

THE SELECTION OF COMMUNICATIONS BOYS FOR MORSE APTITUDE AND TYPEWRITING
ABILITY.

(P.E.V., E.E., 4/49/N/15).

- (I) Summary and Recommendations
- (II) Non-Technical Report
- (III) Technical Notes and Tables of Results.

Normally officers will desire to read only (I) and (II) which give as complete an account as possible in non-technical language. But (III) is included for members of the Senior Psychologist's staff and any others who may want to examine the technical foundations of the conclusions.

I SUMMARY AND RECOMMENDATIONS

1. This report is based mainly upon the examination and test results of some 200 Boy Communications ratings in HMS GANGES. It is concerned with the problem of picking out W/T Boys who possess the necessary auditory aptitude (together with reasonable education and intelligence) and a certain degree of finger dexterity (for morse typing).

2. It was found that course marks (i.e. in Morse principally) at the end of the 5th and 12th weeks had low predictive value for final results. It is therefore recommended that the training staff should be made aware of the low predictive value of the 5th and 12th week marks, and should allow the majority of trainees who appear to be making slow progress at these stages to continue on course. By the 22nd week, failures can be picked out with much greater certainty.

3. If 5th - 12th week results are not to be used for selecting those who are to continue with Morse, it is all the more necessary to select accurately before the course starts. The report shows that

- (a) the Morse Aptitude Test,
- (b) the English and
- (c) the Arithmetic I examinations

provide the most promising instruments. Other tests or examinations of an educational, mechanical or intelligence type are relatively valueless.

4. It is recommended that a minimum score of B Grade (i.e. 52 marks) be set on the Morse Aptitude Test, and a combined mark of at least 90 on English + Arithmetic I papers. Boys accepted for training should usually fall above both minima (i.e. 100 on the papers should not compensate for 40 on the Morse test). At the same time these tests only yield probabilities, not certainties, hence other factors such as good previous training or exceptional keenness may reasonably make up for slight deficiencies on either test.

5. There has been less opportunity for reaching reasonably certain conclusions in the case of the typewriting dexterity test. It is therefore recommended that the decision to continue the dexterity test depend on whether it readily fits into, or conflicts with, the present scheme of typing instruction. If the former, then a minimum standard of 200 marks is desirable. This will eliminate some 15% of boys who would be slow learners at least up to the 22nd week, though we cannot guarantee that they would not acquire the necessary facility for Morse typing thereafter.

Introduction: Training Difficulties and Need for Selection.

The learning of Morse receiving is one of the most difficult parts of the syllabus in naval boy training establishments. Doubtless some of those who fail and revert to the Seaman branch are boys who are insufficiently keen, but clearly there are many who lack the necessary aptitude. Others, who may be both keen and generally intelligent, are very slow learners and require much extra instruction and back-classing before they eventually make the grade. It would be a great advantage if even a proportion of such cases could be picked out at the start by means of suitable selection tests.

Similar, though not quite such serious, difficulties occur in the training of V/S boys for Flash. Semaphore, on the other hand, seldom constitutes an important cause of failure. Morse transmitting, again, is less troublesome than receiving. For example among some 200 boys taking the 22nd week tests, only 8.6% were unable to exceed 80% accuracy in transmitting, whereas 30.8% were unable to score as highly in receiving. Now that receiving is recorded by typewriter instead of by hand, the learning of typewriting itself and its linkage with Morse constitute additional problems. It may be desirable therefore to try to pick W/T boys who not only possess the necessary auditory aptitude (together with reasonable education and intelligence), but also a certain degree of finger dexterity.

2. Present Selection Procedure.

At the present time about twice as many boys volunteer for Communications as can be accepted. The Signals Officer in HMS GANGES turns down applicants with obvious speech or other physical defects. He has available their marks on one examination in English, two dictation tests and two arithmetic papers; also their scores on the R tests (given at Recruiting Centres) and the Chelsea Intelligence Test. He tries to choose boys with good education and intelligence, who also seem keen, and favours any with previous Morse experience. This method of selection is the best possible under the circumstances, but it still lets through an appreciable proportion of failures and slow learners.

