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Abstract

Scores on the Bentley Measures of Musical Ability test (BMMA) for 897 seven- or eight-year-old children were analysed with respect to a number of factors which previous research suggested might be associated with test performance. Comparisons between the 17 schools participating revealed that the same schools tended to produce either high or low scores. Further analyses revealed a significant relationship between BMMA scores and assessments of school achievement (Standard Attainment Targets – SATs). An association was also present between those schools scoring poorly on the BMMA and those containing relatively large numbers of children receiving subsidised school meals. There was also an association with age. No significant relationship was found, however, between handedness and BMMA scores. The results not only identify some specific limitations of the BMMA, but also point to more general problems in interpreting tests designed to screen for musical ability in children.

Introduction

Questions about the origins of musical ability recently have been the focus of considerable attention by psychologists (Manturzewska, 1990; Sloboda and Howe, 1991). There has been much debate about the relative roles in the education of young musicians of innate ability, of practice, and of home and school experiences (Ericsson, Krampe and Tesch-Romer, 1993; Larsen, 1987; Sloboda, Davidson and Howe, 1994; Torff and Winner, 1994; Winner and Martino, 1993). Attempts have also been made to clarify the relationship between components of music aptitude such as tonal and rhythmic imagery, music syntax, music flexibility and originality, and various conditions which enable its development (Webster, 1988).

The present study examined the relationship between children's scores on a standard test of musical aptitude, the Bentley Measures of Musical Ability (Bentley,

1966), and a variety of factors that might be related to test performance. The rationale for this study stemmed from the desire to identify some of the factors associated with musical aptitude. The Bentley Measures of Musical Ability test (BMMA) was employed as it had for many years been used by the local County Education Service to assess the musical aptitude of seven- and eight-year-old children in local schools. Consequently, a considerable body of normative data was available for all schools in the county. The Bentley test, moreover, was specifically designed for use with children between the ages of seven and fourteen. Furthermore, when this test has been administered in local schools all members of a given class participated, thus avoiding any selection bias.

Bentley was impressed by the wide range of musical abilities already existing in children as young as seven years, and he argued that given the relative homogeneity of his standardisation groups and their similar training in schools, "one cannot avoid the conclusion that the abilities disclosed are to a great extent innate" (Bentley, 1966, p. 101). If this were the case then one might predict that in young children there would be relatively little influence of teaching and experience, and hence only minor variation between schools. Over the years since the Bentley Measures were developed, it has become clear that performance on tests of musical ability and aptitude is determined not just by innate musical ability, but is influenced by such factors as test-taking experience, learning, and motivation (Shuter-Dyson and Gabriel, 1981; Shuter-Dyson, 1982; Webster, 1988).

However, in order to perform the BMMA task accurately, the child is faced with a number of cognitive demands. Not only must the child be able to hear and identify the different sounds, he or she must also be able to follow quite complex instructions which often use relatively technical language. For example, the instructions make use of the words "pitch" and "chord", which are likely to be unfamiliar to the large majority of seven- and eight-year-olds unless they have already started private music lessons. Many of the tests also make quite heavy demands on working memory (Hitch and Halliday, 1983) and throughout the test session the child must be able to concentrate and attend very carefully.

A closely related issue concerns the extent to which scores on a test of musical ability should be expected to be independent of other abilities. Correlations between musical ability and other intellectual abilities are almost without exception positive but low – r being typically about 0·3 with ordinary unselected subjects (Hargreaves, 1986; Shuter-Dyson, 1982). For example, Bentley (1966) reports that scores on the BMMA are only weakly associated with I.Q. (r ranging from 0·24 to 0·34), suggesting that performance on this test taps a quite different domain of cognitive skills. These matters take on a practical significance when the results of formal musical tests are used to direct programmes of musical training.

