IV.—RESEARCH.

THE TIME TAKEN UP BY CEREBRAL OPERATIONS.[1]

By JAMES MCKEEN CATTELL, Ph. D.,

Assistant in the Psychological Laboratory, University of Leipsic.

III. *The Perception-Time.*

We have found the simple reaction-time on daylight for B and C to be about 150σ, and I have given my reasons for assuming that a perception-time is not included in this interval. The perception-time can be defined as the interval between sensation and perception (or between indefinite and definite perception, apperception), that is, the time passing after the impression has reached consciousness before it is distinguished. The impression is perhaps in the back-ground of consciousness when it reaches the optic thalami; before it is in the centre of consciousness it must probably travel to the cortex of the cerebrum and excite there changes corresponding to its nature. The method used by Wundt[2] to determine this time is to let the subject react as quickly as possible in one series of experiments, and in a second series not to react until he has distinguished the impression, the difference of the times in the two series giving the perception-time for the impression. I have not been able myself to get results by this method; I apparently either distinguished the impression and made the motion simultaneously, or if I tried to avoid this by waiting until I had formed a distinct impression before I began to make the motion, I added to the simple reaction, not only a perception, but also a volition. The method for determining the perception-time suggested by Donders[3] and since used by a number of others, is to let the motion depend on the nature of the stimulus. It has been thought by Donders, v. Kries and Auerbach and others, that if the subject reacts on one of two impressions and makes no motion when the other occurs, only a perception has been added to the simple reaction. This is however not the case, it being necessary after the impression has been distinguished to decide between making a motion and not making it. This question, which has been much discussed, becomes quite simple if we consider the cerebral operations that probably take place. I assume that the changes do not penetrate into the cortex at all when a simple reaction is made.

[1] Continued from MIND 42, pp. 220-42.

[2] *Physiol. Psych.*, ii., 247 ff.; *Phil. Studien.*, i., 25 ff.

[3] De Jaager, *De physiologische Tijd Bij psychische Processen*, Utrecht, 1865; Donders, *Archiv f. Anat. u. Physiol.*, 1868.

When, however, lights of two different colours (say red and blue) are used, and the subject may only lift his hand if the light is blue, the motor impulse cannot be sent to the hand until the subject knows that the light is blue. The nervous impulse must therefore probably travel from the thalami to the cortex and excite changes there, causing in consciousness the sensation or perception of a blue light; this gives a perception-time. In the cortex after the light has been distinguished a nervous impulse must be prepared and sent to the motor centre discharging a motor impulse there held in readiness.; this gives a will-time. I do not think it is possible to add a perception to the reaction without also adding a will-act. We can however change the nature of the perception without altering the will-time, and thus investigate with considerable thoroughness the length of the perception-time.

The object most quickly perceived through the sense of sight is a simple light. In order to investigate the time required I took two cards, one entirely black, the other having on the black a white surface. One of the cards, the observer not knowing which, was placed by the experimenter in the springs of the gravity-chronometer, and the clockwork of the chronoscope was set in motion. The observer fixated the grey spot on the screen immediately before the centre of the white surface (supposing this card to be there), and with his left hand broke an electric current and let the screen fall. The card appeared at the point fixated, and at this same instant the current controlling the chronoscope was closed. The observer either saw nothing, or at the point fixated a white surface. If the light appeared he lifted his hand as quickly as possible, if there was no light he did not let go the key, and the hands of the chronoscope ran on until the clockwork was stopped by the experimenter. Twenty-six experiments were made in a series, the white light occurring thirteen times. Determinations were only made when the light occurred, so the averages in this section are from thirteen reactions (in the corrected series from ten). It will be seen that, as the observer tries to make the reaction as quickly as possible, he may lift his hand when the light is not present. If this happens often the times measured are not correct, but too short, since we may assume that the observer lifts his hand as often when the white light is present before he has seen it, as he makes the motion when no light comes. We must however expect such a false reaction occasionally to occur, otherwise we might assume that the reaction is not made in the minimum time when the light is present. In these experiments such false reactions scarcely happened except when the observer was disturbed, or when the impressions to be distinguished were similar (E from F, for example). In the first case the average is not seriously affected, as the reactions are as apt to be unduly retarded as unduly hurried. In the second case false reactions lead us to suppose that some of the reactions on the stimulus are too short. The method I have introduced of giving a corrected average eliminates all premature reactions. I give in the Tables the number of false reactions made;[1] it would have been well if v. Kries and Auerbach, Merkel and others had done the same.