3. Trial of New S.P. Tests.

Since the beginning of 1948 the Signals Officer has arranged, with the advice of the Senior Psychologist's Department, to give S.P. Test 121 - a test of Morse aptitude -, also, starting a few months later, SP Tests 174 and 179 - the former a typewriting dexterity test and the latter a clerical aptitude test. SP Department is much indebted to this officer for his careful application of the tests, and for collecting the scores and marks of classes over a long period. Sufficient data has now accumulated for the predictive value of the tests to be analysed. This data is all the more valuable because so far no use has been made of the results of the tests. Hence the follow-up described below is an unusually unbiased one.

The Morse Aptitude test is a British adaptation of the US 'Speed of Response' test, and is given by gramophone records. The candidates are first trained for some 17 minutes on three actual Morse characters, and are then tested for about 10 minutes in the quickness and accuracy of reception of these characters. Test 174 involves tapping various letters or combinations of letters with specified fingers on standard typewriters, for several 10 or 15 second periods. Test 179 includes the detection of errors in typed names, of spelling mistakes, and of errors in alphabetical arrangement of names. Its time limit is 10 minutes. The three tests can be given by officers or instructors in roughly $\frac{3}{4}$, $\frac{1}{2}$ and $\frac{1}{4}$

hours. Their scoring is somewhat lengthy, but quite straightforward. Thus they can be effectively applied without the provision of a psychologically trained tester.

4. Classes Studied, and their Examinations.

Selection and training take place in other establishments besides HMS GANGES. But as full test data were not always available, the investigation was based mainly on the results of some 200 boys in Classes 243-264.

All Communications boys receive the same training up to the 12th week and are tested on Morse receiving, Flash and Semaphore at the end of the 5th and 12th weeks. Thereafter classes are split into W/T and V/S, hence the numbers taking later tests are approximately halved. Both groups are tested at the 22nd and 38th weeks, and take a final or passing-out examination. The numbers for whom 38th week results were available were 70-100 W/T, and 60-80 V/S; still fewer had final results. Hence our conclusions regarding the later parts of the course are less certain than those referring to the earlier stages. The 5th, 12th, 22nd and 38th week examinations in Morse receiving represent accuracy at roughly the following speeds: slow alphabet, 10 w.p.m., 16 and 22 w.p.m., respectively.

5. Prediction of Final Results by Early Examinations.

The agreement between marks at the various examinations was first studied, and was found to be unexpectedly poor except over short periods. Thus 5th week Morse gives moderately good predictions of 12th week Morse and V/S, but not of 22nd or 38th week marks. Again 12th week Morse and V/S give mediocre predictions of 22nd week marks and poor predictions of later stages. But 22nd week Morse receiving results coincide fairly well with 38th week and final results, as does 22nd week Flash with 38th week. Similarly 12th week typing gives unsatisfactory predictions of 22nd week, and both of these bear little relation to 38th or final Morse typing. (For more detailed results, the appended Technical Report and tables may be consulted).

It follows that early progress gives little indication of eventual success, and that boys who are quite slow at the 5th and 12th weeks may well pick up later. By the 22nd week however their final form is fairly clearly established. Thus, except in extreme cases, it is unsafe to throw out trainees on the basis of slow progress in the first three to four months. Presumably in Morse training the reason for this state of affairs is the notorious hurdle at about 12 w.p.m. speeds. Those who learn best at speeds below this are not always the best at acquiring higher rates of reception. We realise that the scores obtained in the formal tests at 5th, 12th and later weeks do not give a complete picture of any boy's progress. (Indeed we have not even made use of all the marks awarded, only of the crucial buzzer, flash or semaphore accuracies). Doubtless the officers and instructors who see the boys' day-to-day work and observe their keenness as well as their performance in training exercises, can predict more accurately. Nevertheless our findings justify the recommendation that:

The training staff should be made aware of the low predictive value of the 5th and 12th week marks, and should allow the majority of trainees who appear to be making slow progress at these stages to continue on course. By the 22nd week, failures can be picked out with much greater certainty.

