec. It will be noticed that the time was longer (Bg. 272, C. 128 $\sigma$ ) when the given noun was abstract than when it was concrete. This is an interesting fact supported by all our experiments. The time of association with verbs was between that for concrete and abstract nouns. According to this method, in all, 832 associations were made by C., about half of them on new words, the other half on words which had already been used. The average time of association was 475 $\sigma$ , a little less than  $\frac{1}{2}$  sec. The mean variation of the different associations from the series in which they were made was 134 $\sigma$ , nearly  $\frac{1}{4}$  sec. If difficult and unusual associations are omitted by dropping the 6 most irregular times from each series of 26, the average time becomes 431 $\sigma$ , the mean variation 69 $\sigma$ . Thus the usual time required by C. to form an association such as we are here considering is somewhat less than  $\frac{1}{4}$  sec., and does not vary greatly from time to time. The longest associations were *deliverance-hope* (1453), *cut-knife* (1085), and *civilisation-wilderness* (1064); the quickest *good-bad* (111), *father-mother* (132), and *life-death* (143). With these latter it will be noticed that the relation between the two ideas is so close that the association follows almost as a matter of course.

(b) In our second series of experiments associations were made by B. and C. on 500 words. Of these words 250 were concrete nouns, 100 abstract nouns, 50 proper nouns, 50 verbs, and 50 adjectives. Associations with the concrete and abstract nouns were also made by Mr. Stout, and with the concrete nouns by Mr. Edgeworth and Miss Hughes. We further selected 10 abstract and 10 concrete nouns (given in Table V.), and used these with 17 university graduates (men). With these, also, Miss Dudley tested 25 students of an American women's college (Bryn Mawr), and Dr. Berger 40 students of a German gymnasium. In these cases a list of ten words was first used for practice, the results not being recorded. The average time of

<sup>1</sup> The nouns were divided into three classes: *author* and *hour* are not as concrete as *book* and *clock*.

association in seconds is given in Table II, the interval including, however, the perception-and-movement-time.

TABLE II. *Average Time of Association.*

	CONCRETE.	ABSTRACT.	PROPER.	VERBS.	ADJ.
B.....	1.58	1.77	2.06	1.68	1.74
C.....	1.14	1.2	1.28	1.2	1.16
S.....	1.76	2			
E.....	1.88				
H.....	1.19				
University Graduates..	2.11	2.42			
Bryn Mawr College.....	3.14	4.1			
Gymnasium IIb.....	2.42	4.81			
id. IIIb.....	4.46	7.07			

With these observers, consequently, the average time of the mental process varied from a little more than one to about seven seconds. These varying times evidently indicate important personal differences in rate of thought and stage of mental development. The shorter times may be partly referred to clearer understanding of what was to be done and to greater decision in choosing out some special association, as well as to the fact that some think faster than others. Other conditions, such as practice, are also concerned, and the nature and complexity of the process doubtless varies considerably with different observers. But all the factors are psychological; and, while at present we may not be able to define the part played by each, we may hope that such experiments will ultimately throw light on the development and nature of thought. It will be noticed that in all cases the associations on abstract nouns took up more time than those on concrete nouns, but the ratio of the two times varies with the different observers, and shows that the use of abstract thought greatly quickens its relative rate.

(c) Our third series of experiments was made with the three lists of nouns above-mentioned, but the observer, instead of naming a single association for each word, wrote what was suggested during 20 secs. The average time could thus be obtained, but the first association of the series differs somewhat from the following, and the time devoted to writing was a larger part of the whole interval than was the movement-time when the suggested idea was named. Table III. contains a summary of our results, the average time for each word being given in secs. The observers were mostly students of a London and a Dublin girls' school. The experi-

ments in the latter were made by Miss Josephine Conan, who also made those on the Irish Royal University graduates.

TABLE III. *Average Time of Association.*

FORM.	NO. OF PERSONS.	AVERAGE AGE.	ON CONCRETE NOUNS.	ON ABSTRACT NOUNS.	AVERAGE OF BOTH.	RATIO OF CONCRETE TO ABSTRACT.
LONDON SCHOOL.						
VI.....	80	17.8	3.70	4.55	4.18	.81
V.....	188	16.3	4.28	6.06	5.16	.7
IV.....	111	14.8	4.76	7.41	6.09	.64
III.....	84	12.7	6.90	11.76	9.88	.59
Average.....		15.1	4.76	7.14	5.95	.67
DUBLIN SCHOOL.						
	71	14.5	6.25	8.84	7.80	.75
BRYN MAWR COLLEGE.						
	10		3.51	4.88	4.20	.72
LONDON GRADUATES.						
	18		3.08	3.85	3.44	.79
IRISH GRADUATES.						
	8		3.08	3.92	3.58	.75

The Table explains itself. A distinct shortening of the mental process accompanies growth and education. The students of the sixth form of the London school required less than half the time of students of the third form. A corresponding result was obtained in the German gymnasium (see above Table II.).<sup>1</sup> The girls in the Irish school required about the same time as girls of the same age in the English school, and the students in the American college the same time as the students in the sixth form of the English school. It will be noted that the relative time for the abstract associations becomes less as the students are older; it is less for the Irish than for the English students. The number of students in the forms of the English school was sufficient to eliminate accidental sources of variation. The times for the separate divisions of the forms are not so regular, but any variation can to a large extent be explained by the character of the class, and in turn throws light on it.