For all of these reasons the factors under consideration in the present study included past performance by a given school on the BMMA, current class performance on the Standard Attainment Targets (SATs), and a measure of the socio-economic background of the pupils in the school – the proportion of pupils eligible for free school meals (FSM). The latter measure was included in response to evidence that socio-economic factors are associated with musical ability (Hill, 1970; King, 1972; Larsen, 1987; Rainbow, 1965; Sergeant and Thatcher, 1974; Zenatti, 1976).

Additional attention focused on another factor, namely, handedness. This was selected because some previous studies have reported an increased incidence of left-handedness and mixed-handedness among accomplished musicians. These studies have typically focused on skilled musicians (students at schools of music or professional musicians). Thus while two studies reported a normal incidence of left-handedness among musicians (Gotestam, 1990; Oldfield, 1969), others have found an increase in mixed-handers (Byrne, 1974), an increase in left-handers (Fry, 1990), and an increase in both left- and mixed-handers (Aggleton, Kentridge and Good, 1994). The latter study is of particular interest as it used a far larger pool of musicians than had previously been studied. This suggests that the inconsistent pattern of previous reports may reflect the use of relatively small numbers of subjects. Furthermore, there is evidence that left-handed and/or mixed-handed people are more prevalent among musicians who play instruments requiring greater bimanual co-ordination (Christman, 1993), that left- and mixed-handers may have improved pitch memory (Deutsch, 1978; 1980), and that left-handedness is associated with better-than-average memory for rhythmic sequences (Craig, 1980). Very little is known about the nature of this apparent association between handedness and musical ability, and one important question concerns the extent to which it might be acquired or innate. The present study attempted to address this issue by examining handedness and a measure of music aptitude in children at an age (seven and eight years old) when they will have had little formal music education. It should be added that the BMMA includes sections designed specifically to test those abilities (pitch and rhythm memory) thought to be enhanced in left-handed adults (Craig, 1980; Deutsch, 1978; 1980).

The opportunity to conduct this study arose from the practice in County Durham, U.K., of testing all pupils in state schools on the BMMA. The test results were used by the County Education Music Service as part of the process of determining which children were to be offered subsidised musical tuition. The BMMA itself is divided into those items concerned with pitch discrimination, chord analysis, tonal memory and rhythmic memory. As a consequence, separate scores can be calculated for each of these components. We therefore collected the total and sub-test BMMA scores from 17 schools which had been tested in the same academic year (1991–92). These scores were then analysed in respect to those factors already specified.

Method

Subjects

The subjects were pupils from 17 mixed-sex schools in County Durham, U.K. A total of 20 schools were originally invited to participate, the selection being determined by the desire to include schools representing a wide range of catchment areas and with a wide range of previous scores on the BMMA. These catchment areas included middle-class residential areas as well as former mining and steel towns and villages with high levels of unemployment. Ten schools which had scored well on the BMMA and ten which had performed poorly were originally selected for the study. This distinction was made on the basis of the class scores from an earlier year (1989). The current study only involved those classes taking the BMMA in the same school year as the study (1991–92). Three schools declined the invitation to take part in the study.

From the 17 schools, a total of 897 school-children participated in the study. Of these 448 were male and 449 female. The age of the children at the time of testing was either seven (n = 375) or eight (n = 518). An additional four children who were nine at the time of testing were excluded from those analyses concerning age.

Materials and Procedure

The Bentley Measures of Musical Ability (BMMA). The BMMA (Bentley, 1966) is in three parts: pitch discrimination, memory, and chord analysis. Each part consists of 20 items. The memory part is sub-divided equally into tonal memory and rhythmic memory. Overall, four scores can be derived: pitch discrimination (P), in which the subject must decide if a sound is higher, lower, or the same as the preceding sound; tonal memory (T), in which the subject must identify the note in a tune that has changed; chord analysis (C), in which the subject writes down the number of notes in a chord; and rhythmic memory (E), in which the subject identifies the change in the rhythm of two monotonic examples. By summing these together a total score (TOT) is also derived. These various sub-test scores recognise the fact that musical ability may be made up of a number of different aspects. While several of these aspects have significant positive association with one another (P, T, C), the scores for rhythmic memory (E) do not appear to be significantly related to the other three (Bentley, 1966). The test was originally designed and validated for use with children of between seven and fourteen years of age. Reliability coefficients for the sub-tests range from 0·57 for rhythmic memory to 0·74 for pitch, with a reliability of 0·84 for the test overall (Shuter-Dyson and Gabriel, 1981, p. 284). Significant associations between test scores and teachers' estimates of the musical ability of children have been demonstrated, as well as a correlation between test performance and perseverance in the learning of a musical instrument (Shuter-Dyson and Gabriel, 1981).