We can now examine the Table giving the time needed to perceive and react on a white surface.

TABLE XII.

	B				C			
	R	V	R′	V′	R	V	R′	V′
14. I.	203	8	203	6	239	14	246	7
19	217	18	213	12	219	13	217	10
20	222	22	222	15	226	13	226	9
31	234	35	217	11	238	13	241	10
2. II.	219	21	214	13	215	16	217	11
	214	30	206	18	216	12	219	7
3	207	20	203	7	256	20	254	10
25. III.	239	28	234	21	250	19	253	15
	212	19	205	6	263	22	259	9
31	215	34	205	15	244	16	248	9
	189	13	186	6	245	10	242	7
	191	16	189	7	251	11	252	5
	183	12	185	8	246	17	242	12
2. VII.	213	13	212	7	262	7	262	4
4	209	13	210	8	251	11	251	6
A.	211	20	207	11	241	14	242	9

The simple reaction-time for B and C is about 150σ, therefore (on our hypothesis as to the nature of the cerebral operations, and assuming, though not without hesitation, that the corresponding physiological processes take up the same time as in the simple reaction) the time needed for the nervous impulse to travel from the thalami to the centre for sight in the cortex and excite the cells there so as to call forth the sensation of a light, and for a will-impulse to be prepared there and sent thence to the motor centre, was for B 61, for C 95σ. We may suppose that the time of the centripetal and centrifugal progress through the brain is about the same, and that the time used in the cortex is about equally divided between the perception of the light and the preparation of the motor impulse; at all events the whole time is so short that, if we divide it equally between the processes of perception and volition, the error cannot be great. We therefore set the perception-time for light, where the nature of the light need

[1] After "false," the entire number made during the series given in the column under which it stands.

not be distinguished, at 30σ for B, 50 for C, and the will-time in these and similar experiments at the same.

The reaction was made with the speech-organs in quite the same manner. When the white surface was seen the observer said 'Weiss' and the hands of the chronoscope were stopped by means of the lip-key or sound-key. When no white surface was present the observer said nothing, and the hands ran on until the experimenter stopped the clockwork.

TABLE XIII.

	SOUND-KEY.				LIP-KEY.			
	B		C		B		C	
	R	R′	R	R′	R	R′	R	R′
3. IV..........	246	241	282	281	236	241	276	275
4..............	255	247	302	308	241	246	281	276
5..............	234	237	274	268	233	235	256	250
	247	244	264	264	243	248	263	263
7..............	248	246	274	268	244	245	256	256
A..............	246	243	279	278	239	243	266	264
AV............	20	11	18	12	14	9	18	12

We have seen that the motor-time is longer when a simple reaction is made with the speech-organs than when it is made with the hand. There is no reason why the perception and will-time found by subtracting the simple reaction-time (Table III.) from the time here measured should not be the same as when the reaction was made with the hand. If we average together the determinations with the sound-key and lip-key we get 65σ for B, 100 for C, which agrees very well with the determinations made with the hand.

If instead of two black cards on one of which there is a white surface, we take two white cards on one of which there is a black surface, and let the observer react only when the black is present, the conditions are substantially as before; the perception may require slightly longer, the will-time is probably the same. The results of such experiments are given in Table XIV.

If, instead of black, we place a colour on the white card, the perception becomes slightly more difficult; it is not quite so easy to see that something is there when it is yellow as when it is black, the will-time however presumedly remains the same. In one series of experiments (to the left in Table XV.) only one colour was used at a time, in a second series (right in Table

XV.) ten colours, the observer not knowing which was to come, but not needing to distinguish it before making the motion.

TABLE XIV.

	B				C			
	R	V	R′	V′	R	V	R′	V′
6. I.	250	20	253	15	236	21	233	16
14	227	19	226	7	236	13	234	10
19	245	21	249	13	231	14	230	8
20	215	20	212	14	244	12	243	7
31	227	10	227	7	246	21	241	13
A.	233	18	233	11	239	16	236	11

TABLE XV.