<sup>1</sup> Dr. Berger has recently published experiments on the rapidity of mental processes in the different classes of a German gymnasium. See *Phil. Stud.*, v. 170 ff.

The 363 students of the London school were divided, according to their class-rank, into four parts. The average time of association for each quarter is given in Table IV.

TABLE IV. *Average Time of Association according to Rank.*

	CONCRETE.	ABSTRACT.	AVERAGE.	RATIO OF CONC. TO ABST.
1st Quarter.....	4.65	6.90	5.78	.67
2nd Quarter.....	4.88	7.14	6.01	.68
3rd Quarter.....	4.76	6.90	5.83	.69
4th Quarter.....	5	7.41	6.21	.67

This shows an increased rate of association as the class-rank of the students is higher, but the difference is not great. Indeed, it is possible that such experiments measure the alertness of the student's mind more accurately than does the class-rank, which depends largely on diligence and other factors not telling in such experiments. The Table does not show a difference for the several quarters in the relative rate of the concrete and abstract associations; consequently higher class-rank does not seem to be accompanied with greater ease in abstract thought, attention to objective details being equally useful.

We may lastly notice the average number of associations made by the English students in 20 secs. on the several words used. This is given in the next Table, and, for convenience, the amount that it is above or below the average.

TABLE V. *Average Number of Associations with different Words.*

CONCRETE NOUNS,					ABSTRACT NOUNS.						
House	4.7	+6	Bird...	4.1	Time....	3.9	+1.1	Love.....	2.4	-.4	
Tree...	4.6	+5	Shoe..	3.9	-.2	Courage	2.9	+ .1	Strength	2.6	-.2
Ship...	4.8	+7	Hat...	3.8	-.3	Form ...	2.7	-.1	Part.....	2.4	-.4
Chair.	4	-1	Child.	3.7	-.4	Virtue...	2.8	-.5	Beauty..	2.8	
Clock.	3.9	-.2	Hand.	3.6	-.5	Art .....	3.1	+ .3	Number	2.7	-.1
Average.....4.1					Average.....2.8						

The Table shows a tolerably constant decrease in the number of words written as the series was continued. Thus with the first word of the concrete list on the average 4.7 associations were made, with the last word 3.6; with the first word of the abstract list 3.9, with the last 2.7. This bears witness to, and in a way measures, fatigue or decrease in attention as the experiments were continued. The falling-off in the number of associations was not, however, regular, and we may thus see that some ideas lend themselves more readily to associations than others. It was found easier to make associations on *ship* than on *clock*, on *time* than on *virtue*.

### 3. THE NATURE OF THE ASSOCIATION.

We have explained the method used to obtain our associations. The observer was given a word and was required to say or write as quickly as possible what other word was suggested by it. For the sake of uniform results and for other reasons, this seemed the best way to begin an investigation into Mental Association, but it by no means concludes it; our experiments being, as we have seen, conditioned by the need of *naming* the suggested idea and doing it *quickly*. The nature of the process can best be gathered from our results, wherefore we give them as fully as is consistent with the reader's convenience. The lists of ten concrete and ten abstract words were used with 465 observers, and in Table VI. we give all the associations which occurred ten times or oftener, together with the number of times they occurred.

TABLE VI. *Most Frequent Associations.*

CONCRETE NOUNS.	
<i>House.</i>	74 room(s), 48 window(s), 89 brick(s), 25 [door(s), furniture], 28 garden, 19 people, 12 chair(s).
<i>Trees.</i>	212 leaf (ves), 45 branch(es), 28 green, 17 flower(s), 11 colour, 10 shrub.
<i>Ship.</i>	111 sail(s), 80 mast(s), 67 sea, 88 water, 19 boat, 16 [sailor(s), wood].
<i>Chair.</i>	115 leg(s), 64 wood(en), 52 seat, 46 table, 85 cane, 14 sitting, 12 stool.
<i>Clock.</i>	157 time, 121 hand(s), 27 watch, 23 pendulum, 18 tick, 14 [face, works].
<i>Bird.</i>	181 wing(s), 69 feather(s), 40 song(s), 28 singing, 15 sings, 14 flying, 12 nest.
<i>Shoe.</i>	86 leather, 74 boot(s), 60 foot (eet), 46 lace(s), 24 sole, 18 heel, 17 button(s).
<i>Hat.</i>	70 head, 46 feather(s), 41 straw, 88 ribbon(s), 82 bonnet, 80 trimming(s), 12 cap, 11 brim.
<i>Child.</i>	85 boy, 29 mother, 21 baby, 20 dress, 18 young, 16 girl, 15 parent, small, 18 age, 12 man, 10 [hair, infant, pretty, toy(s)].
<i>Hand.</i>	219 finger(s), 28 nail(s), 20 arm(s), 15 foot (eet), 18 glove(s).

ABSTRACT NOUNS.

<i>Time.</i>	102 clock, 56 hour(s), 27 minute(s), 18 tide, 18 watch, 12 year, 11 work.
<i>Courage.</i>	108 bravery, 68 brave, 19 strength, 16 bold(ness), 10 [fear, hero, man].
<i>Form.</i>	74 shape, 10 colour.
<i>Virtue.</i>	127 good(ness), 45 vice, 14 [patience, truth], 10 grace.
<i>Art.</i>	115 painting, 49 drawing, 45 picture(s), 48 science, 18 music.
<i>Love.</i>	84 kind(ness), 24 affection, 86 hate(red), 16 [mother, parents], 15 friendship, 12 like, 11 gentleness.
<i>Strength.</i>	46 strong, 48 weak(ness), 80 power, 26 force, 21 man, 15 courage, 14 health, 18 muscle.
<i>Part.</i>	60 whole, 24 portion, 18 share, 17 half, 18 piece.
<i>Beauty.</i>	55 lovely(iness), 46 pretty(iness), 22 ugly(iness), 16 face, 10 beautiful.
<i>Number.</i>	44 figure(s), 89 many, 84 one, 18 quantity, 17 arithmetic, 10 crowd.

