VOCAL RANGE AND POOR PITCH SINGING

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Around 330 B.C. the philosopher Aristotle argued for the inclusion of music as part of the balanced education of a gentleman. He deliberated on the structure of the music curriculum and concluded that:

> "First . . . they should while young do much playing and singing" (*Politics*, Book VIII, Chapter 6).

Both his predecessors and those who came after him appear to have reached similar conclusions, *i.e.* that a balanced musical education must include some vocal activity. For example, in Geneva, Jacques-Dalcroze included vocal exercises (solfège) in his comprehensive theory of music education. In Munich, Orff added the singing voice to his *Schulwerk* so that movement, playing and singing could become a unity.

While most music educators may agree that singing is an important element of the music curriculum, there is less agreement in defining what should be sung, and how to begin singing activities. Jacques-Dalcroze used scales and arpeggios based on a fixed doh, while Orff believes the cuckoo-call, or falling third as a basis to the pentatonic scale to be the first stage.

The published music for the voice ranges from lieder, oratorio and opera, to folk music, both traditional and modern, as well as the ubiquitous world of "pop". Thus the diversity of vocal music potentially available for purposes of music education is enormous, and this presents the music teacher with a major problem in choosing where to begin.

One possible solution is not to look at the music one wishes to promote in the processes of education, but rather to look at the child himself, to see what he is capable of singing. A review of the literature on vocal range reveals numerous different research findings which might superficially appear to be contradictory. These contradictions, however, are the products of differing definitions of what may be regarded as singing; for example, in measuring the range of the singing voice, should the limit be taken as the highest possible note, or the highest comfortable note? Differing methods of research also produce apparently contradictory data, as do differences in composition and locations of samples employed in studies. Nevertheless, the results of recent research reveal some common trends that provide some level of guidance to help us to match our educational programmes to the capabilities of the children we teach.

Although research studies of vocal range have been undertaken since the end of the last century, it is only recently that such research has been used to indicate possible causes of poor pitch singing. The research has not been primarily concerned with those children who cannot sing accurately, but rather with defining the upper and lower pitch limits of those who can.

It will be shown in the following review of the literature, that despite the use of differing criteria, there is a general research concensus that the child's vocal range changes with age. It is proposed to show that failure to recognise this change in vocal range, and to take account of it in planning the music curriculum, could directly affect the incidence of poor pitch singing among the child population.

Early research. One of the earliest studies of the development of the vocal pitch range was carried out by Paulsen (1895). The sampling of 3,000 schoolchildren indicated a gradual increase in vocal range over the first 15 years of life.