		B		C			B		C	
		R	R′	R	R		R	R′	R	R′
Orange	22. XII.	291	296	258	261	22. XII.	289	293	245	237
Violet		262	269	251	255		260	254	259	263
Black		250	253	236	233		263	255	250	253
Pink	6. I.	268	263	270	266	6. I.	238	242	245	240
Brown	7.	295	290	267	263	7.	278	282	241	244
Gray	9.	291	280	267	265	9.	234	237	276	277
Red	10.	277	282	264	265	2. II.	230	230	232	229
Blue		265	263	284	279		219	223	242	237
Green		262	264	268	268		229	219	245	244
Yellow		264	262	280	286		230	228	254	257
A.		272	272	264	264		247	246	249	248
AV.		20	13	18	13		25	17	24	17
False		1		0			0		2	

It thus takes a little longer to recognise the presence of a colour (even though the colour need not be distinguished) than of a white light. It is to be noticed that B's times became shorter in 1885 than they were in 1884.

We next determine the perception-time when it is necessary to distinguish the colour. Two cases were considered; in one the colours were taken in pairs, and one colour was distinguished from the other; in the second each colour was distinguished from ten colours. With blue and red electric lights (the above-mentioned Puluj's tube seen through coloured glasses) I got as perception- and will-time 75σ for B, 109 for C.[1] In most of my experiments however, with aid of the gravity-chronometer, I used daylight reflected from coloured surfaces, these exciting the processes with which our brain is occupied in our daily life. Red and blue and green and yellow were taken in pairs, the coloured surface being 3 × 30 mm. The numbers in Table XVI. give the average of six series.

TABLE XVI.

		B				C			
		R	V	R′	V′	R	V	R′	V′
27. XI.-2. XII.	Red....	278	22	272	11	322	40	324	26
	Blue...	287	19	280	17	291	24	288	16
I.-5. XII........	Green..	268	26	265	18	313	32	312	21
	Yellow	276	26	273	16	297	31	300	20
	A.......	277	23	272	15	306	32	306	21
	AV.....	2				8			

Ten colours were further taken in pairs, as indicated in Table XVII., and the time required to distinguish the one from the other determined.

If we average together the results given in Tables XVI. and

[1] These are the only experiments described in this section which had been previously made ; Donders (*Archiv f. Anat. u. Physiol.*, 1868) found the time to be 184σ, Wundt (*Physiol. Psych.*, 11, 251) 210 to 250σ, v. Kries and Auerbach, working under the direction of Helmholtz (*Archiv f. Anat. u. Physiol.*, 1877), 12 and 34σ. I cannot accept the results reached by these latter experimenters. The times seem to be too short to be correct. I do not know where the error lies, the experiments having apparently been made with great care, but the simple reactions are very long, the reactions with perception and volition very short. The latter may have been made unduly short through the frequent occurrence of premature reactions (the number of false reactions is not given) ; at all events I consider their method of calculating the averages dangerous, they ignoring what reactions they saw fit. They do not give the number of measurements made in the series, but in the model series given in the appendix, we find that in one 22 reactions were used, in one on the perception of light only 9 ; we may therefore assume that in the latter series over half of the reactions were ignored. If the mean variation of the reactions used in this series be calculated, it will be found to be 6 (smaller, I imagine, than the mean error of the recording apparatus) ; the mean variation of the corresponding series of simple reactions (from which determinations had also been omitted) is 12σ. When averages are made up in this way any results desired can be obtained.

TABLE XVII.

		B				C			
		R	V	R′	V′	R	V	R′	V′
22. XII..........	Orange	308	21	309	11	316	47	299	21
	Violet.	258	23	262	15	289	16	297	8
	Black..	267	35	262	26	278	16	275	9
6. I..............	Pink...	288	19	284	14	302	26	303	18
7..................	Brown.	308	20	294	15	340	31	323	16
9..................	Gray...	283	12	287	6	397	80	367	31
10................	Red....	278	22	272	11	322	40	324	28
	Blue...	287	19	280	17	291	24	228	26
	Green..	268	26	265	18	313	32	312	21
	Yellow	276	27	273	16	297	31	300	20
	A.......	282	22	279	15	314	34	303	20
	False..	1				5			

XVII., and subtract the reaction-time and supposed will-time, we find that it took B 100, C 110σ, to distinguish one colour from another.