We shall give below a classified list of all associations made on *house* and *time*. Here it may be worth while to call attention to the frequency of certain associations as shown by the Table. Thus, to nearly half the observers *tree* suggested *leaf (ves)* and *hand finger(s)*. In the above Table an average of less than eight associations with each word is given, and more than half of all the associations made were included within these narrow limits.

Before treating of the classification of our results, we shall give, in addition to Table VI., a selection from the associations made by B and C on the longer lists of words. The original word is given first in each couple, and after it the associated word.

TABLE VII. *Examples of Associations.*

- B. Water—pail, candle—stick, curls—yellow, tooth—wash, rod—spare, elbow—out at, cloak—blue, jam—raspberry, cap—fur, house—door, hair—golden, watch—clock, heathen—Christian, coat—red, nightingale—bird, philosopher—wise, battle—soldiers.
- C. Garden—house, forest—tree, spectator—theatre, rod—child, beast—beauty, melody—tune, queen—king, friend—enemy, affect—effect, building—house, mind—magazine, music—art, farm—food, rib—Eve, water—flow, tea—drink, protection—government, heathen—heath.

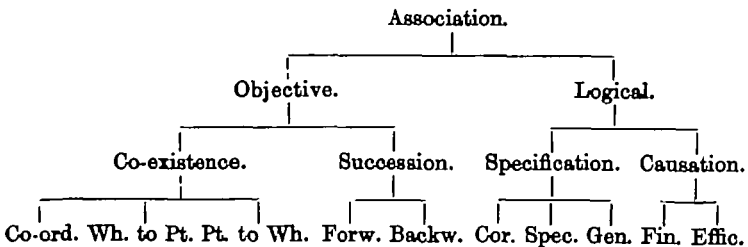
The associations given in Tables VI. and VII. illustrate the "Laws of Association" dwelt on by the English psychologists. The majority of them could be classified under Contiguity in space and time, Similarity and Contrast. Following the best authority, we may at once depose Contrast to a subdivision. We should then have left Contiguity in space and time, and Similarity. These two classes represent fundamental differences which are borne out by our experiments. Contiguity in space and time defines, perhaps, with sufficient accuracy the nature of the associative link, but the meaning is clearer when we



reflect that this class contains such associations as have been given us ready-made by sensation. Contiguity-in-space does not cover all cases of simultaneous contiguity, for example, a melody suggesting the words belonging to it. Contiguity-in-time calls up too much the idea of disconnected and sharply defined events following each other, whereas the associations of this class are probably due to the overlapping rather than to the succession. We prefer to use the terms Objective or Outer to define association due to previous connexion in sensation, and to subdivide it into Co-existence and Succession.

Similarity seems to be an unfortunate term. It gives at the outset an explanation, which is altogether rejected by many psychologists, and it does not naturally include cases of specification, definition and cause. In contradistinction to those associations which are given in sensations, we wish to designate such as are due to thought. These we shall call Logical or Inner. We do not wish to imply that the link of association must be wholly objective or wholly logical, on the contrary the results of our experiments show that in many, if not all, associations both factors are concerned. But in most cases it is easy to see which is predominant. Logical associations we shall subdivide into Specifying and Causal, analogous to the division of objective associations into co-existing and successive.

These four classes may with advantage be further subdivided. In the case of the Objective-Co-existing associations, there is an important distinction as to whether the movement is from Part to Part, from Whole to Part, or from Part to Whole—for example, whether *house* suggests *garden*, *window* or *street*. There is a quite analogous distinction with the Logical-Specifying associations, the relation in which may be Correlation, Specialisation or Generalisation; thus *house* may suggest *church*, *villa* or *building*. In Successive associations the direction may be forward or backward, that is, in an order the same as, or the reverse of, the original presentations,—thus, *house* may suggest *top* or *glass*. Analogously Causal associations may be either Final (forward) or Efficient (backward), that is, may give end or means, the terms being used in a sense broad enough to include all causal relations; thus *house* may suggest *shelter* or *builder*. The plan of classification which we obtain is thus as follows:—



In Table VIII. we give all the associations made by 465 observers on the words *house* and *time*, classified according to the method we have proposed.

