

Is it possible to predict students' ability to develop skills in practical phonetics?

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ABSTRACT

Predicting ability to develop skills in practical phonetics is of particular importance for Speech and Language Therapy (SLT), where these skills are an integral part of clinical practice. The aim of this study was to evaluate the potential of two screening tests to predict later student performance in practical phonetics. SLT students with no previous phonetics training were asked to complete two tests on entry to the course: a test of phonetic skill and a test of musical aptitude. Results indicate that both tests have some predictive power, but that selection on the basis of pre-tests alone would have excluded some students who subsequently achieved near- or above-average marks in phonetics exams. The musical aptitude test is at least as effective as the phonetics test in predicting later phonetic ability.

1. INTRODUCTION

Most university level courses in phonetics include a substantial component aimed at developing students' skills in practical phonetics. The term "practical phonetics" is used here to describe auditory perceptual analysis, transcription and performance of speech sounds; these skills are generally viewed as core attributes of any "phonetician". Practical phonetic skills are also required in a range of other occupations, including foreign language teaching, acting and Speech and Language Therapy. The emphasis placed upon practical phonetics within the education of Speech and Language Therapists [1], [2] reflects the central role of these skills in clinical assessment and monitoring of speech production during treatment of speech disorders.

Anecdotal reports and observations by teaching staff suggest that students vary widely in their ability to develop practical phonetic skills and in their approach to phonetic analysis. For example, some students are immediately aware of the position of their articulators, whilst others need explicit instruction about how to interpret available tactile and proprioceptive feedback before they can easily identify their own articulatory movements. Some find it much easier than others to override their knowledge of orthography and phonology when listening to phonetic features. The nature and causes of

this variation have been little studied, however. For professions such as Speech and Language Therapy there would be obvious advantages in being able to predict which students will find phonetics difficult to master, and in knowing how best to offer remedial help to those who do. Some courses leading to a qualification in Speech and Language Therapy include some kind of phonetics "test" as part of the student selection process, but there is little or no evidence of the predictive power of such tests.

An underlying theoretical motivation for this work, which cannot be fully addressed in this paper, arises from the possibility that a better understanding of the process of phonetic learning, and of the attributes which support it, could inform models of psycholinguistic processing.

The skills that are generally seen as belonging to practical phonetics seem to draw on a range of abilities. Firstly, good phoneticians are often described as having a "good ear", although this is not easy to define. It probably includes some combination of auditory acuity with a facility in a specific type of auditory perceptual processing. It is not clear to what extent the patterns of perceptual processing involved in practical phonetic analysis are similar to the patterns of auditory-perceptual processing involved in normal spoken communication, but it is likely that they are somewhat different. It has been suggested that a "good ear" for phonetics might be related to musical ability or aptitude, but this possibility has been little explored. Musicians have been found to be better judges of certain aspects of voice quality than either naïve non-musician listeners or experienced speech pathologists [3]. This may not be surprising given that at least some types of prosodic expression and reception seem to rely predominantly on right hemisphere brain activity, or on coordinated activity of both hemispheres [4], as do some musical skills. One aim of this study was to discover whether musical aptitude is correlated with more general skills in phonetic analysis and performance, including analysis and performance of segmental speech features. Brain imaging studies have shown that multiple areas in both hemispheres of the brain are activated when musicians are asked to identify melodic, harmonic and rhythmic errors in music [5], and it may be that the processes involved in phonetic analysis are similarly disseminated within the brain. Given that neurological control of spontaneous linguistic expression and reception is generally localized predominantly within the left

hemisphere, a strong correlation between musical aptitude and overall practical phonetic skill could reinforce the view that the activities involved in practical phonetics are quite distinct, in terms of neurological pathways, from normal speech and language processing.

Practical phonetics also requires an ability to control speech production consciously and accurately. This involves self-awareness of articulatory activity, and draws on proprioceptive and tactile feedback. Traditional approaches to practical phonetics training are often based on an explicit belief that auditory perceptual analysis of speech sounds is supported and enhanced by skills in phonetic performance. The theoretical basis for this belief is not entirely clear, but it leads to the expectation that those students who have less awareness of their own articulatory movements and hence find it harder to monitor their own phonetic performance might also find it harder to develop auditory perceptual skills.

A range of other attributes that may be involved in practical phonetics include phonological awareness and an ability to divorce the analytical listening process from knowledge and expectations about the language of the speaker.