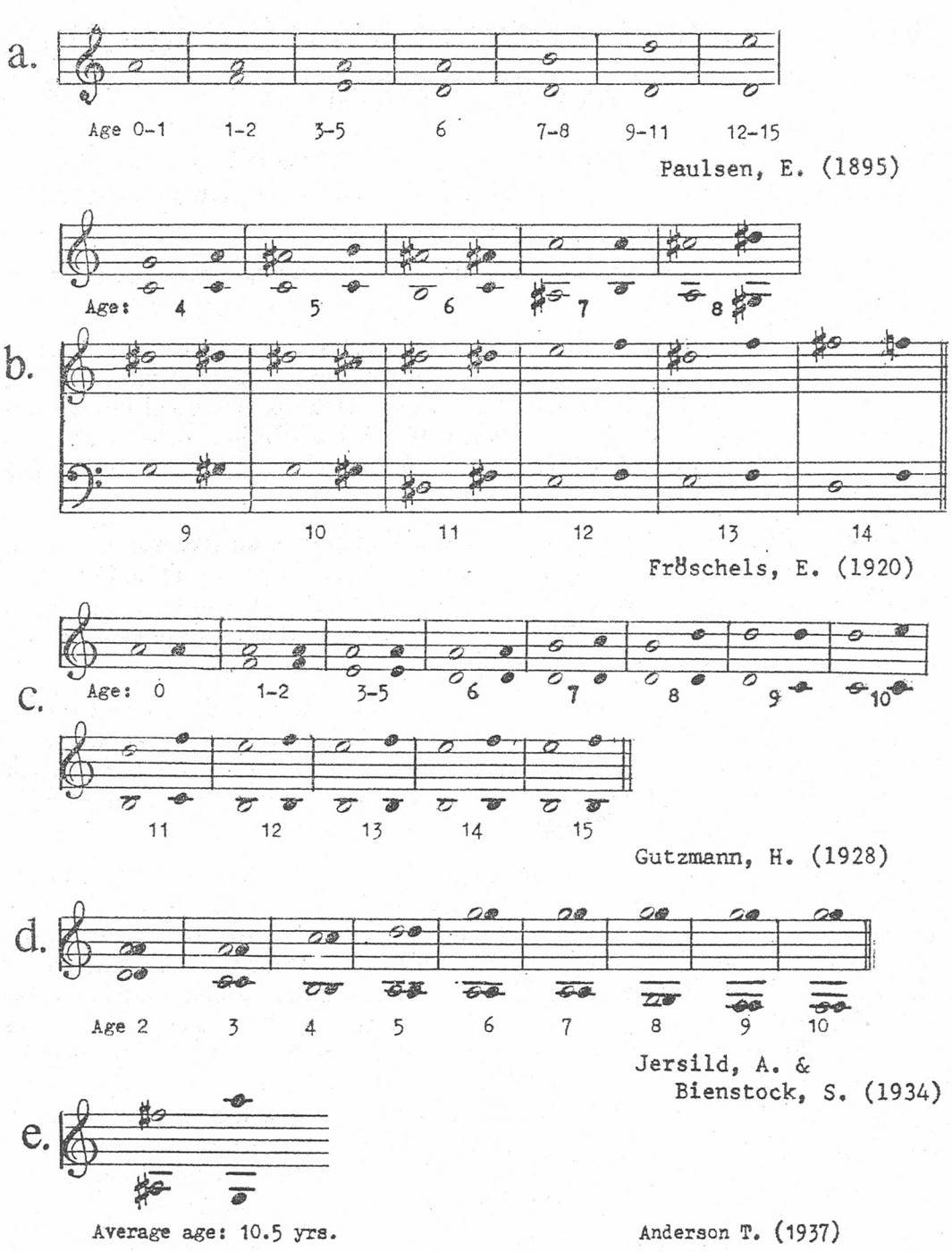


Fig. 1. Data of vocal ranges from early researches;
Boys shown as 𝅗𝅥
Girls shown as ●

The table in Fig. 1 (*a*) shows the changes for boys. According to the same investigation, the girl's voice reaches on an average one major second higher than the boy's voice. It is not known if the pitches given are the limits of the vocal range or the mean. By reference to comparable studies it would seem these notes are seen to be common to the ages of the sample, and could be argued as their usable range. The method employed in the investigation is not known nor are the criteria employed.

Schoen (1940) reports an investigation carried out by Fröschels (1920) with 380 children of both sexes, ranging in age from 4 to 15 years:

> Each child was called upon to sing the C scale, ascending and descending. The keytone was sounded by a tuning fork and the scale was first sung for the child either by the experimenter or by the teacher. The child was then called upon to sing the scale. If he could not do so because of lack of training or vocal deficiency a song was attempted. If this also failed the assistance of a child of similar age was called upon,* since it is well known that some children can imitate the voice of another child better than that of an adult. Only seven children failed in this attempt also (Fröschels, E., as reported in Schoen, pp. 220–221).

The children in the Fröschel study sang the scale to vowel sounds: "a", "i", and "u". The upper limit of the vocal range was determined by the highest tone that a child could produce without evident strain of the vocal muscles: "In other words, the tone below the forced tone was taken as the upper limit of vocal range" (Schoen, *op. cit.*, p. 221).

The range reported is shown in Fig. 1 (*b*).

The most striking result of this research is the very large range indicated from the age of 11 onwards, and the depth of the voices. The lower limits of the vocal range are the most extreme reported in the literature. It could be that Fröschels is reporting the range limits of individual subjects rather than age group means.

This research was followed by a study of children from birth to 15 years by Gutzmann (1928), as reported by Fieldhouse (1937, p. 49) [Fig. 1 (*c*)]. Very little is known of this research as the vocal pitch range was reported by Fieldhouse without provision of any other details or comment. A feature of this study is its constancy at the lower vocal extremity. This provides a sharp contrast with the data of Fröschels.