TABLE VIII. *Associations with*

*House.*

- Co-ordination—25 furniture, 23 garden, 19 people, 12 chair(s), 7 table(s), 4 trees, 2 bed, pictures, 1 [boy, cat, girls, grounds, lady, master, men, road, servant-girl]; (108).  
 Whole to Part—74 room(s), 48 window(s), 25 door(s), 18 roof, 7 stairs, 6 bricks, walls, 4 chimney, 8 storey, 2 floor, stones, 1 [bedroom, glass, kitchen, street-door, slates]; (190).  
 Part to Whole—8 [street, town], 2 road; (8).  
 Forwards—7 -top, 4 -maid, 2 [-dog, -rent, -to let], 1 [-agent, -hold, -of commons, -step, that Jack built, watch, -wife, -work]; (25).  
 Backwards—1 glass; (1).  
 Correlation—6 cottage, 5 mansion, 2 cot, 1 church, hut, 8 mouse (*verbal*); (18).  
 Specialisation—6 tall, 5 [brick, size], 8 [home, large, situation], 2 [dolls, height, high], 1 [big, grey, kind, low, magnificent, Morton Hall, pretty, this house of wood, tool-house, villa]; (41).  
 Generalisation—7 buildings, 5 dwellings, 2 habitation, 1 abode; (15).  
 End—8 [home, inhabitants], 2 [inmates, to live in, shelter], 1 [dwelling-place, habitation, live, people]; (16).  
 Means—88 bricks, 6 builders, 2 built, 1 [build, stones, wood]; (44).  
 Unclassified—1 [dice, hat, wind]; (8).  
 Misunderstood—(1).

*Time.*

- Co-ordination—(0).  
 Whole to Part—(0).  
 Part to Whole—(0).  
 Forwards—18 tide, 11 work, 7 flies, 2 [be quick, space], 1 [ever-rolling stream, flies fast, how it flies, -keeper, money, o'clock, price, race, reapers, slaves, -table, "time, gentlemen, time," -to do it, -to learn, -up, "waits for no man," -waits]; (57).  
 Backwards—1 [lose, lost, thief, when Father Time]; (4).  
 Correlation—8 eternity, 6 place, 5 [age, space], 8 [hurry, speed, to death, quickness, weather], 1 [duration, duty, haste (need for), life, manner, old age, swiftness], 8 thyme; (49).  
 Specialisation—56 hour(s), 27 minute(s), 12 year, 9 [day, long], 7 [late, lessons], 4 [quick, second(s)], 8 [length of time, scythe, short, when], 2 [early, fast, holidays, how long, how much, lost, night, quickly, seasons, waste], 1 [classes, examination, fast or slow, Father Time, for play, good, image, infinite, leaving school, magazine *Time*, moment, no time now, present, slow, slowness, something o'clock, soon, swift, term, train, twenty-four hours, what, what time, what time now, youth]; (194).  
 Generalisation—4 length, 8 space, 1 [passing, value]; (9).  
 End—1 [commerce, employment, not to waste, use, work]; (5).  
 Means—102 clock, 18 watch, 2 [hands (of clock), works (of clock)], 1 [hour-glass, sun-dial, tick (of clock), vibration]; (128).  
 Unclassified—1 [poems, temper, water, will]; (4).  
 Misunderstood—(23).

This classification gives the most convenient divisions which we were able to make of the associations obtained by our experiments. We do not, however, look on the classes as 'natural kinds'. On the one hand our subdivisions run into each other, and an association is rarely or never due to one only of the relations; on the other hand further subdivisions might be made.

The relation of Part to part, Whole to part, and Part to whole, with the corresponding logical subdivisions, Correlation, Specialisation and Generalisation, are perhaps the most important of the distinctions, but they are not defined with entire sharpness. Thus it depends on the attitude of the observer's mind whether *house—furniture* is a relation of Part to part or of Whole to part, and *house—cottage* of Correlation or Specialisation.<sup>1</sup> It seems possible that in most cases of Co-ordination the mind goes first to a whole and then to a part; thus, *house* may call up the complex *house and garden*, but there being no convenient name for this, *garden* is named. In associations which have been put under Cause and Succession the movement is often from a part to a whole; thus, when *bird* suggests *sings*, the total complex may be a singing bird, and when *house* suggests *top*, the part leads to a verbal whole.

As concerns further subdivisions of the classes, it is evident that the Objective associations might be distributed among the senses by means of which they were originally given. As a matter of fact the associations of Co-existence are almost without exception visual, and the associations of Succession verbal, i.e., a complex of auditory, muscular and perhaps visual sensations (of printed words). The Logical associations might conveniently be further subdivided. Similarity and Contrast are natural subdivisions of Correlation, and there is an intervening class represented by associations such as *king—queen*, *shoe—boot*, &c. Then verbal similarities such as rhymes and alliterations are materially different from the rest. Specialisation includes a general or particular case as, *strength—man*, or *Sampson*, and a qualification, as *hair—yellow*. Generalisation includes associations as different as *snow—white* and *music—art*. An End or Final Cause may be purpose, object or act, as in the examples, *house—shelter*, *love—mother*, and *boy—run*, and in the case of act the given idea may be taken either as active or passive; thus water may suggest *flow* or *drink*. Under Means or Efficient Cause are included source, material, &c.

Returning to our chief divisions, we give in Table IX. the percentage of associations falling to each. It contains the results of more than 12,000 observations made with 516 observers. The majority of these, however, were school-girls, as their results

<sup>1</sup> In Table VIII. such associations are put under Co-ordination, but C thinks in the case of young students the relations were most likely of Whole to part and Specialisation. There are also a few other cases in which the writers differ as to the classification.

dominate. An analysis for different classes of observers will be given below.

