The SINGAD (Singing Assessment and Development) system: First Applications in the Classroom.

by

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Abstract

SINGAD, a BBC microcomputer-based system for singing assessment and development has recently been undergoing trials with a class of seven year-olds in Bristol. The sample (n=32) were divided into three matched groups: (a) experimental interactive, (b) experimental non-interactive, and (c) control. Groups (a) and (b) used the SINGAD system while the control group followed an example of a more traditional music curriculum. After one school term, results indicate that the experimental groups showed a significant improvement in their singing ability compared to the control group, and that SINGAD is effective in promoting singing development.

Introduction

Recent research (1,2,3) suggests that singing can be regarded as a continuum of ability characterised by certain stages of development. At one end of the continuum there are those who are not yet pitch accurate (termed 'poor pitch singers' or p.p.s), whilst at the other there are those who exhibit a multi-faceted singing ability, such as being able to sing 'at sight'. Furthermore, it has been demonstrated that singing development can be facilitated through the application of appropriate feedback (4,5,6).

In order for feedback to be 'appropriate', however, it needs to be in a form which is accessible to the developing singer. Such singers must be able to extract and use the information offered. Within the private studio or conservatoire lesson, with a pupil-teacher ratio of 1:1, extracting meaning from the feedback is not too difficult because of the opportunity for individual commentary and discussion, and there is the likelihood that the pupil already possesses a fair degree of singing skill. With a school class of thirty children, however, the provision of 'appropriate' feedback becomes much more problematic, particularly if the teacher does not have a background in voice skills development.

The SINGAD (Singing Assessment and Development) system First Application in the Classroom

The SINGAD microcomputer-based system (7) has been developed to assist the teacher in the classroom by presenting visual feedback of pitch to the singer. The microphone input of voiced fundamental frequency is estimated by a peak-picking device (8) linked to a BBC microcomputer with monitor display. The peak-picking device is pocket-sized and battery-powered and operates in real-time with no output smoothing. The SINGAD software has two features: it provides an objective measure of vocal pitch accuracy, and facilitates singing development through the presentation of a visual correlation of voiced fundamental frequency to the user.

Initial school trials suggested that the SINGAD system could be used effectively with children (9). Confirmation has been sought through a more extended pilot programme which would also allow different methods of use to be compared.

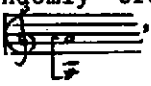
Method

Sample

The sample consisted of thirty-two children aged seven drawn from a Bristol Primary school. (Originally thirty-three children were to be involved in the study but one child left the school during the development phase). Prior to treatment, the children's ability to sing in-tune was measured using the SINGAD assessment program. The sample was then divided into three groups, equally matched statistically ($F=.0008$) for the range of vocal pitch accuracy that they contained. There were two experimental treatment groups and a control group. The Experimental Interactive group (EI) (n=10) had regular singing development sessions using the SINGAD development software with one of the authors. The Experimental Non-Interactive group (ENI) (n=11) used SINGAD development software without any adult intervention. The Control group (C) (n=11) followed a more traditional programme, singing songs in a group with guitar accompaniment.

Apparatus

Initial and post-treatment assessment sessions were undertaken using the SINGAD system in conjunction with a BBC microcomputer and monitor. The two experimental groups (EI and ENI) continued to use the computer during the intervening development phase.

In the pre- and post-treatment assessment sessions the computer generated eight randomly ordered pitches across the range 224.3Hz to 449.3Hz  , with timbre, intensity, and

duration being held constant. This frequency range was chosen to be within the notional 'comfortable' singing range which research has indicated is customary for the majority of untrained voices in this age group (10). The attempts at vocally matching the stimulus sounds were estimated in Hz and tabled for each subject.

In the development phase, the two experimental treatment groups (EI and ENI) used the SINGAD development suite of programs. These allowed the subject to have real-time visual feedback of vocalised pitch. The voiced sound was displayed as a line which moved at a fixed speed across the screen from left to right. Pitch was indicated by the relative position of the line on a vertical axis, i.e. the higher the pitch, the nearer the line was to the top of the screen. The visual presentation allowed the subject to have a visual correlate of auditory space.

Three related programs were used in the development phase. In the first, the subject had a blank monitor screen and was allowed free exploration of vocalised pitch. In the second, up to four symbols appeared on the screen (e.g. rocket). These acted as pitch targets; the objective being to hit the displayed symbol with the pitch line by adjusting the sung pitch. The location of the symbols on the screen was altered randomly by hitting the space bar. The third software option generated one visual symbol with an associated frequency, thus presenting subjects with a concurrent bi-modal pitch model and visual feedback.

Design

Subjects were allowed a familiarisation session with the SINGAD system, working in pairs with one of the authors, prior to the initial assessment session. Singing assessment was undertaken individually, and subjects were subsequently allocated to one of three groups, equally matched for the range of vocal pitch accuracy that they contained. Individual pitch accuracy varied from being virtually in-tune across all eight test pitches to an average out-of-tuneness of more than six semitones.

The singing development phase for all three groups covered six weekly sessions. Each development session lasted ten minutes, with subjects from the two experimental groups working in pairs or threes and the control subjects being seen as a group. The Experimental Interactive group (EI) worked in pairs with an adult on the the SINGAD software. The adult's role was to enhance the visual feedback by promoting discussion of the monitor display, and to switch to an alternative development program at appropriate times. The Experimental Non-Interactive group (ENI) worked in pairs using the same software programs as the EI group, but without interaction with an adult.