The test was administered to schools by trained peripatetic staff from the Durham County Music Department. The test items were pre-recorded on audiotape together with standardised instructions. These were then played to each class. Responses, which consisted of a single letter or number, were made by each child on a standard form. The children were asked not to speak or make any other sounds that might interfere or distract fellow class-members.

Handedness Test. Handedness was assessed from the performance of four actions: writing, brushing teeth, throwing a soft ball at a target, and hammering a peg into a pegboard. The actions selected were all known to be good predictors of handedness (Annett, 1985; Bryden, 1977; Oldfield, 1971). Each child was tested individually.

Each test began with the child writing their name. The child was then asked to pick up a toothbrush and pretend to brush their teeth (but not to place the brush in their mouths). A small rubber ball was then placed on a table and the child asked to pick up the ball, and throw it with one hand to the experimenter so that the experimenter could catch the ball. Finally, the child was shown a tapered wooden peg that was lodged in a block of wood and asked to hit the top of the peg with a small wooden hammer. These actions, apart from writing, were then repeated. If any change of hand was noted during this repetition, the relevant action was tested for a third time. This third trial was used to determine the preferred hand

for that item. Care was taken when presenting the items (pencil, toothbrush, ball, and hammer) to place them in the middle of a table facing the child, so as not to favour either hand.

Other information

The age of each child at the start of the academic year in which they were tested on the BMMA was recorded. Information was also provided by the Education Department of Durham County Council concerning the Standard Attainment Target scores (SATs) of the 11 schools that had made the assessments in 1992. These educational assessments (which had just been introduced by the Department of Education) examine the attainment of children in four areas – English, Mathematics, Science, and in Technology). As the SAT is taken by children in their seventh year, these scores concerned the same cohort of pupils as those taking the BMMA. For each of the relevant schools, the SAT results (which were anonymous) were used to compile mean scores for each of the four components and a mean total score. Finally, the percentage of children eligible for free school meals in 1992 (FSM) was provided for all 17 schools, along with the total number of pupils in the school (in the U.K., children from low-income families receive free school meals as a state benefit). The information on subsidised meals, which gives a useful pointer to the socio-economic background of the pupils at a given school, referred to the entire school.

TABLE 1

Percentage of children qualifying for free school meals for all schools, school averages for mean overall SAT scores from the 11 schools in which assessments had been made, and average Bentley P, T, C, E, subscale and total (TOT) scores broken down by school type (good previous Bentley scores = 0, poor Bentley scores = 1).

School Id	School Type	Meals	Average SAT	Bentley TOT	Bentley P	Bentley T	Bentley C	Bentley E
1	0	4.3	-	22.71	9.95	3.05	5.98	3.73
4	0	2	1.91	31.20	12.76	5.29	7.86	5.29
6	0	2.6	2.43	30.48	12.10	4.19	8.00	6.19
7	0	1.2	2.06	33.40	13.38	5.65	8.68	5.70
11	0	22	2.32	31.89	12.11	4.39	10.00	5.50
12	0	0.5	2.34	27.26	10.18	3.69	8.04	5.37
13	0	5.6	1.98	32.70	12.00	5.81	9.12	5.69
14	0	14	1.68	21.33	6.71	3.13	7.00	4.50
17	0	2.2	-	22.71	9.86	3.24	5.98	4.38
2	1	17.5	-	9.29	4.42	1.04	2.49	1.33
3	1	26.7	2.23	19.62	6.23	2.15	7.69	3.54
5	1	45.9	1.27	15.30	5.23	0.94	6.27	2.90
8	1	29.9	1.74	24.77	9.40	3.55	7.47	4.34
9	1	27	-	20.41	7.14	3.10	7.14	3.22
10	1	34.6	1.49	12.49	5.84	1.84	2.84	2.00
15	1	58.4	-	20.41	8.13	2.36	6.69	3.23
16	1	15.6	-	17.20	7.10	2.19	5.47	2.45