TABLE IX. *Percentage of Associations.*

		CON- CRETE.	AB- STRACT.	PROPER	VERBS.	AD- JECT.
	No. of Associations.....	6120	5810	200	200	200
Objective.	Co-ordination.....	10	0	17	0	0
	Whole to Part.....	84	0	10	0	0
	Part to Whole.....	1	0	17	0	0
	Forwards.....	4	5	9	15	9
	Backwards.....	2	1	5	1	0
Logical.	Correlation.....	10	88	16	18	18
	Specialisation.....	19	81	7	48	68
	Generalisation.....	8	8	5	0	1
	Final Cause.....	18	4	12	9	0
	Efficient Cause.....	1	4	2	9	4
	Unclassed.....	1	2	0	0	0
	None.....	1	6	0	0	0
	Misunderstood.....	0	6	0	0	0
	Objective.....	51	6	58	16	9
	Logical.....	46	80	42	84	91
	Verbal.....	6	6	11	14	6

The Table shows that in the case of concrete nouns the ratio of Objective to Logical associations was 51 : 46, that is, the link of association was not quite as often supplied by thought as by sensation. As regards subdivisions it will be noticed that Whole to part and Specialisation are favourite categories, whereas Part to whole and Generalisation are not often used.<sup>1</sup> Employing the terms to include both Logical and Objective associations, Co-ordination was the relation in one-fifth of the cases, Whole to part in more than half, and Part to whole in one-twenty-fifth. In Succes-

<sup>1</sup> Steinthal says (*Einl. in die Psych. u. S.W.*, p. 161) the part more readily suggests the whole than the reverse, because "the mind rests in the thought of a whole". The advantage of experiment to theory is illustrated by comparing this with our results.

sion, Backwards occurred half as often as Forwards; and in Cause, Efficient was much rarer than Final. In 1 per cent. of the cases the association could not be classified, and in 1 per cent. no association was made. Our classification is not as useful for abstract as for concrete nouns, as with abstract nouns, Objective associations, other than verbal, scarcely occurred. The classes Correlation and Specialisation are about equal in size, each including nearly one-third of the cases, and four times as many as Generalisation. Fewer experiments were made with proper nouns, verbs and adjectives, and these were confined to B and C. In the last line of the Table is given the percentage of cases in which the association seemed to be purely verbal.

The nature of the association differs considerably with different persons and classes of persons. This variation in the case of concrete nouns may be studied in Table X. The first four columns contain the results of experiments made by Mr. Edgeworth, Miss Collet, and the writers; the fifth column by 31 university students and graduates (mostly women); the four following columns by the several forms of the London girls' school; the next column by the Dublin girls' school; and the last column by the boys of a German Latin school.

TABLE X. *Percentage of Associations with different Observers.*

OBSERVERS.	E.	CT.	B.	C.	UNIV. GLADS.	LONDON SCH.				DB. SCH.	GER. SCH.	AV.
						VL.	V.	IV.	III.			
No. of Assoc....	250	250	250	250	810	800	1880	1110	840	710	470	
Co-ordination..	11	8	14	9	7	15	12	10	10	7	8	10
Whole to Part..	4	8	4	1	47	85	41	47	42	80	82	84
Part to Whole..	1	6	8	8	0	8	1	0	1	0	4	1
Forwards.....	8	14	14	10	1	1	1	1	0	5	10	4
Backwards.....	5	19	5	2	0	0	0	0	0	0	5	2
Correlation.....	22	19	20	12	9	24	6	4	6	18	17	10
Specialisation..	88	19	24	21	20	10	18	19	15	28	16	19
Generalisation..	11	1	5	2	2	1	1	8	2	5	5	8
Final Cause.....	7	8	8	87	11	10	15	11	16	12	7	18
Efficient Cause.	1	2	1	8	2	0	1	2	1	0	1	1
Unclassed.....	0	4	0	0	1	1	1	1	1	1	0	1
None.....	0	0	0	0	0	0	1	0	4	4	0	1
Objective.....	24	50	40	25	55	54	55	58	58	42	54	51
Logical.....	74	44	68	75	44	45	41	89	40	58	46	46
Verbal.....	8	88	26	12	2	1	2	1	1	8	14	6

The Table shows that Logical and Verbal associations are favoured by the first four observers, who teach and write. With the students Whole to Part is the favourite category, they seem to visualise the object and name some part of it. With the English school girls less than half the associations are Logical, and very few are Verbal. With the Irish school girls more than half are Logical, and 8 per cent. are Verbal; this is perhaps due to the fact that the training in the Irish school is more literary. While the students of the London school made only about 1 per cent. of Verbal association, Ct and B, who teach in the school, made respectively 33 and 26 per cent. The 14 per cent. of Verbal associations made by the German students is doubtless due to the nature of the language. The largest proportion of logical associations ( $\frac{2}{3}$ ) was made by E and C, who are engaged in abstract studies.

The nature of the association depends not only on the observer, but also on the word given. The percentage of the several kinds of associations occurring with different words is given in Table XI.