In the series of experiments next to be given, I determine the time it takes to distinguish a colour from nine others, that is the real perception-time for a colour. The results of ten series in which the motion was made with the hand, and of five in which it was made with the speech-organs, are given in Table XVIII.

This gives as the time needed to distinguish a colour 105σ for B, 117 for C; respectively 5 and 7σ longer than it took to distinguish one colour from another, and 26 and 41σ longer than it took to see that a colour was present when it was not necessary to distinguish it.

The results given in Table XVIII. (where the reaction was made with the hand) were obtained at the beginning of the investigation; the determinations were repeated after four months of constant practice, and again after a pause of three months, the results being given in Table XIX.

Practice therefore shortened the perception- and will-times about 30σ for B and 20 for C, and this decrease in the length of the times was not lost by an interruption in the practice.

With the same methods I found the time it takes to see or distinguish a letter. I tried in my experiments to determine the time taken up by those operations which are constantly going on in the brain; the letters chosen therefore were such as we usually have to read (of the size in which this is printed). The time for larger letters is somewhat shorter. In the first experiments it was not necessary to distinguish the letter, only to know that a letter was present; the conditions were consequently the same as in the first experiments (Table XV.) on colours.

TABLE XVIII.

		B				C			
		R	V	R′	V′	R	V	R′	V′
		HAND.							
17. XII.	Red	317	19	310	10	341	31	340	20
	Green	298	19	291	10	330	31	338	22
	Gray	302	29	295	20	316	33	319	22
18.	Blue	289	28	276	9	316	7	315	3
	Yellow	260	12	261	9	317	24	310	14
	Black	283	22	284	14	289	15	293	9
19.	Orange	309	51	290	23	285	20	279	12
	Violet	302	16	299	11	312	34	308	24
	Brown	318	12	314	8	313	30	313	18
	Pink	293	30	282	12	312	22	305	12
	A.	297	24	290	13	313	25	312	16
	False	1				4			
		SOUND-KEY.							
17. II.	Red	306	35	297	18	359	25	360	19
19.	Green	293	11	289	7	360	12	364	7
21.	Black	286	34	279	17	306	16	311	11
24.	Violet	271	30	265	22	309	20	304	14
26.	Brown	296	18	291	11	359	46	347	32
	A.	290	26	284	15	339	24	337	17

TABLE XIX.

		B		C			B		C	
		R	R′	R	R′		R	R′	R	R′
Red	4. IV.	244	237	294	287	2. VII.	283	267	292	286
Green		247	239	311	309	4.	247	252	277	278
Gray	7.	270	258	283	279	31.	264	257	325	314
Blue		246	246	273	275		253	257	286	279
Yellow	8.	290	249	304	302		245	245	267	264
A.		259	246	293	290		258	256	289	284
AV.		35	13	16	10		30	17	24	15
False		5		2			0		0	

TABLE XX.

	B				C			
	R	V	R′	V′	R	V	R′	V′
3. II............	261	31	260	18	268	12	266	11
27. III..........	234	21	228	12	235	23	229	11
1. IV...........	205	37	194	23	261	32	255	25
	230	38	220	25	251	24	255	19
	206	18	208	6	277	23	281	16
A...............	227	29	222	17	258	23	257	16

It therefore (making the same assumptions as above) took B 47, C 58σ, to see that a small object was on a white surface.

The next case to be given is where it was necessary to distinguish one of two letters from the other, A and Z being taken. The averages given are taken from six series.

TABLE XXI.

		B				C			
		R	V	R	V	R	V	R′	V′
4.—10. XII.....	A	315	26	319	16	327	31	323	18
	Z......	330	31	325	21	348	29	348	21
	A......	322	28	322	18	337	30	335	19
	False..	3				5			

It thus took B 142, C 137σ, to distinguish one letter from another, respectively 45 and 31σ longer than to distinguish one colour from another.