In 1934 Jersild and Bienstock gave tests of the vocal reproduction of pitch to 407 children aged two to ten years, and to 65 adults:

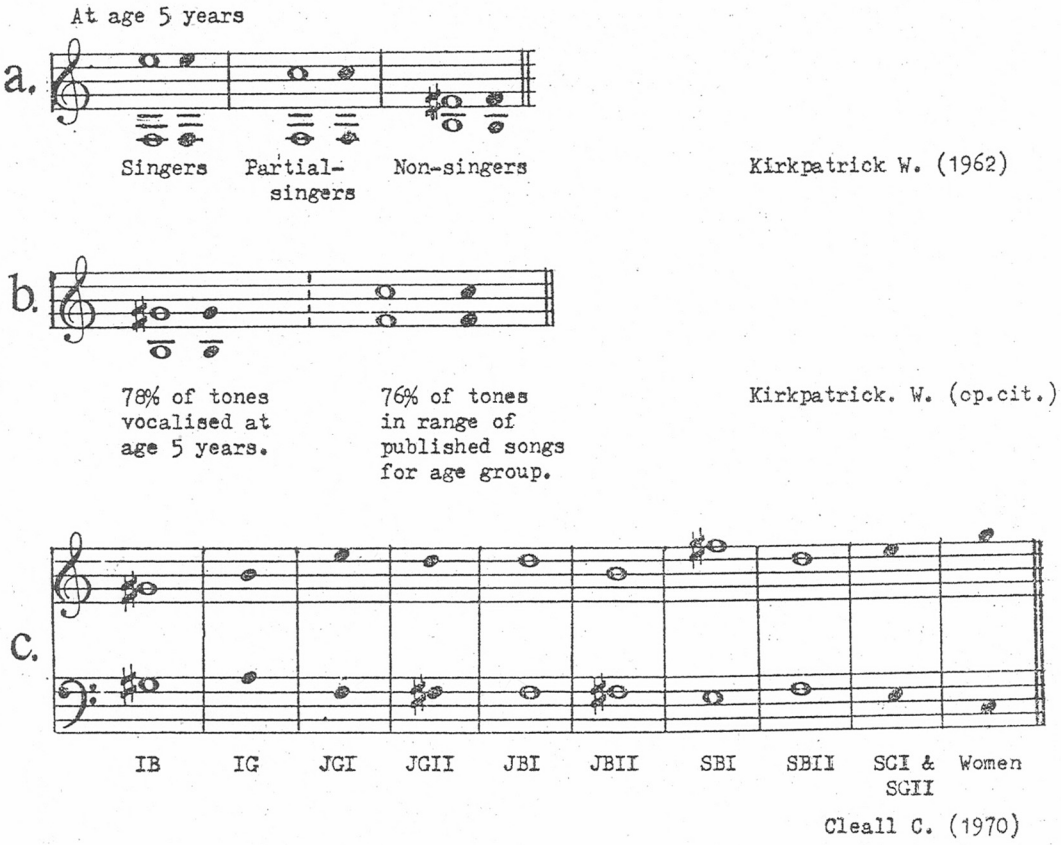
> The scoring was based upon the reproduction of the individual tones and half-tones corresponding to the C major scale. [As had Fröschels in 1920.] Each tone or half-tone correctly reproduced added a tally of one to the subject's score (1934, p. 482).

Each subject was asked to listen to the sound of each tone as produced on a piano or xylophone, listen to the experimenter sing it, and then reproduce it. The experimenters' ability to make judgements as to whether or not a note was reproduced accurately was later verified by a team of six judges (*op. cit.*, p. 483). Each subject was tested three times, *i.e.* once on three separate days. This was to give an indication of the consistency of the scores, which gave an average coefficient of ·87.

The vocal range of 50 per cent. of their subjects expanded as shown in Fig. 1 (*d*) (*op. cit.*, p. 491).

Credit was given on the basis of the vocal reproduction of individual tones, not: " . . . how well he might be able to use them or incorporate them into a song" (*op. cit.*, p. 484). This could explain the enormous vocal range indicated at the age of six years onwards, which is in conflict with all the other research. No other investigation reports such a large vocal range until the children are much older. As Jersild and Bienstock were only interested in the "temporary" (*op. cit.*, p. 484) pitch production of a tone rather than its sung quality as a proper note, the discrepancy of their results with other researches could be

*This method of using either a song or another child, or both, to aid the researcher in determining the vocal range of a nervous or shy child was also employed by Plumridge (1972, p. 18).