TABLE XI. *Percentage of Associations with different Words.*

456 ass. on each word.	TRML.	CHAB.	BIRD.	CLOCK.	CHILD.	HAND.	TIME.	ART.	COURAGE.	LOVE.	NUMBER.	BEAUTY.
Co-ordination..	4	10	12	1	12	10	0	0	0	0	0	0
Whole to Part..	65	40	46	41	11	56	0	0	0	0	0	0
Part to Whole..	2	2	1	0	0	1	0	0	0	0	0	0
Forwards.....	0	0	0	0	8	8	12	2	2	5	2	8
Backwards.....	0	0	0	0	0	0	1	1	0	0	0	0
Correlation....	8	8	1	8	16	5	10	15	54	36	21	80
Specialisation..	15	29	18	4	40	9	42	62	16	12	52	37
Generalisation.	5	0	1	1	7	2	2	6	18	15	6	18
Final Cause....	1	9	28	42	4	9	1	4	2	18	1	8
Efficient C.....	0	0	0	0	0	0	26	7	0	2	7	2
Unclassed.....	0	0	2	2	2	1	1	1	2	1	2	0
None.....	0	1	1	1	5	4	5	2	6	11	9	5
Objective.....	71	52	59	42	26	70	18	8	2	5	2	8
Logical.....	29	46	38	55	67	25	81	94	90	88	87	90

The Table shows that the association is largely determined by the original word. *Tree* and *hand* are natural objects which are easily pictured, and have parts (leaves and fingers respectively)

readily named. With *child*, on the other hand, Specialisation was the favourite category. Final Cause was the largest class in the case of *clock*, a thing made and used for the special purpose of measuring time. Conversely *time* often suggested the means of its measurement. Of the other abstract nouns, *art* and *number* were commonly specialised, while *courage* and *love* most frequently suggested a similar or contrasted idea.

We wish to lay special stress on our Tables, as these contain the results of extended series of experiments. In a joint paper it is not convenient to enter into criticism and discussion; we have, consequently, confined ourselves to the exposition of our research. We, however, add a section in which several of the observers discuss the experiments with special reference to the subjective aspect of the association.

#### IV. REMARKS ON THE EXPERIMENTS.

By G. F. STOUT.

I wish chiefly to draw attention to the nature of the process by which the mind passes from the given idea to that suggested idea which is the first to be definitely recognised and named. In my case the transition seems to be most commonly mediated by a more or less obscure total presentation, including as part of its content both the given and the suggested ideas. At the time when I was subjected to these experiments, I always felt that the word which came first to my lips, and which was therefore set down in Dr. Cattell's list, was a hopelessly inadequate indication of what was actually taking place in my mind. By retrospection following close upon the actual process, I was for the most part able to recover and analyse those contents of my consciousness which I had found it impossible to express in words or to render explicit in thought.

Examples will make my meaning clear. *Smoke* suggested *fire*. The intermediate link in this case was not the picture of a fire smoking. It was the phrase, "Where there is smoke there is fire". Nor was the connexion merely a verbal one. The words were quite indistinct. The first among them to emerge into clear consciousness was the word *fire*. In the intermediate state, what vaguely floated before my mind was the general sense of the saying considered as an example of inference. There was also traceable in my mind a dim and distant reference to a lecturer who had used this illustration in my hearing. *Finger* suggested *heart*: in this instance, transition was mediated by the vague total presentation of the circulation of the blood. I thus came to think of the heart as propelling blood to the extremities. *Cannibal* suggested *Andrew Lang*. Here there loomed before me the massive and blurred presentation of what I now in retrospect name and recognise as "anthropology". In this in-

distinct totality, the first detail, besides the given one *cannibal*, which acquired sufficient definiteness and salience to be verbally expressed was the name of the well-known author, *Andrew Lang*.

It would be possible for me to analyse a large number of similar examples. The great majority of the suggestions in my case were of the kind described. The transition from *tail* to *the rest* is worth noting, because in this case the process was concluded, so to speak, at an earlier stage than usual. *Tail* revived the obscure presentation of the whole animal. Instead, however, of singling out some special detail within this whole, it occurred to me just to name *the rest* of it without further ado.

The instances in which I proceeded from given whole to a part of that whole, or from a given part to the whole comprehending it, were comparatively few, and I do not think that they require any special discussion. The usual course of reproduction in my case passed from a named and definite partial presentation by the mediation of an unnamed and obscurely defined total to another named and definite partial presentation.

The next point to which I wish to call attention is the limitation imposed on the subject of the experiments by the necessity of finding a verbal expression for his thought as soon as possible. This is certainly a disturbing condition, which interferes with the analogy between the experiments and the normal course of reproduction. There is perpetually present in the mind of the experimentee a voluntary effort to find some word or other, whatever it may be. This circumstance seems to me greatly to augment the influence of merely verbal connexions on the flow of ideas. It might be well to try experiments in which no regard should be paid to the time occupied by the process of suggestion.

In conclusion, I may remark that what interests me most in these experiments is the indication which they seem to afford, when closely examined, of the operation of obscure links in the process of reproduction. The psychological atomism of the English associationists is perhaps mainly due to the neglect of these obscure phenomena. If we lose sight of the indistinct whole which mediates transitions between its component parts, the train of ideas must of necessity appear a separate and exclusive succession.

By F. Y. EDGEWORTH.

With regard to these words I have hardly any explanation to give. I just stuck down, or rather cried out, whatever word came up first. The first word did not always correspond to the first idea. Often there seemed to be a throng of ideas struggling for expression. Thus, in the case of *Saint Matilda*, the word *Saint* raised the ideas of an amiably mild lady, in fact the picture of Saint Cecilia, only I could not remember in time her name; and the first name which occurred was that of the heroine in *Rokeby*, suggested by some similarity of character.



I could have gone a little faster, I think, if I had made an effort; but I thought it best to make as little effort as possible. The most conscious exercise of will occurred after assigning adjectives to several words, such as *beautiful* to *hair*, *bright* to *lamp*. I felt it would be stupid, and perhaps disappointing to the experimenters, if all the results came out of this type, so I changed my hand and checked the flow of adjectives.

By E. P. HUGHES.