6. Morse-typing.

Final Morse-typing ability clearly depends chiefly on the Morse receiving capacity developed by the 22nd week and after, and very much less on typewriting capacity. This result does not properly provide an answer to the question - when should typing be combined with receiving - and no formal recommendation can be made. But it suggests that this combination might be better left until fairly late in the course, i.e. until

a firm foundation of receiving at more than 12 w.p.m. has been established.

7. Initial Selection Tests.

If 5th-12th week results are not regarded as a kind of selection test it is all the more necessary to select accurately before the course starts. Our investigations show that the Morse aptitude test and the English and Arithmetic I examinations provide the most promising instruments. Other tests or examinations of an educational, mechanical, or intelligence, type are relatively valueless. The Morse aptitude test gives moderately good predictions of receiving not only at the 5th and 12th, but right up to the 38th week, and though less successful in predicting V/S, Morse transmitting or Morse typing, it does have some relevance. The English and Arithmetic examinations bear little relation to the early stages, but tend to give progressively better predictions until they surpass the Morse aptitude test in predicting 38th week Morse typing.

None of these tests are anywhere near 100% accurate in placing boys at the start of the course. Hence it is necessary to judge what pass-mark or dividing line will most effectively separate groups likely to contain few failures without rejecting too large a proportion of possible successes. The following Table shows the relation of the tests, and of 5th week buzzer marks, to success at the 22nd week. The term 'Failures' is here used of boys who score 70% or less in the 22nd week examination, and 'Passes' mean those scoring 71% or over; 'Good Passes' are those scoring 90% or more.

Method of Selection	Possible Pass-Mark	% of Failures eliminated	% of Passes eliminated	% of Good Passes eliminated
5th week Buzzer	96	86	48	40
	91	50	37	31
	86	36	30	23
Morse Aptitude Test	60	91	51	44
	50	67	30	25
	40	38	15	12
English + Ari. I combined	110	82	48	41
	100	59	33	31
	90	41	21	20
	80	27	7	4

The Table reads: if all boys scoring less than 96 at 5th week buzzer were excluded, 86% of the 22nd week 'Failures' would be eliminated, but at a cost of 48% of the 'Passes', and 40% even of the 'Good Passes.' With a cut-off of 86, almost as many passes (30%) as failures (36%) would be eliminated. In contrast, a cut-off of say 40 on the Morse aptitude test and 90 on English + Arithmetic I combined would exclude about 40% of the failures at a cost of only some 15-20% of the passes. (Moreover the Morse test and educational tests would no doubt work slightly better in combination than does either separately). Since there is at present a large excess of candidates for the Communications branch, there is no harm in excluding 20% or more of possible passes if this will reduce the weak learners and failures to half or less of their previous proportions.

8. Proposed Selection Standards.

We therefore recommend that a minimum score of B Grade (i.e. 52 marks) be set on the Morse Aptitude Test, and a combined mark of at least 90 on English + Arithmetic I papers. Boys accepted for training should usually fall above both minima (i.e. 100 on the papers should not compensate for 40 on the Morse test). At the same time these tests only yield probabilities, not certainties, hence other factors such as good previous training or exceptional keenness may reasonably make up for slight deficiencies on either

test. If these borderlines still admit too many candidates they can be raised by 5 and 10 points respectively, and this will further reduce the proportions of failures.

9. Selection for Typewriting Ability.

The typewriting and clerical tests have not been in use for so long as the Morse test, hence their value is less certain. The indications are that neither the Clerical test, nor the Establishment's Dictation paper are predictive. Though the dexterity test does give some prediction of proficiency at 22nd week typing, it is less successful than is the 12th week typing mark. Insufficient numbers have reached the 38th week for any comparison of the dexterity test with Morse typing.

We recommend that the decision to continue the dexterity test depend on whether it readily fits into, or conflicts with, the present scheme of typing instruction. If the former, then a minimum standard of 200 marks is desirable. This will eliminate some 15% of boys who would be slow learners at least up to the 22nd week, though we cannot guarantee that they would not acquire the necessary facility for Morse typing thereafter.