2. METHODOLOGY

Subjects

Three cohorts of students (N=98) entering the BSc Hons Speech Pathology and Therapy course at Queen Margaret University College Edinburgh were asked to complete a musical aptitude test and a phonetics pre-test designed by the author to assess a range of phonetic skills. Selection to the course does not include any phonetics pre-testing, and students with prior experience in phonetics were excluded from the study. All subjects will be tracked through the first two years of the course, up to the time of their second year practical phonetics exam. This paper presents results for the first cohort (N=30), who have now completed their second year

Musical aptitude testing

Three sections of the Bentley Measures of Musical Aptitude [6] were used in this study, on the basis that they have been reported to be effective indicators of musical ability in teenagers [7]. These sections assess:

- ability to identify minor pitch differences between pairs of tones.
- ability to identify differences between pairs of short rhythmic sequences.
- ability to identify differences between pairs of melodies.

Phonetics pre-testing

This included 3 tasks:

- judging number of syllables in polysyllabic words

- judging whether pairs of nonsense words were the “same” or “different” (differences involved single phonetic features within one segment)
- ability to compare tongue positions during production of pairs of sounds.

Student performance on key tests and examinations in practical phonetics during the first two years of the course were recorded. These were timed as follows.

- End of year 1: segmental transcription of normal adult speech, children’s speech and nonsense forms + supplementary questions exploring knowledge of underlying speech production processes
- Midway through year 2: transcription of normal adult speech (differing accents) + supplementary questions as above.
- End of year 2: segmental and prosodic analysis of normal and disordered speech patterns, and an individual viva examination to assess phonetic performance of simple and more complex phonetic sequences, including patterns normally associated with speech disorder. Students are also asked to describe and discuss underlying speech production processes.

The predictive power of the pre-tests was evaluated using three approaches.

Correlations

Pearson’s r was used to measure correlations between:

1. Pre-test results and performance on subsequent practical phonetics assessments.
2. Musical aptitude and phonetics pre-tests
3. Pre-test results and overall academic success in the first year, as measured by the mean mark for all modules.

The latter was in order to test whether the pre-tests related specifically to phonetic skills or to more general ability.

Calculation of “false positives” and “false negatives”

For a pre-test to be an effective screening process in student selection, two criteria must be met: there should be a minimum of “false positives” (i.e. students who appear to be at risk of failing in phonetics who subsequently show good performance) and there should be a minimum of “false negatives” (i.e. students who do not appear to be at risk of failing in phonetics who subsequently have problems with phonetics). The precise definition of a “false positive” used here is a student who scored below a given threshold in a pre-test, but who scored above the 10th percentile in later assessments. A “false negative” is a student who scored above a given threshold in a pre-test, but fell below the 10th percentile in later assessments.

Tracking of individual students

Students who scored more than 2 SD below the mean on pre-tests were individually tracked through later phonetics assessments.

3. RESULTS

Correlation between pre-tests and later performance

Table 1 shows Pearson's r for relevant pair-wise comparisons. Results for two sections of the Phonetics pre-test are presented separately, for reasons which will be discussed later. Note that music and phonetics pre-tests showed only a moderate positive correlation (Pearson's $r = 0.53$).

	1 st year phonetics	2 nd year midpoint phonetics	2 nd year final phonetics	Overall academic results
Combined pre-tests	0.74	0.57	0.62	
Musical pre-test	0.69	0.53	0.61	0.26
Phonetics pre-test	0.63	0.44	0.49	0.29
Tongue awareness section	0.75	0.58	0.54	
Same vs. different section	0.07	0.03	0.08	

Table 1: Correlations between pre-test results and later practical phonetics tests, using Pearson's r . Moderate to strong levels of correlation ($r > 0.5$) are shown in bold type.

Several interesting observations emerge from this table. One is that both pre-tests correlate much more strongly with later phonetics test marks than with overall academic achievement. It does appear, therefore, that both the musical aptitude and phonetics pre-tests tap abilities which relate specifically to practical phonetics.

A second important observation is that there is a rather stronger correlation between the musical aptitude test and the final phonetics exam than there is between the phonetics pre-test and the same exam. Combining the scores of both pre-tests gives a slightly stronger correlation with performance at the end of first year than either pre-test alone, but the correlation with the final exam results is no stronger than for the musical aptitude test alone. In other words, using this approach, the musical aptitude test alone appears to be a better predictor of performance in the final phonetics exam performance than does the phonetics pre-test, and is as good as combining the phonetics and music pre-tests.