Consequently, the ENI group did not experience the same variety of software changes per weekly session as the EI group, although both groups used all the SINGAD development programs during the course of the six weeks. The Control group (C) had weekly group singing sessions with guitar.

At the end of the six week development phase, a further session was allocated to post-treatment assessment of vocal pitch accuracy. However, there was evidence that the one week interval between the last development session and the post-treatment assessment was influencing subjects' performance negatively. It was decided, therefore, to include the assessment immediately after a further development session.

Results

The mean deviations in cents from the eight computer-generated pitch stimuli for each subject pre- and post-treatment are given in Table 1. Scores were subjected to an Analysis of Variance (ANOVAR,see Table 2) in order to (a) compare the performance of the groups pre- and post-treatment (Levels), and (b) compare the performance of the two experimental groups with the control group (Treatments). Results show a highly significant difference pre- and post-treatment (Levels, $F=11.10$, $p<.005$), but no significant difference between the three types of treatment ($F=1.08$). This failure of Treatments to reach significance is due to the even matching of the groups before the development session began. (The range of mean deviations post-treatment was reduced for all groups, but the ANOVAR takes account of the overall spread of scores pre- and post-treatment.) There was evidence, however, of a significant interaction between the duration and type of treatment given (Treatments x Levels, $F=3.32$, $p<.05$).

In order to determine the exact nature of the differences shown in the Analysis of Variance, further statistical analyses were undertaken. Table 3 shows t-Test comparisons for each group pre- and post-treatment, and compares each group's post-treatment scores with the other two. The t-Tests show that both the experimental groups performed significantly better on the post-treatment assessment. The control group showed a slight improvement but this was not statistically significant. The comparison between groups of their post-treatment scores indicates that the differences in the means (see Table 1) are not significant, although the EI vs C comparison approaches significance at the $p<.05$ level.

Discussion

The results indicate that, compared with the control group who followed a more traditional approach to singing development, the subjects in the two experimental groups benefited significantly from using the SINGAD system. The mean score of the Experimental Interactive group improved by more than 50% after working with the system for approximately an hour across a six week period. The Experimental Non-Interactive group improved collectively by almost the same amount.

The importance of having an adult involved in the development process was shown by the results of the EI group. This finding was confirmed by the slight (non-significant) improvement shown by the control group who had followed a more traditional programme of class singing. Nevertheless, perhaps the most interesting result was that of the ENI group who improved significantly without adult intervention. This result suggests that the SINGAD system could make a positive contribution to singing development in the classroom, irrespective of the vocal skills development expertise of the teacher.

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Table 1: Mean deviations in cents for each subject pre- and post-treatment.

Pre-treatment

EI		ENI		C	
Subject 1	403	Subject 11	562	Subject 22	614
Subject 2	643	Subject 12	394	Subject 23	424
Subject 3	483	Subject 13	433	Subject 24	198
Subject 4	131	Subject 14	352	Subject 25	369
Subject 5	273	Subject 15	207	Subject 26	397
Subject 6	416	Subject 16	393	Subject 27	108
Subject 7	112	Subject 17	576	Subject 28	214
Subject 8	533	Subject 18	352	Subject 29	497
Subject 9	526	Subject 19	44	Subject 30	387
Subject 10	266	Subject 20	222	Subject 31	328
		Subject 21	442	Subject 32	540
($\bar{X}$=378.6)		($\bar{X}$=358.3)		($\bar{X}$=370.5)	

Post-treatment

EI		ENI		C	
Subject 1	41	Subject 11	67	Subject 22	128
Subject 2	89	Subject 12	106	Subject 23	288
Subject 3	97	Subject 13	280	Subject 24	324
Subject 4	159	Subject 14	334	Subject 25	347
Subject 5	155	Subject 15	147	Subject 26	620
Subject 6	320	Subject 16	322	Subject 27	64
Subject 7	185	Subject 17	87	Subject 28	355
Subject 8	288	Subject 18	372	Subject 29	206
Subject 9	77	Subject 19	290	Subject 30	217
Subject 10	410	Subject 20	277	Subject 31	172
		Subject 21	452	Subject 32	546
($\bar{X}$=182.1)		($\bar{X}$=207.4)		($\bar{X}$=297.0)	

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Table 2: Analysis of Variance between groups.

Source	SS	df	ms	F	p
Total	1904493	64	-	-	-
Levels	268031	1	268031	11.10	<.005>.001
Treatments	51945	2	25972.5	1.08	n.s.
Treatments x Levels	160224	2	80112	3.32	<.05>.025
Error	1424293	59	24140.5	-	-

Table 3: t-Test comparisons between groups.

EI pre- vs EI post-treatment	t = 3.013	df19	p<.01
ENI pre- vs ENI post-treatment	t = 2.02	df20	p<.05
C pre- vs C post-treatment	t = 1.07	df20	n.s.
Post-treatment:			
E1 vs EN1	t = 0.357	df19	n.s.
ENI vs C	t = 1.16	df20	n.s.
EI vs C	t = 1.78	df19	<.1>.05 app.sig.