Range of 50 per cent. of treble voices

IB	= Infant Boys, aged 5–7 or 8
IG	= Infant Girls, aged 5–7 or 8
JGI	= Junior Girls, upper stream, aged 8–11
JGII	= Junior Girls, lower stream, aged 8–11
JBI	= Junior Boys, upper stream, aged 8–11
JBII	= Junior Boys, lower stream, aged 8–11
SBI	= Senior Treble Boys, Grammar School, aged 11 plus
SBII	= Senior Treble Boys, Secondary Modern School, aged 11 plus
SGI & II	= Senior Girls, both streams, aged 11–18
Women	= Adults, aged 27–66

Fig 2. Data of vocal ranges from more recent researches;
Boys shown as *o*
Girls shown as *e*

explained by their choice of criteria. The other investigations are more concerned with the production of notes, *i.e.* implying a more musical criterion and indicating some sustained frequency level.

One innovatory feature of their research which has since been utilised by Gould (1969), Joyner (1971), and Roberts (1972) was to first find a tone which the child could produce with ease, and work outwards from there, rather than begin at a preconceived pitch level.

The last of the earlier researches was carried out by Anderson (1937) with a small sample of 30 subjects. His investigations into the variations in the normal range of children's voices indicated the pitch limits shown in Fig. 1 (*e*).

However, with such a small sample it is difficult to give much weight to these results. A difficulty with this early research detailed above is that there appears to be no general agreement as to the criteria for judging the vocal pitch range of children. As a result there is no general agreement in the evidence presented. However, this early research does indicate a general growth in the range with age, both upwards and downwards. The nature of this development is revealed more clearly in the more recent research reviewed below.

Recent research. Kirkpatrick (1962) investigated the relationships between the singing ability of prekindergarten children and their home musical environments. He recorded the singing repertoire of 116 children in their homes. An analysis of the singing led to the postulation of three levels of ability,

i.e. singers— 90 per cent. or more correct tones of a song with no tonality changes;

partial singers—75 per cent. to 89 per cent. correct tones, or one or more tonality changes; and

non-singers— less than 74 per cent. correct tones or no tonality established.

These three abilities had range limits (p. 886) as shown in Fig. 2 (*a*).

The children sang over 80 folk and nursery songs, and these were compared to to the California State Series Kindergarten Music Book:

> A comparison of pitch levels showed 78 per cent. of children's tones ranged from B below C to G♯′, whereas 76 per cent of tones in the music book ranged from F′ to C″—a diminished fifth higher (*ibid.*): that is, as shown in Fig. 2 (*b*).

It was concluded from these results that, although some children are capable of singing over an extensive range at the age of five years, the vast majority are not. The children's singing of the songs was naturally pitched a third or fourth below that published. A similar finding had been reported by Hattwick (1933). He worked with 95 children aged four-and-a-half to eight years, allowing the children to sing any song they chose at any level they wished. He came to the conclusion that the pitch level printed in songbooks for the age of children he tested was far too high for the children's natural pitch (*op. cit.*, p. 281).

Cleall (1970) tested 1,216 subjects aged four years ten months to 66 years: "I continued to encourage each subject to sing as long as it seemed to me that there were more notes to come" (*op. cit.*, p. 107). He was only concerned with the pitch of the notes, not their quality. His results showed sex differences in the pitch range, and also a marked discrepancy of vocal range between upper and lower streams of academic ability (Fig. 2 (*c*)).

Cleall suggests a transposition of published music downwards to take into account the vocal range of more children (*op. cit.*, p. 134). He believes that much tone-dumbness (poor-pitch singing) is attributable to earlier vocal strain and discomfort, resulting from attempting to sing music which is pitched too high (*op. cit.*, p. 135). He shows that the majority of hymn tunes rise to D″ (*op. cit.*, p. 111), which is too high for the following percentage of treble voices:

Junior		*Infant*		
Girls	*Boys*	*Girls*	*Boys*	
37%	61%	72%	75%	(*op. cit.*, p. 112)

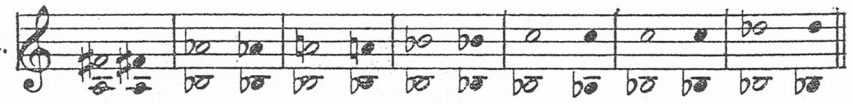
His findings are backed up by those of Joyner (1971), who writes:

> The clear indications were that the infants, in being asked to sing songs at their normal pitch, had been given tasks beyond their natural powers (*op. cit.*, p. 136).