Correlation Method

The follow-up of Communications trainees is beset with many technical difficulties, both because the training is lengthy and many individuals are class-changed or withdrawn (either because of slow learning, or through illness or other unavoidable causes) and because the distributions of proficiency scores at the various examinations are highly abnormal. Even the 12th week marks are highly skewed, as shown in Table 1, and at later stages - particularly at the final examination - the range is even more restricted.

Table 1. Distribution of 12th Week Marks.

Score	Buzzer	V.S.
96-100	75	66
91-95	26	43
86-90	24	28
81-85	8	15
76-80	15	19
71-75	8	10
66-70	12) 15
61-65	4	
60 or less	12	
	Totals 184	196

It was seldom possible therefore to use product-moment correlations, and the less reliable biserial method (usually with two splits around the 20th-25th percentiles), or tetrachorics (with several splits) had to be substituted. Class-changed boys could seldom be traced, hence the numbers tended to vary from one set of correlations to another. Since however the scatter on the Morse aptitude test remained almost identical from the 5th week to the final exam correlations, it appeared legitimate to regard the groups at all stages as reasonably comparable. No corrections were made for selectivity, since selection was not based at all on the Morse aptitude test and only to a minor extent on the other selection tests or examinations. Nevertheless the trainees were predominantly high-grade (thus on naval candidate RT standards, 37% were A's, 47% B's and practically all the rest C's, not D's or E's); hence correlations will all tend to be lower than they would in more representative groups.

2. Correlations among Examinations.

Before studying the validities of selection tests, some of the correlations between successive stages will be considered. Table 2 shows tetrachorics with various splits between 5th and 12th week buzzer, and Table 3 shows 12th week buzzer with 12th week V/S (semaphore + flash).

Table 2. Correlations of 5th with 12th week Buzzer.

		12th week buzzer split at:					
		75	80	85	90	95	p
5th week	75	.62 ⁺	.68 ⁺	.61	.60	.60	.17
buzzer	80	.71 ⁺	.72 ⁺	.68	.67	.84	.22
split at:	85	.60	.63	.64	.63	.64	.32
	90	.50	.51	.48	.57	.50	.45

Table 3. Correlations of 12th week Buzzer and V/S.

		12th week buzzer split at:					
		75	80	85	90	95	p
12th week	75	.48 ⁺	.60 ⁺	.68	.76	.84	.13
V/S split	80	.52 ⁺	.64 ⁺	.68	.77	.84	.22
at:	85	.44	.56	.61	.73	.80	.30
	90	.36	.44	.49	.61	.74	.44
	95	.27	.35	.42	.54	.67	.66

The former coefficients are fairly stable over the whole range. But the latter suggest that boys weak at buzzer may sometimes do well at V/S, whereas those weak at V/S scarcely ever do well at buzzer. This is quite reasonable if buzzer is the more difficult. The asterisked figures were taken and averaged, since it is the poorer levels of ability that mainly concern us. These yielded mean coefficients of .68 and .56 for the two Tables. These, and similar correlations for other stages, are shown in Table 4.

Table 4. Correlations between Examinations at Different Stages.

Name of Examination Week	Rm 5	Rm 12	Rm 22	Rm 38	Typing 22	VS 12	F 22	S 22	F 38
Rm, Morse receiving, 5th									
" " " 12th	.68								
" " " 22nd	.33	.50							
Rt, Transmitting 22nd			.30						
Rm, Receiving 38th	.22	.33	.65						
Rt, Morse typing 38th	.03	.30	.65	.75	-.07				
Rt, " " Final	-.17	.65	.84	.68	.25				
V/S 12th	.62	.56							
F, Flash 22nd						.46			
S, Semaphore 22nd						.19	.14		
F 38th						.17	.77	.28	
S 38th						.17	.05	.43	.43

Final Rt results were available only for some 60 cases, and the spread was so small that 38th week figures (available for nearly 100 cases) are more reliable. The final examination in any case tends to be a formality, and the 38th week the most grueling test. We see that correlations of 5th week results with 38th week are extremely low, and that 12th week only amount to .33 and .30. The 22nd week Rm, however, predicts 38th week Rm and Rt fairly successfully (.65).