We now come to consider the time needed to distinguish one letter from all the others; that is the time it takes to see a letter. This is a process with which our brain is constantly busy; the time taken up by it is therefore of special interest. If for example the time is different for the several letters, it is a matter of the greatest practical importance, for those letters which it takes the longest to see might be so modified as to shorten the time. If it takes 20σ longer to see E than it would to see a symbol that might be taken in its place, say Δ, it is startling if we calculate how much time is being wasted and how much unnecessary strain is being put on eye and brain. I have published[1] extended series

[1] *Phil. Studien*, ii. 4; *Brain*, No. 31.

of experiments, determining the time the light reflected from a printed letter must work on the retina in order that it may be possible to see the letter. These experiments show that there is a great difference in the legibility of the several letters; out of 270 trials W was read correctly 241, E only 63 times. In this case the whole time was short, 1 to 1·5σ, and the difference in the time for the several letters correspondingly small. When however we determine the entire time needed to recognise the letter, we may expect to find the time considerably shorter for a simple and distinct symbol than for one complicated or easily confused with others, just as the time is shorter for a colour than for a letter.[1] The speech-organs as well as the hand were used in these experiments. Here however a slight complication is added, as we cannot be sure that a difference in the time for the several letters is to be referred only to the perception-time, it being possible that the time needed to name the several letters or to register the different motions may be different. This difference in time can however only be very small, as the observer knew what letter he had to name, so there was no choice between different motions, as in the experiments to be considered in the next section of this paper. Tables XXII.-XXIV. (placed, with others, at the end of this paper) give the results obtained at different times, the motion being made both with the hand and the speech-organs.

A shortening in the time through practice will be noticed in these Tables; if we take Table XXIII., which contains the most determinations and times representing about the average of the three Tables, we find the perception-time for a capital letter of the size in which this is printed to be 119σ for B, 116 for C. The Tables contain the results of a great many experiments, but not enough to determine finally the time for the several letters; if however the four series made with the hand on E and M are averaged together, we find that it took B 19, C 22σ longer to see E than to see M. The order for the five letters on which four series were made is M A Z B E, which (except the position of Z) agrees with the order of legibility established in the paper referred to.

Similar determinations were made with the small letters, the results being given in Table XXV. It seems from this Table

[1] I have not been able to determine accurately and finally the perception-time for different alphabets and for the several letters. In these experiments the different letters cannot well be used in the same series, and further in half the cases no measurement is made. As the difference in the times is small and the variation of the series not inconsiderable, a large number of experiments must be made before the difference in the time for the several letters can be determined with certainty. This is however not only a subject of scientific interest, but also of great practical importance; it is to be hoped that it will be thoroughly investigated by independent experimenters.

that the perception-time is about the same for the large and small letters, which agrees with experiments I have made by an entirely different method (see MIND 41).

We now come to consider the time it takes to see a word, a process with which the brain is constantly occupied. Twenty-six words were taken, and when the expected one was seen the observer lifted his hand. The perception-time so determined is the time needed to distinguish the word from the other twenty-five; the time is slightly longer when it is necessary to distinguish words from others very similar in form; for example, hand from band. Indeed we must remember that perception is not a sharply defined process. As I have shown, we see a letter before we see what letter it is; in like manner a further time passes before we see the letter in all its details, that it is not perfectly printed, for example. The perception-time for a painting by Raphael is indefinitely long. The results of experiments with English and German words are given in the Tables XXVI.-VII.

The Tables give us a perception-time for short English words B 132, C 141σ; for short German words B 118, C 150σ; for long English words B 154, C 158σ. The time was therefore slightly shorter (B 22, C 17) for a short than for a long word, and for a word in the native than in a foreign language (B 14, C 9). It will be noticed that the perception-time is only slightly longer for a word than for a single letter; we do not therefore perceive separately the letters of which a word is composed, but the word as a whole. The application of this to teaching children to read is evident; I have already in connexion with other experiments called attention to it.

The only other perception-time we have to consider is for a picture. It takes, we may suppose, about the same time to recognise the picture of a tree as it takes to see the tree itself; this is consequently a process nearly always going on in the brain. I had carefully drawn twenty-six pictures of common objects, tree, hand, ship, etc., about one square cm. in size, the method of determining the perception-time being as before.

We thus find that the perception-time for a picture, and we may assume for the objects we are continually seeing in our daily life, was 96σ for B, 117 for C, about the same as for a colour and shorter than for a letter or word.