He based this conclusion after studying the vocal pitch range of 130 children as part of his investigation into the association between pitch, perception, tonal memory and the larynx. He indicates "comfortable ranges" (*i.e.* not the "limits", as had Cleall and Kirkpatrick) (Fig. 3 (*a*)).

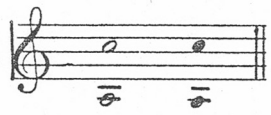
'Comfortable' ranges:

a.



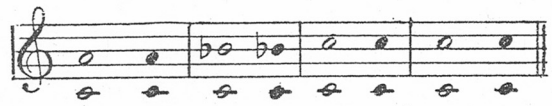
Mean Age 4.7 5.6 6.7 7.9 8.8 9.7 10.9 Joyner D. (1971)

b.



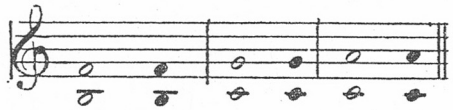
Comfortable singing range, 4th, 5th and 6th grades. Cobes C.J. (1972)

c.



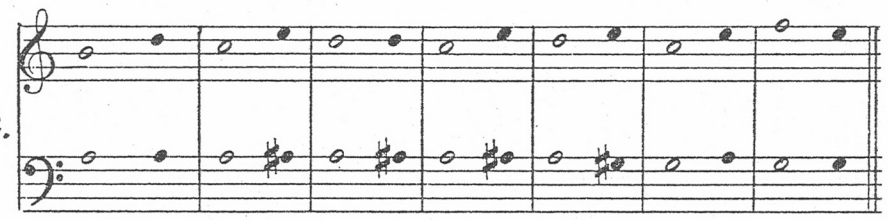
Age: 7.5 yrs. 8.5 9.5 10.5 Plumridge J.M. (1972)

d.



Age: 5 yrs. 6 7 Plumridge, J.M. (op. cit.)

e.



Age 7.5 yrs. 8 8.5 9 9.5 10 10.5

Hall K.J. (1972)

Fig. 3. Data of vocal ranges from more recent researches
Boys shown as o
Girls shown as •

These pitch ranges compare favourably with those reported by Kirkpatrick at the age of five years, and are within the primary school limits defined by Cleall.

Another researcher to indicate the "comfortable" singing rather than the vocal pitch limits was Cobes (1972), who investigated the conditioning of a pitch response using uncertain singers. As part of her screening procedure for uncertain singers: "they were asked to hum or sing a note that was comfortable for them" (*op. cit.*, p. 28). In her conclusions she writes:

> Judging from pitches voluntarily emitted by an initial population of 346 subjects, a comfortable singing range for both certain and uncertain singers of this age seemed to be from A_3 to C_4. More than 10 per cent. of the population emitted each of these pitches (*op. cit.*, p. 29) (Fig. 3 (*b*)).

Her sample were from the fourth, fifth, and sixth grades, (*i.e.* 9 to 12 years of age). Similar findings were reported by Coffman (1968) in his study of boys' voices in the fourth, fifth, and sixth grades.

Cleall's research was followed up by Plumridge (1972). She tested his finding that: "Infants (tested by Cleall) appeared to pitch their voices around middle C♯ and D" (*op. cit.*, p. 10).

As well as sampling 504 infant children aged five to seven years, she conducted a preliminary survey of 293 junior aged children. The reported comfortable singing ranges (*op. cit.*, p. 9) for juniors are shown in Fig. 3 (*c*), and for infants (*op. cit.*, pp. 26–28) in Fig. 3 (*d*). The infant ranges are those sung by the majority of the subjects (over 60 per cent.). The reported comfortable range for juniors is almost identical to that reported by Joyner; and the infant range is very close to that reported by Kirkpatrick, Joyner, and Cleall. All four researchers appear to be agreed on the relative narrowness of the vocal pitch range at this young age for the majority of children.

Hall (1972) investigated the vocal pitch range of junior schoolchildren. Using a sample of 98 boys and 98 girls, aged from seven years six months to ten years eleven months; she asked the children to either copy a song, or explore the range working outwards from a "comfortable" note. She found this latter method more successful with children who were: "unable or embarrassed about singing" (*op. cit.*, p. 21). This contrasts with Plumridge's conclusion that infant children performed more easily given a song rather than a note model to copy. It could be that older children prefer to sing something which has less connotation of "performance" about it.