Results

A child preferring the same hand for all four test actions was classified as right-handed or left-handed, as appropriate. This was true even if the child required three tests on a given item to determine the preferred hand. A child who consistently performed as least one action with the opposite hand to that used for the other actions was classified as mixed-handed. Using these criteria the study involved 787 right-handers, 69 left-handers, and 41 mixed-handers.

A series of five analyses were then carried out, one for each of the Bentley test scores – Pitch (P), Tunes (T), Chords (C), Rhythm (E), Combined Total Score (TOT) (see Table 1). For each of these analyses a four-way ANOVA (of factors handedness, school type, sex, and age) was calculated. "Handedness" had three levels (right, left, mixed), while "age" had two (seven or eight years old). The factor "school type" referred to whether the school had performed well or poorly on the BMMA in previous years.

Prior to these analyses the ages of the subjects from the 17 schools were compared using a one-way ANOVA to assess whether there were significant differences in the average age of children attending different schools. Although a significant difference between the average ages of children at different schools was found [$F(16,880) = 20{\cdot}15$, $p < 0{\cdot}001$] there was no clear evidence that these differences were systematically related to school-type [$t(895) = 1{\cdot}56$, n.s.].

TOT – total BMMA score. The overall mean score of the seven-year-olds was 16·6 whilst that of the eight-year-olds was 23·7. These can be compared with the mean scores reported by Bentley (1966) for seven- (20·4) and eight-year-olds (23·4). It can be seen that while the scores of the eight-year-olds were comparable, those of the seven-year-olds in the current study were slightly lower than those reported by Bentley (1966). An initial ANOVA between the 17 schools highlighted the fact that some schools performed better than others [$F(16,880) = 43{\cdot}1$, $p < 0{\cdot}001$].

Post-hoc multiple comparisons on total Bentley scores by schools were carried out using Scheffé's test with a significance level of 0·05. The results are shown in Table 2.

The results of this analysis can be summarised by breaking down the number of schools that each school differs from significantly by school type as shown in Table 3.

From this summary it is clear that the classification into school types based on past performance is, in general, consistent with the results reported in this study in that most schools differ from fewer other schools of their own type than from schools of the other type. Only two schools with scores near the overall mean (where fewer significant differences will be found) are inconsistent – school 14 differs from one school of either type and school 8 differs from three high-scoring schools of its own type in addition to one school of the other type.

In the overall ANOVA, significant main effects were found for both school type [$F(1,869) = 44{\cdot}7$, $p < 0{\cdot}001$] and age [$F(1,869) = 16{\cdot}3$, $p < 0{\cdot}001$]. There was, however, no effect of handedness [$F(2,869) = 0{\cdot}01$] or sex [$F(1,869) = 1{\cdot}26$, n.s.]. Of the various interactions none was significant (at an alpha level of 0·05), and only hand by school type [$F(2,869) = 2{\cdot}63$] had a probability of less than 0·1.

TABLE 2

Post-hoc multiple comparisons on total Bentley scores by schools using Scheffé's test with a significance level of 0·05. The comparison matrix shows school IDs and their respective school types on both axes. Mean overall Bentley scores for each school are also shown on the ordinate. Significant differences are indicated by asterisks; these are shown in the lower triangle of the comparison matrix.