My attitude of mind during the experiment was this: I did not care at all what words were suggested; my mind was free to suggest any words; but I had decided the words were to come quickly. I *willed* that they should come quickly; I did not *will* as to the kind of words that came.

At first I found nouns suggested nouns, and there was generally a connexion that could be traced. After a little, however, I found the nouns suggested not nouns but whole sentences, and a word out of these sentences was taken, sometimes an adverb, or a verb, or an adjective, and very occasionally a noun. *E.g.*, the word *slave* brought up to my mind many sentences expressing my detestation of slavery, and I said the word *bad*.

I allowed my mind to work in any direction as long as it worked quickly; but all the time I found myself criticising the connexions, and generally recognising whether they were reasonable or not, and being amused at absurd and far-fetched connexions, and also when the word said was in no way connected, as far as I could see, with the word given.

I found a great difficulty in remembering afterwards the words I had said. I found it easier to remember them several minutes later than immediately after I had said them. In one instance I utterly failed to remember what word I said at the time, and remembered it with little effort ten minutes later.

I found it was easy to say words after the first three or four words of the 10 words in a group; it then became difficult, but I felt at the end of the 10 words, if the list had been longer, I should eventually have given the words more quickly.

After two or three groups of 10 words, I came to a word I could not read, and from that time I felt a waste of energy in so far as I continually dreaded meeting a word I could not read. In the fourth group I misread a word, and thought it was a verb and not a noun, and when I learnt my mistake I felt there was a further expenditure of energy to the end of the experiment, because I always dreaded taking a noun for a verb; and once the word *bottle* raised in my mind the question whether it was a verb or a noun, and I said mentally 'noun,' and ejaculated *Yes*.

When I started by mentioning the 'colour' of a noun given I generally gave several colours, and the same with 'shape'. I found there was a greater inclination to give shape than colour.

Occasionally I remembered the general impression given by a word, e.g., *slave*, but I could not remember the particular word I gave, viz., *bad*.

The word *cow* appeared frequently. I have a special horror of cows.

*Hat-good*: I had lately made a hat-rack, and one part of it was specially praised; my teacher was a foreigner and used the word 'good,' and, as he did not speak in English as a rule, the word was very impressive. *Baggage-bandage*: my father, when a surgeon in the militia, kept a supply of bandages in his baggage, which I had rolled up sometimes.

By C. E. COLLET.

Eight per cent. of the words suggested by the 250 concrete nouns selected for experiment were names of things in coexistence; here in nearly every case the idea excited by the name suggested the next idea, and that idea suggested the name: the mental processes were comparatively simple. The word *cavalier* suggested the word *Charles I.*, having aroused a picture of the times of Charles I., in an atmosphere of Sir Walter Scott's novels, with Vandyke's portrait somewhere in space. *Scaffold* suggested confused representations of persons in fiction ascending scaffolds, including Sydney Carton (*A Tale of Two Cities*), Clayton the actor, and, most distinct of all, Strafford, whose name was the one actually uttered. The names of the others did not enter my thoughts, and the whole picture was vague, most prominent being the representation of feelings excited when reading the stories of Carton and Strafford.

Only two per cent. of the words suggested were the names of parts of the things denoted by the words read.

Six per cent. were names of wholes suggested by names of parts; e.g., *violin* suggested by *string*; *theatre* by *curtain*; *Attic* by *philosopher*, this association being partly due to an image of *Le Philosophe sous les Toits*, and partly to the verbal association 'Attic philosopher'.

Fourteen per cent. of the words come under the head of Forwards Associations, nineteen per cent. under the head of Backwards Associations; so that thirty-three per cent. are classed as Verbal Associations, and of the nineteen per cent. classed under Specialisation many are undoubtedly verbally suggested.

As examples of verbal forwards associations, *bell* suggested *bell-horse*, the name given by workmen to men encouraged to spur them on to greater speed; *cap* suggested *cap-à-pie*, neither word raising any representation beyond the printed letters; *mob* suggested *mobilise*; *hand* suggested *hand-maiden*. In these cases the train of thought is started by words, not by ideas. One noteworthy exception to this is the suggestion of the word *sweep* by the word *chimney*. This word at once revived Hans Andersen's story of the China shepherdess; the word was localised in China-

shepherdess land, and the whole story reviewed, so far as I can judge, before the word *sweep* came to the lips as the easiest to be uttered.

The 48 words classed as instances of Specialisation, and the 48 words classed as instances of Backwards verbal association resemble each other in being to a great extent the result of verbal association, but the dominating mental process was different. The specialisations were nearly all suggested by words rather than by a specialising process on my own part, but the words did actually suggest to me the special things, and my attention was given to them; e.g., *garden* suggested *kitchen*, and attention was given to the representation of a kitchen-garden. Under the head of Backwards associations I have put words which were verbally suggested but which were not accompanied by representations of the things denoted by them. The instances under this class are the results of a complex process. E.g., *ornament*. The first syllable, together with the meaning of the word, aroused faintly the words, "Beauty unadorned adorned the most," and the first word actually uttered was *beauty*.

*Men* suggested the title of Stevenson's book, *The Merry Men*, but concomitantly with it rose the representation of the story in which I localised the 'men'—the story, not the book. The written word seems always to take up a position in space and to be a kind of keyhole through which the mind passes to an imaginary world. It arises most probably from a constant habit of reading fiction and looking at a world located beyond the printed page which gives admittance to it.