Hall reported the comfortable vocal range by age and sex (*op. cit.*, p. 39) shown in Fig. 3 (*e*).

A gradual increase in the range is indicated as the children get older, but the pitch levels reported for each half-yearly age group are otherwise quite consistent. However, they are a third or more greater than those reported by either Plumridge or Joyner.

Probably the most complete study in recent years is that of Wilson (1973). The investigator employed two separate research situations. First a longitudinal study beginning with 69 first graders in 1957 and ending with 25 of the same students at high school 12 years later. These were compared with cross-sectional data from all children (697) enrolled in the first to sixth grades at the Chicago State College laboratory school from 1964 to 1969 (*op. cit.*, p. 55). The children's vocal range was administered individually starting with a pitch selected by the child and working outwards on the vowels "oo" and "ah". She also used a song familiar to all the children which the child was asked to sing starting at a pitch of his own selection (*op. cit.*, p. 56).

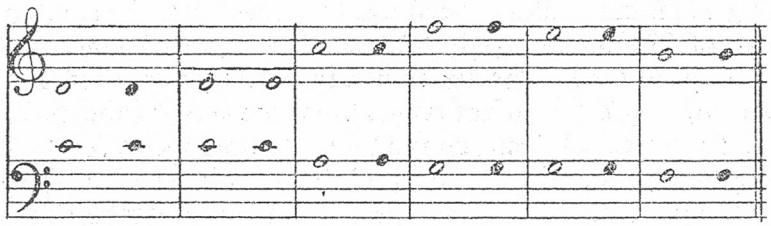
As a result of her investigations Wilson concluded: "marked individual differences in children's voice compass and span exist at all grade levels" (*op. cit.*, p. 57). She also reported that: "the pitch range selected by boys as a comfortable range for singing to be consistently lower than that selected by all girls in all grades" (*op. cit.*, p. 58) and: "the pitches selected by children as comfortable for singing are lower than the pitches traditionally recommended for children's singing" (*ibid.*). Common pitches reported from the longitudinal study are shown in Fig. 4 (*a*).

There is no explanation given for the rapid change between the vocal ranges of the second and third grades, but as she is giving the "common" notes this could mean that the third grade children are a more homogeneous group than those of the second grade. She observes that:

> When the pitch range of a♯ to a♯¹ (below and above middle c) is used for group singing in the classroom in all grades the participation of the students is the greatest (*op. cit.*, p. 58).

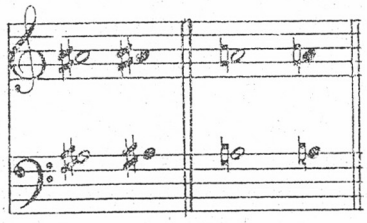
This range compares closely with that recommended by Cleall (1970, p. 134) (Fig. 4 (*b*)).

a.



Grade 1st . 2nd . 3rd . 4th . 5th . 6th Wilson D.S. (1973)

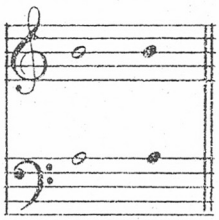
b.



Wilson (1973) Cleall (1970)

Recommended singing ranges.

c.



Natural range of junior voices as recorded from playground songs. Thurloway L. (1977)

Fig. 4.

Finally, the most recent evidence of vocal pitch range is reported by Thurloway (1977). She investigated children's ability to sing through the study of their playground songs. Eleven schools were surveyed, with 1,200 children in the sample. She recorded the pitch levels of 45 different songs as they were being performed in the school playgrounds (*op. cit.*, p. 41). The significance of this study is in the investigator relying on unprompted and spontaneous singing from her subjects—rather than providing an initial stimulus or a model to be copied. She concludes that the natural range of junior voices from the schools visited would appear to be as shown in Fig. 4 (*c*). This finding agrees with the recommended singing ranges of both Wilson (1973) and Cleall (1970).

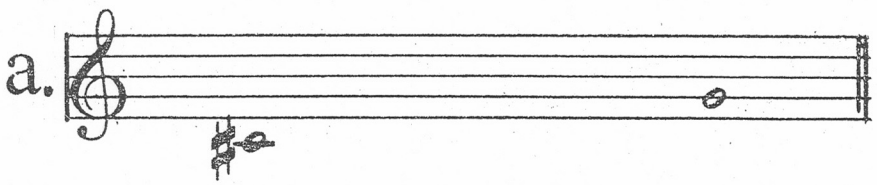
OTHER EVIDENCE PERTAINING TO VOCAL PITCH RANGE

The Importance of Certain Individual Notes

There is a lot of evidence which points to certain parts of the vocal pitch range having more significance than others.