The 5th week also predicts 12th week V/S, but later V/S results (based on around 70 cases) tend to be very irregular, as might be expected if the course is fairly easy and the examinations not very reliable. But again we note that 38th week Flash is well predicted by 22nd week Flash, though not by 12th week marks. Flash and Semaphore seem to be largely independent, correlating .14 at the 22nd and .43 at the 38th week. Similarly Morse transmitting is very different from receiving, the correlation being .30 at the 22nd week.

Finally, Typing, as measured at the 22nd week, gives no correlation with 38th week Rt and only .25 with final. The correlation of 21st with 22nd week typing was .64. Thus, like buzzer, it is probably consistent over short periods only.

3. Correlations of Selection Tests.

Since the greatest numbers of cases (some 200) were available with 12th week marks, it was decided to use these as the first criterion for distinguishing promising from unpromising tests. The correlation between the Morse aptitude tests and 12th week buzzer, calculated by centroids, was .348. Next biserials were obtained with splits at different levels. These results are given in Table 5. It will be seen that the correlation rises as a lower split is taken on buzzer, though this effect is slight over the lower splits. The test therefore contrasts markedly with the old M.A.T., which tended to correlate better at the upper than the lower end. Similar results (Table 6) were obtained for buzzer with Recruiting Centre test scores. Here the biserials sink as the split is lowered, but again a fairly stable value is reached.

Table 5. Biserial Correlations Between Morse Aptitude and 12th week Buzzer.

Buzzer marks split at:	p	r _{bis}
95	.59	.185
90	.45	.330
85	.32	.397
80	.28	.420
75	.20	.420
70	.15	.441

Table 6. Biserial Correlations Between RT Scores and 12th Week Buzzer.

Buzzer marks split at:	p	r _{bis}
95	.59	.161
90	.44	.160
85	.31	.055
80	.26	.053
75	.19	.071
70	.14	.007

Since the main object of selection is to eliminate failures rather than to pick out the exceptionally able, it was decided that the average of biserials calculated at the 20th to 25th percentiles would provide a better index of validity than would product-moments based on centroids or biserials taken nearer to the median.

Various correlations with 12th week buzzer calculated on this basis are shown in Table 7.

Table 7. Correlations of Tests with 12th week Buzzer.

Morse aptitude	.420	Chelsea Intelligence Test	.020
RA (Mechanical)	-.131	Arithmetic I	.256
RB (Maths.)	.143	Arithmetic II	.118
RC (Spelling)	-.015	Dictation II	.144
RD (Abstraction)	.034	English	.187
RT (Total)	.062	Clerical Test SP 179	.061

Morse aptitude provides by far the best index of 12th week performance. Tests with the highest g loadings (Chelsea and RD) yield very small coefficients, as does the Clerical test. The mechanical Part A of the R test gives a (barely significant) negative correlation. A similar finding has occurred in several previous investigations of signallers and telegraphists; apparently good Communications ratings should not be particularly 'mechanically-minded.' Dictation II's coefficient of .144 is rather higher than expected, but as the Spelling test RC is useless, it did not seem likely that Dictation would give more predictions at later stages. (Dictation I was omitted since its score distribution was so highly skewed). The English and Arithmetic I examinations, however, appear quite promising, and Arithmetic I is better than Arithmetic II or the mathematical Part B of the R test. Thus Morse Aptitude, Arithmetic I and English were chosen for further study. Their inter-correlations are .295, .140 and .476.

The multiple correlation of these three measures with 12th week results is .449. This indicates that the Morse test is much superior to the examinations, since they effect so little improvement in prediction over the Morse test alone.

The validities of these tests at later stages, also in relation to V/S marks, are shown in Table 8.