Some reassurance for phonetics teachers may come from the fact that the correlations between pre-test performance and phonetics exam results are generally weaker in second year than in first year. An optimistic interpretation of this might be that phonetics teaching can eventually

compensate for lack of initial aptitude.

A final and rather unexpected finding is that the only section of the phonetics pre-test which showed a strong correlation with later phonetic performance is the section which assessed awareness of tongue position during speech sound production. The section which required students to decide whether pairs of nonsense words were the same or different had, by contrast, virtually no predictive power.

False positives and negatives

The number of false positives and negatives (as defined in Section 2, above) was calculated for the pre-tests alone and in combination, using two levels of cut-off: scores > 1.5 SD below the pre-test mean and scores > 2 SD below the mean. The results are shown in Table 2.

	False positives		False negatives	
	1.5 SD cut-off	2 SD cut-off	1.5 SD cut-off	2 SD cut-off
Combined pre-test	1	0	2	2
Musical pre-test	2	1	1	2
Phonetic pre-test	3	0	1	2

Table 2: Number of "false positive" and "false negatives" which would result if the pre-tests were used for screening.

As the table shows, neither of the pre-tests is entirely successful in correctly predicting which students will perform most poorly after two years of phonetics. When the pre-tests are combined and a cut-off of 2 SD is applied, the rate of "false positives" (i.e. students mistakenly identified as being likely to fail) falls to zero, but two students with final exam marks below the 10th percentile in the final exam would not be identified as being at risk.

Tracking of individual students

This expands on information provided by calculations of "false positives". Figure 1 is a graphic display of student tracking using the phonetics pre-test as an example. Degrees of shading identify the 5 lowest-ranking students on the phonetics pre-test, all of whom achieved scores more than 1.5 SD below the mean. Their rankings can be tracked through later phonetics tests by following the levels of shading. Although the two lowest-ranking students remain within the three lowest ranking places, note that three students (the "false positives" identified above) achieved adequate performance in practical phonetics tests. Conversely, one student who scored well within 1 SD of the mean on the pre-test (indicated by asterisks) had the lowest ranking in the final exam.

This approach has allowed the progress of students with both high and low pre-test scores to be tracked through the 2 years of phonetics teaching. It shows very clearly that

although the pre-tests are correlated with later performance, they are not fully predictive of an individual's development.

	Phonetics pre-test	1 st year phonetics	2 nd year midpoint phonetics	2 nd year final phonetics
Best mark				
RANK ORDER				
	**			
		**		
		**		
			**	
Worst			**	**

Figure 1: A graphic display of student tracking. Depth of shading is used to identify the 5 students who scored lowest in the phonetics pre-test so that changes in their ranking can be tracked as they progress through the course.

4. DISCUSSION AND CONCLUSIONS

Although this study is only a preliminary exploration of some of the factors which may be involved in learning phonetics, it indicates that the pre-tests used have some predictive value and lends support to the suggestion that musical ability is correlated with practical phonetic skill.

The pre-tests are probably not sufficiently robust to justify their use in selection of students for phonetics or SLT courses, but may be useful as a means of alerting teaching staff to the potential need for additional support. One practical consequence of this study, prompted by the strong correlation between awareness of tongue position and success in phonetics exams, has been the introduction of more systematic and explicit instruction to students about how to use tactile and proprioceptive feedback to monitor their own articulations.

Questions about neurological control of practical phonetic skills, and about how this might relate to normal psycholinguistic processing, or to performance and perception of music, remain unresolved. However, the

finding that student performance in practical phonetics exams and in the musical aptitude test are more strongly correlated with each other than with overall academic performance suggests that musical and phonetic ability might have something in common in terms of their neurological bases. It was suggested earlier that good phoneticians might be characterised by good phonological awareness combined with an ability to divorce the listening process from normal language processing. It would be interesting to investigate this further by relating assessments used here to specific tests of psycholinguistic functioning.

A better understanding of these issues could have significant practical and theoretical implications, not only for phonetics teaching, but also for some of the other fields in which new patterns of speech production and perception have to be learned. Obvious examples include foreign language learning and rehabilitation of acquired speech disorders, both of which probably draw on at least some of the skills subsumed under practical phonetics.

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