(To be concluded.)

TABLES XXII.-XXVIII.

TABLE XXII.

		B				C			
		R	V	R′	V′	R	V	R′	V′
		HAND.							
11. XII	B	358	25	354	18	342	28	346	17
12	Z	345	24	350	18	370	33	353	20
	A	327	31	314	14	337	22	342	16
16	M	338	36	345	20	329	15	324	7
	E	360	31	345	9	343	28	326	9
17	S	333	22	326	11	341	25	338	17
	P	339	24	332	14	329	32	318	18
	T	330	29	320	16	323	30	330	18
18	O	293	19	297	11	302	25	301	18
	L	338	15	339	10	350	37	333	16
	A	336	26	332	14	337	27	331	16
	False	5				4			
		SOUND-KEY.							
17. II	A	330	27	337	17	406	16	401	11
19	M	336	36	332	30	410	29	412	17
21	E	308	36	310	22	359	35	354	28
24	P	311	22	307	13	321	13	325	8
26	O	303	21	307	16	380	33	372	27
	A	318	28	319	20	375	25	373	18
	False	1				1			

Table XXIII.

	Hand.					Lip-key.				
		B		C			B		C	
		R	R′	R	R′		R	R′	R	R′
A..............	13. I.....	309	312	323	328	15. I.....	288	295	338	332
B..............	12........	307	311	353	350	13........	348	353	362	363
C..............	17........	304	306	319	322	17........	307	310	333	325
D..............		342	309	332	341		320	324	346	354
E..............	14........	328	334	341	345	15........	333	345	340	330
F..............	17........	322	324	358	344	20........	307	310	317	321
G..............		326	321	331	327		309	308	311	309
H..............	19........	323	320	320	317		305	308	338	333
I..............		294	293	295	301		271	275	296	290
J..............		329	326	299	288	21........	342	338	330	335
K..............		330	335	305	297		334	334	315	314
L..............	14........	296	304	302	299	29........	320	302	357	353
M..............	13........	311	316	320	322	15........	342	330	373	366
N..............	20........	318	317	333	330	21........	318	321	323	328
O..............	14........	263	266	292	288	13........	315	319	355	352
P..............		288	284	337	326	29........	321	324	338	339
Q..............	20........	317	315	315	319	21........	312	314	312	302
R..............		311	313	322	317		334	340	322	315
S..............	14........	285	281	327	332	15........	318	325	313	313
T..............		319	295	310	305	29........	318	315	366	363
U..............	20........	311	298	329	331	24........	320	320	335	331
V..............	22........	322	330	334	330		324	327	333	338
W..............		278	283	338	332		312	314	343	345
X..............		315	297	349	341		292	297	362	366
Y..............		303	307	341	337		318	313	339	339
Z..............	12........	323	319	347	345	13........	350	343	331	324
A..............		310	308	326	324		318	319	336	334
AV............		22	15	22	14		22	14	25	16
False..........		13		13			18		4	

TABLE XXIV.

		B		C			B		C	
		R	R′	R	R′		R	R′	R	R′
B…	5. IV…	275	262	321	319	31. VII.	307	308	304	306
Z…	6…	272	273	310	301		313	314	311	303
A…		276	281	292	288	2…	295	295	309	302
M…	7…	293	291	302	306	4…	298	299	307	306
E…	8…	316	316	337	331		313	306	315	319
A…		286	285	312	309		305	304	309	307
AV…		25	16	20	13		22	14	26	18
False…		2		3			0		0	

TABLE XXV.

		HAND.					LIP-KEY.			
		B		C			B		C	
		R	R′	R	R′		R	R′	R	R′
b…	5. I…	301	306	314	306	22. I…	313	317	327	321
z…		307	298	324	325		305	300	336	322
a…	7…	316	320	327	320	23…	330	328	313	309
m…		310	312	311	313		310	304	313	315
e…	12…	337	342	356	356		331	321	330	322
s…		322	325	368	359		297	290	338	343
p…	13…	323	320	341	337	28…	345	345	370	372
t…		311	310	319	315		305	300	346	342
o…	14…	293	290	306	304		299	299	335	332
l…		303	300	306	304		311	314	344	339
A…		312	312	327	324		315	312	335	332
AV…		19	13	28	19		20	11	25	16
False…		4		8			7		2	

TABLE XXVI.