Bentley Mean	School Id	School Type	2	10	5	16	3	15	9	14	1	17	8	12	6	4	11	13	7
	School Id		2	10	5	16	3	15	9	14	1	17	8	12	6	4	11	13	7
	School Type		1	1	1	1	1	1	1	0	0	0	1	0	0	0	0	0	0
9.28	2	1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.49	10	1			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15.29	5	1				-	-	-	-	-	-	-	-	-	-	-	-	-	-
17.20	16	1	*				-	-	-	-	-	-	-	-	-	-	-	-	-
19.62	3	1						-	-	-	-	-	-	-	-	-	-	-	-
20.41	15	1	*						-	-	-	-	-	-	-	-	-	-	-
20.41	9	1	*							-	-	-	-	-	-	-	-	-	-
21.33	14	0	*								-	-	-	-	-	-	-	-	-
22.71	1	0	*	*								-	-	-	-	-	-	-	-
24.74	17	0	*	*	*	*							-	-	-	-	-	-	-
24.76	8	1	*	*		*								-	-	-	-	-	-
27.25	12	0	*	*	*	*									-	-	-	-	-
30.47	6	0	*	*	*	*										-	-	-	-
31.19	4	0	*	*	*	*			*								-	-	-
31.89	11	0	*	*	*	*			*									-	-
32.69	13	0	*	*	*	*		*	*										-
33.40	7	0	*	*	*	*	*	*	*	*	*	*	*	*					

TABLE 3

Breakdown by school type of the number of schools of each type that each school differs from significantly in the Scheffé post-hoc analysis.

School Type	School Id	Number of p<0.05 differences from type 0 schools	Number of p<0.05 differences from type 1 schools
0	7	3	7
0	13	0	6
0	11	0	5
0	4	0	4
0	6	0	4
0	12	0	4
0	17	1	4
0	1	1	2
0	14	1	1
1	8	0	3
1	9	4	1
1	15	2	1
1	3	1	0
1	16	7	2
1	5	7	0
1	10	8	1
1	2	9	4

The same pattern of results was found when the mixed-handed and left-handed children were combined to form a "non-right" group. Similarly, when the mixed-handed children were combined with the right-handers the pattern of results remained the same.

P – pitch discrimination. The scores for P produced the same pattern of results as for TOT. That is, there was an effect of school type [$F(1,869) = 41{\cdot}7$, $p < 0{\cdot}001$] and age [$F(1,869) = 6{\cdot}11$, $p = 0{\cdot}014$], but not of handedness [$F < 1$] or sex [$F < 1$]. Once again, none of the interactions was significant and only the interaction between hand and school type had a probability of less than 0·1. The same pattern of results was found when the left- and mixed-handers were combined to form a single group.

T – tonal memory. The pattern of results was exactly the same as for TOT and P. That is, the only significant effects were for school type [$F(1,869) = 24{\cdot}12$, $p < 0{\cdot}001$] and age [$F(1,869) = 25{\cdot}0$, $p < 0{\cdot}001$].

C – chord analysis. As before there was a significant effect of school type [$F(1,869) = 8{\cdot}69$, $p = 0{\cdot}003$] and age [$F(1,869) = 5{\cdot}37$, $p = 0{\cdot}025$]. There was also, however, an effect of sex [$F(1,869) = 6{\cdot}16$, $p = 0{\cdot}013$], reflecting higher scores by the female pupils. There was also a significant interaction between school type and age [$F(1,869) = 8{\cdot}27$, $p = 0{\cdot}002$], reflecting the larger improvement with age found in those schools that have a history of performing well on the BMMA. There were no effects associated with handedness.

E – rhythm. Once again, the only significant effects were for school type [$F(1,869) = 29{\cdot}4$, $p < 0{\cdot}001$] and age [$F(1,869) = 8{\cdot}99$, $p = 0{\cdot}003$].

In response to the very strong effect of "school type" a further series of analyses were conducted in which the TOT scores were normalised by school in order to reduce the impact of differences between schools. This was achieved by subtracting the mean score of a given school from the individual scores of that school and dividing the result by the standard deviation of the scores of that school. In spite of this modification there was still no effect of handedness or sex, but there was a highly significant effect of age.