Table 8. Validities of Selection Tests.

Criterion	Morse Aptitude	Arithmetic X	English
Morse receiving 5th	.370	.077	.167
" " 12th	.420	.256	.187
V/S 12th	.372	.244	.305
Morse receiving 22nd	.459	.322	.310
" transmitting 22nd	.122		
Flash 22nd	.155	.221	.217
Semaphore 22nd	.047	.128	.067
Morse receiving 38th	.408	.087	.359
Morse typing 38th	.306	.327	.500
Flash 38th	.087		
Semaphore 38th	.160		

The Morse test retains a remarkably good validity almost up to the end, though it is probable less predictive of Morse typing than of receiving. The Arithmetic and English correlations tend to improve, and by the 38th week Morse typing, English obtains a better coefficient than Morse aptitude, though the predictive value of Arithmetic is more irregular. It is important to note that the Morse test, either along or combined with the two examinations, gives better predictions of 38th week performance than either the 5th or 12th week marks, though they are surpassed by the 22nd week marks.

12th week V/S is also quite well predicted by the three tests, but thereafter the validity coefficients sink. Similarly the correlation of 22nd week Transmitting is far poorer than that of Receiving. This investigation therefore throws little light on selection for transmitting or for V/S. However it was designed to provide evidence only on receiving, and here the answer is much more favourable.

4. Prediction of Typing Skill.

Previous enquiries into the selection and training of A.T.S. clerks suggested that few if any recruits fail to acquire typewriting proficiency, provided that they are sufficiently intelligent and well-educated to absorb the bookwork part of their course. Moreover psychologists agree that manual skills tend to be highly specific, so that tests of, say, finger dexterity would be unlikely to predict typing ability at all closely. Hence it was thought that a simple form of clerical test (SP 179) might prove more useful than any practicable series of motor tests. However we are dealing with boys who are starting typing from scratch, hence it did seem possible that a motor test of the 'work-sample' type might be useful, and SP 174 was devised to be carried out on the typewriters which they would use when their training began.

Correlations for the first group of 37 with 12th week typing were:

Dexterity .16 Clerical .23

But at the 12th week, trainees have barely acquired the letters, and it is not until the 22nd or later weeks that they can be said to be typing at all. The number of correct letters typed in a given time was used as

criterion. For 94 cases the 22nd week correlations were:

Dexterity .327 Clerical .142 Dictation II .151

Apparently then paper-and-pencil tests are of no value, but the dexterity test is of some slight assistance. Twelfth week typing correlated rather more highly with 22nd week, namely .49. It would be safer, then, to rely on performance during the early weeks than on any test. However if the test is easily given, it would do no harm to make limited use of it. A score of 200 is found to be needed for good proficiency at the 22nd week. Another reason for laying little stress on the test is that W/T boys who reach the 22nd week are but little superior on it to all boy entries at the time of selection.

5. Morse Aptitude Test Standards.

When the test was first introduced, it was given to all boy entries, numbering 689, in HMS GANGES and ST VINCENT from October 1947 to January 31st, 1948. The norms are shown in Table 9, together with the proportions falling in various Selection Grades in subsequent classes.

Table 9. Standards and Distributions on the Morse Aptitude Test

Selection Grade	Score	All Boys (end of '47)	Communications Classes	
			247-252	253-8
A	73-150	9.9%	17.4%	21.5%
B	52-72	20.7	29.1	38.5
C	31-51	39.7	38.4	32.6
D	20-30	20.5	10.4	6.7
E	0-19	9.1	4.7	0.7

It appears that boys accepted for Communications are rather superior to the general run, partly perhaps because they include a number with previous Morse experience, and partly because the good intelligence and education for which they are selected correlate to some extent with the test. Later classes are superior again. Possibly this represents an improvement in training in the Sea Cadet Corps units, or a tighter selection procedure in GANGES. It does not seem likely that the test itself can be given or scored in a more lenient manner.

If future candidates are of the same quality as Classes 253-8, the imposition of a pass-mark at 51 involves the rejection of about 40%.