	Hand.					Lip-Key.				
		B		C			B		C	
		R	R′	R	R′		R	R′	R	R′
Mind	12. XII.	353	352	337	329	13. I.	360	366	374	364
Life	15.	348	351	373	377		366	367	363	365
Time	16.	333	330	375	372	15.	311	312	371	366
House		377	366	383	389		331	324	355	361
Child		345	343	328	339	17.	347	341	370	375
Year	18.	353	359	369	360		337	336	354	358
Truth		352	329	376	367	29.	302	311	360	353
Name		341	339	392	393		313	315	374	380
Light	19.	332	328	327	323		325	332	372	372
Ship		318	313	336	332		294	302	340	340
A		345	341	360	358		329	331	363	363
AV		24	13	26	17		23	12	28	20
False		2		4			7		0	
Education	5. I.	331	331	346	348	17. I.	349	345	382	386
Philosophy		330	322	349	354		347	351	376	377
Knowledge	7.	341	337	366	360	22.	353	348	329	319
Architecture		377	375	382	377		357	355	336	340
Literature	10.	339	320	363	354	23.	333	332	377	382
Temperance		341	333	399	404		339	330	377	376
Ignorance		300	297	380	369		325	319	378	382
Physician		325	329	380	375	26.	339	333	351	346
Enthusiasm	12.	334	337	405	409		353	349	409	400
Imagination		321	317	384	375		342	337	395	391
A		334	330	375	373		344	340	371	370
AV		25	16	28	19		23	15	27	17
False		8		8			6		9	
Buch	24. I.	290	294	367	363	23. I.	315	318	359	355
Zahl		309	311	380	378		310	319	370	378
Kunst		307	309	369	374		310	314	362	352
Welt		308	307	361	353		308	305	362	362
Haus	26.	295	292	354	353	24.	299	297	339	344
Licht		324	323	354	359		330	329	356	350
Kind		323	323	377	380		303	308	352	356
Land	29.	309	307	363	365	26.	316	321	373	365
Traum		321	316	377	376		324	325	368	373
Jahr		319	318	365	368		321	325	374	378
A		311	310	367	367		314	316	362	361
AV		14	9	20	13		17	12	31	20
False		6		5			10		7	

TABLE XXVII.

		Hand.						Sound-key.			
		B		C				B		C	
		R	R′	R	R′			R	R′	R	R′
6. IV.	Mind...	266	269	312	306	14. II.	Mind...	311	307	380	391
	Life......	302	292	340	340	19.....	Life......	338	333	400	409
7......	Time....	307	303	325	330	24.....	Child...	319	326	360	364
	House...	299	296	321	317		Truth...	317	318	339	345
8......	Child...	282	284	327	322	26.....	Ship.....	320	326	361	367
	A........	291	289	325	323			321	322	368	375
	AV......	18	10	22	14			27	19	25	16
	False....	5		0				3		4	

TABLE XXVIII.

	Picture of a	B				C			
		R	V	R′	V′	R	V	R′	V′
		Hand.							
12. II...	Watch.........	262	23	249	15	295	21	292	14
	Ship............	264	19	268	13	324	31	320	16
	Eye............	271	17	266	11	313	24	316	9
20. III.	Hand..........	297	20	294	15	282	37	266	10
	Tree...........	246	12	244	7	296	28	302	23
	Bird...........	289	28	297	15	310	43	291	10
	Fish...........	290	19	293	17	301	23	294	13
	Leaf...........	267	12	265	9	321	31	317	26
24.......	Hat............	270	28	277	22	306	21	312	10
	Shoe...........	283	17	286	12	341	23	346	18
	A..............	274	19	274	14	309	28	306	15
	False..........	8				8			
		Sound-Key.							
17. II...	Watch.........	308	32	302	14	364	44	357	34
19.......	Eye............	341	30	336	25	408	40	408	25
21.......	Tree...........	283	27	276	17	374	32	361	17
24.......	Fish...........	309	38	315	22	304	23	296	15
26.......	Hat............	305	42	296	24	367	59	348	36
	A..............	309	34	305	20	363	40	354	25
	False..........	2				2			