FSM – Eligibility for free school meals. Linear regression analyses were used to examine the possible relationship between BMMA performance and the percentage of pupils eligible for free meals in a school (see Table 1). The initial analysis used the TOT score as the dependent variable while the independent variable was "meals" (eligibility for free school meals). Linear regression revealed a highly significant effect of "meals" [$F(1,895) = 82{\cdot}0$, $p < 0{\cdot}001$], showing that those schools receiving the larger numbers of subsidised meals tended to perform worse on the BMMA. A similar set of relationships was found for each of the BMMS sub-tests; P, T, C, E, in all cases highly significant correlations were found (all $p < 0{\cdot}001$).

It should be added that further exploration of the data revealed evidence of an association between age and numbers of subsidised meals [$F(1,895) = 6{\cdot}39$, $p = 0{\cdot}012$] which might confound any inference drawn from the relationship between BMMA score and "meals". Informal evidence that this is not sufficient to explain the main effect of "meals" comes from the striking similarity between the list of schools with previous high and low BMMA scores, and the list of schools divided between those with relatively high and low numbers of pupils eligible for subsidised meals. (It was found that only one of the ten schools with previously high BMMA scores was not in the set of ten schools with the lowest proportions of free school meals.) A multiple regression analysis of the dependent variable BMMA score against the variables "age" and "meals" showed that, although both variables are significantly correlated with BMMA in their own right, the change in F-ratio obtained when both variables are entered into the regression compared with either of the simple regressions is highly significant [change in $F(1,895) = 115{\cdot}04$, $p < 0{\cdot}001$]. It can therefore be concluded that there is a significant relationship between "meals" and BMMA score over and above any that might be attributed to a confounding age effect.

SAT scores. A second regression analysis was carried out utilising the TOT score from the BMMA as the dependent variable and the average SAT score as the independent variable (see Table 1). Strong evidence was found for a relationship between school SAT score and the Bentley TOT scores [$F(1,333) = 108{\cdot}5$,

$p < 0{\cdot}001$]. Similar relationships were also found between average SAT scores and all sub-scales of SAT and each of the sub-test (P, T, C, and E) scores (all $p < 0{\cdot}001$). It should be added that there was no association between age at the time of BMMA testing and class SAT score.

Discussion

The present study, which examined the scores of seven- and eight-year-old children who had taken the Bentley Measures of Musical Ability, found a number of factors to be associated with test performance. Not surprisingly, age (eight *versus* seven) was strongly associated with higher scores, and this is consistent with other published results for this test (Bentley, 1966). A more novel finding was the discovery that high performance on the BMMA was associated with whether classes from the same school had performed well on the test in previous years, and whether the school contained relatively few children receiving subsidised meals. These last two factors were strongly correlated with one another. It was also found that those classes performing well on the SAT also tended to perform well on the BMMA.

The overall BMMA score (TOT) was not associated with gender. This agrees with previous studies using this measure and with other surveys of gender and musical ability (Bentley, 1966; Shuter-Dyson and Gabriel, 1981). The only exception to this pattern arose from evidence that female pupils scored better on chord analysis (C). This result may well reflect the fact that the chord sub-test is by far the hardest of the BMMA sub-tests, and is too difficult for many seven- and eight-year-olds (Bentley, 1966). As a consequence accuracy on this sub-test will be more prone to the influence of other factors, such as task comprehension. This may, in turn, lead to scores becoming associated with gender, as well as producing interactions between age and school type.

The present study found no evidence of a relationship between handedness and BMMA performance. This was true of both the total score from the BMMA and of the various sub-tests designed to assess different aspects of musical ability. Similar results were found when the children designated as mixed-handers were re-grouped with either the left-handed children or with the right-handed children. This pattern of results suggests that any left-handed musical advantage found in adults (Aggleton *et al.*, 1994) only emerges in later years. One possibility is that left-handers and mixed-handers have, on average, a higher level of bimanual dexterity than consistent right-handers (Annett, 1985). As a consequence they have an advantage when first learning to play an instrument, especially instruments which require considerable bimanual co-ordination (Christman, 1993). This may lead to such people being more likely to persist and take further musical training (Aggleton *et al.*, 1994). In order to confirm this suggestion it would be necessary to embark on a longitudinal study that looked at drop-out rates among those taking instrumental music lessons.