The word *skin* was followed by the name *Nicodemus*. At first, although quite conscious of the mental process preceding the utterance of the word *Nicodemus*, I could not see any connexion that *skin* had with it. As soon as I saw the word, I was looking at the representation of a fairy tale: a little dwarf was jumping before the fire, and I seemed to know all about him and to know his name, but I could not say it; *Nebuchadnezzar* (the last part of the name being very faint) rose as somewhat analogous, but not the word I wanted, and was followed by the utterance of *Nicodemus*, which seemed more satisfactory. The word which I wanted to pronounce was *Rumpelstiltskin*, and the analogy between the names was then and is now quite clear to me; *Nicodemus* and *Rumpelstiltskin* seem alike, both rhythmically and in a certain element of ridiculousness which I cannot define. But it was some time before it flashed upon me that *skin* had raised the name and the story of *Rumpelstiltskin* by a backwards association.

Instances of Co-ordination were nineteen per cent. of the whole. In this class many of the words suggested were merely different names for the things denoted by the written words; e.g., *brain* suggested *cerveau*. Compared with the others, this class is noticeable for the absence of reference to books, songs, speeches, &c.

There was not one instance of Generalisation.

By S. BRYANT.

The mental process concomitant with the utterance of the suggested word appears to me of such considerable complexity in many cases as to be by no means expressed or even hinted at in the spoken word. This, in fact, expresses one feature of the whole, because that feature was either most interesting, most prominent, most easy to name or earliest in time. In the case of concrete nouns, such as water, plate, lane, the most conspicuous factor of the whole process in my mind was the definite and varied activity of the pictorial imagination. Into whatever class the expressed association eventually falls, there went with it a picturing out of either the expressed or associated idea, or both, with quite a considerable surrounding of local and other particulars.

The simplest cases were those coming under the first head. Thus *water-pail* means a simple picture to the second element in which the spoken word attaches, and this is classed under Co-ordinate Existence; the picture here appeared to be present before the word and to have caused it. On the other hand, *candle-stick* seemed in the making of it to be verbal only—an auditory and motor sequence in time—but the picture of a candlestick followed so simultaneously that this association also might easily have been taken to mean primarily a case of Co-ordinate Existence. Verbal associations with this pictorial sequence occurred quite commonly, and these as well as others I felt bound to classify as Verbal associations, though if made by other people I should have treated them differently in default of the necessary introspective knowledge. With such a verbal association as *rod-spare*, into which was quite consciously condensed the whole quotation, "Spare the rod and spoil the child," imagination threw up vague pictures of naughty children and irate old dames, while the name at least of Solomon rose also to mind, though passing on in haste to the next word on the list. My verbal associations, including rhymes, amount to the large proportion of 26 per cent., being much the largest that occurs with the exception of Miss Collet's high proportion of 33 per cent.

The favourite class for the majority of those experimented on is that of Whole to Part, and this might seem at first to be the most natural expression of the fact that the meaning of a concrete noun is most commonly realised by the formation of a pictorial image. I make, however, only 4.4 per cent. of associations under this head, and only 22 in all the Co-existence classes taken together, while the class of Specialisation alone contains 24.4, and is my most favoured class. But I found the pictorial element very potent in associations of this kind. In *curls-yellow*, for instance, the picture of yellow, curling hair rose distinctly to mind, with attention fixed on its admired character of golden

yellowness ; and the associated word is simply descriptive of the image seen under a distinct play of æsthetically inspired imagination. Similar remarks apply to *cloak-blue*, *jam-raspberry*, *cap-fur* ; the image is described as it happens for some reason or other to be particularised, and in the two former cases I was aware of a preferential motive. In such cases it is probable that the image is less generic than when *house* suggests *door*, or *table chair*. In *house-door* the image may be generic, and the attitude of mind is certainly analytic ; while in *cloak-blue* the image must be specific up to a certain extent, and the attitude of mind qualitatively descriptive as well as particularising. Thus the two descriptions *hair-face* and *hair-golden* indicate quite different movements of mind, though they might have started from similar images of hair in the first instance.

In calling such results as we have obtained associations it is understood that the word is used in a broad sense, and any discussion of the limits which should be put on its exact use would not be suitable here. I may, however, point out that the forced rapidity of the process by which the subject of experiment linked each word to each must have tended to secure that the most readily suggested word came to hand first, thus excluding, so far as possible, deliberate acts of choice, which would certainly have presented results that were not mere associations. To secure the minimum of thought proper is essential in the production of associations. Nevertheless, it is quite certain that even with all haste a considerable amount of thinking and choosing does get itself done in these experiments ; and I believe the introspection of other observers will bear witness with mine on this point. The exact analysis of the processes and their proper classification would require much careful observation and experiment of an introspective character. All that it seemed possible to do in objective experiments, such as ours were in the main, was to eliminate the higher thought activities as much as we could by not giving them time to produce spoken results.

By J. MCK. CATTELL.

I find it extremely difficult to observe by introspection the process of association, whether in the usual course of mental life or in experiments such as are here recorded. If, however, I combine the results of these experiments with introspection, I conclude that, when one idea suggests another, they have previously been associated in a common presentation, and that the suggestion is possible because the idea in distinct consciousness belongs to a larger whole, some of it indistinctly given, the rest below the threshold of consciousness. In conclusion, I should like to emphasise the fact that we have made *quantitative* determinations in two directions : we have measured the time of mental association, and obtained statistics of its nature.