Before concluding that there is no handedness effect among children, however, it is important to appreciate that the current findings have also highlighted certain weaknesses in the BMMA. The discovery that BMMA scores in a given school are linked with previous performance by that school on the same test, with the numbers of subsidised meals, and with SAT scores, must call into question the

validity of the BMMA test when applied to children of this age. While it is possible that the finding of consistently higher scores in certain schools is a reflection of better standards of music teaching in those schools, and that this is associated with being in a more affluent catchment area, it seems unlikely that this would be evident at such an early stage of school music education. Furthermore, the kind of task given in the BMMA does not correspond to that normally taught to children of this age in class lessons. It is also possible, however, that some of the children in the "higher-scoring" schools had already begun private instrumental tuition. At the time of the initial collection of the handedness data it had not proved practical to obtain this information. Subsequent discussion with some of the peripatetic teachers involved suggested that this would have applied to only a very small proportion of the children tested in the high-scoring schools. A consideration of the actual demands of the BMMA suggests that there are other, more probable causes for the associations uncovered in this study.

This view is reinforced by the finding of a relationship between BMMA results and class SAT scores (a broad indicator of the child's performance on a wide range of school curriculum work), and with the other factors identified in this study. It is also consistent with the finding that the same set of relationships applied to the various sub-test scores, even though some are regarded as testing quite separate aspects of musical ability (Bentley, 1966). From this it can also be seen that if the BMMA is an imprecise measure of musical ability then the apparent lack of any association with handedness must be treated with caution, as indeed must any conclusion about the dominant role of environmental factors in the determination of musical ability.

The finding of a significant association between BMMA scores and SAT scores does appear to run counter to the claimed lack of a relationship between BMMA scores and I.Q. (Bentley, 1966). In fact Bentley did find a positive relationship between all of the sub-tests and I.Q. (as measured by the Moray House Verbal Reasoning Task), but none of these was significant. Subsequent studies have found positive correlations between BMMA measures of musical ability and other abilities such as reading, sentence completion, and digit span (Barwick, *et al.*, 1989; Whellams, 1971), and between the Gordon Primary Measures of Music Audiation and measures of academic achievement in reading and mathematics (Hobbs, 1985). One explanation for this apparent discrepancy with respect to the BMMA is that most of the initial validation studies (Bentley, 1966) were carried out on children older than those participating in the present study. It may well be that for younger children such as those participating here (seven- and eight-year-olds) the task is confounded as it strongly taxes other cognitive abilities, such as the ability to assimilate and apply novel terms such as "chord" and "pitch", or the ability to concentrate throughout the test session. For example, children unfamiliar with the meaning of the term chord may hear the chord correctly but fail to understand the need to identify the separate notes. From this it can be seen that the set of factors found to be associated with BMMA performance in seven- and eight-year-olds can be re-interpreted in quite a different light. That is, the task makes demands on a range of cognitive functions such as task comprehension, working memory, attention, etc., and musical ability is only one of them. Some more recent tests of musical aptitude make fewer cognitive demands on children of this age (Simons, 1976).

The present results highlight the care that is required in constructing a test of musical ability for children. Unless the instructions are in very simple language and the test does not unduly tax other cognitive demands, the findings are likely to be of limited value. Furthermore, the results indicate that when tests like the BMMA are used for screening purposes it is important, at the outset, to determine what the goals of such a programme might be. If the intention is to provide subsidised training to those who might otherwise never receive instrumental lessons, then it is probably better not to rely solely on such a test, or at least to select pupils by taking the top percentage in each school, rather than apply a standard cut-off point. The present results show that the latter practice will concentrate resources in certain schools and favour those in the more affluent areas.

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