Kirkpatrick (1962) taped the singing repertoire of 716 prekindergarten children and found: "The children's preferred starting tone was d♭′, compared to g′ used most frequently in the kindergarten Music Book" (*op. cit.*, p. 886) (Fig. 5 (*a*)). This finding was echoed by Thurloway (1977). The starting notes most frequently selected by her sample of 1,200 in their playground songs were c′ and d′, (*op. cit.*, p. 123A) from a range of a to b′ (Fig. 5 (*b*)).

a.

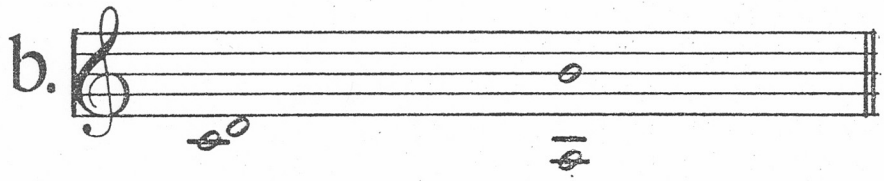


Children's spontaneous starting note at age 5.

Most frequent starting note in kindergarten song book.

Kirkpatrick W. (1962)

b.

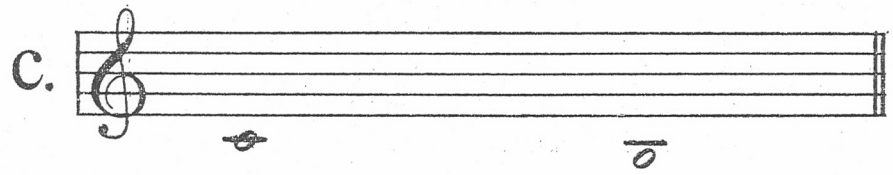


Most frequent starting notes.

Total range of starting notes.

Thurloway L. (1977)

c.

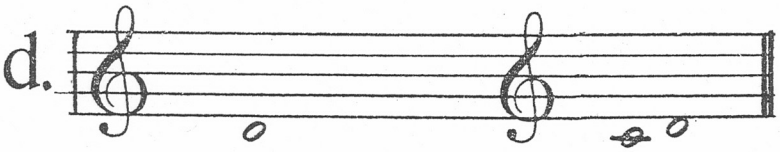


singers

uncertain singers

Mean pitch of initial vocalization. Yank Porter (1977)

d.



Plumridge (1972) Wilson (1973)

Most commonly vocalized pitches.

e.

Lowest terminal pitch. Warren Joseph (1966).

Fig. 5.

If this is compared to a study of uncertain singers, the evidence becomes more conclusive. Yank Porter's study of 80 uncertain singers (1977) showed: "the mean initial pitch response of students qualifying as uncertain singers was slightly lower (*b*) than that of the more accurate singers (c^1) (*op. cit.*, p. 80). (Fig. 5 (*c*)).

The mean initial pitch for the more accurate singers was obtained when administering a pretest to 263 fourth and fifth grade students. It was from these that the 80 uncertain singers were selected (*op. cit.*, p. 72). The mean initial pitch is defined as follows:

> The student was asked to sing or hum one tone that he or she felt comfortable with. Then the experimenter determined by stroboscope the pitch of the note of the closest scaled tone to the sound emitted (*ibid*).

Plumridge (1972) tested 504 children aged five to seven years and found the most common note was d′ (*op. cit.*, p. 29). This was sung by 94·5 per cent. of all subjects (Fig. 5 (*d*)). This finding is supported by Wilson (1973, p. 57), who noted the most common range of notes for all her subjects over a period of 12 years was c′–d′ (three semi-tones) (Fig. 5 (*d*)).

All the above evidence indicates a vocal centre for children of the primary range around middle c, c♯, and d′. This leads to the assumption that the lowest point of the vocal pitch range is somewhat lower. Confirmation of this has been provided by Warren Joseph (1966) in his study of vocal growth in the human adolescent. He reports the majority of both pre-pubertal male and female voices had the F♯ below middle C as their "low terminal pitch" (*op. cit.*, p. 138). By this he means their commonest bottom note (Fig. 5 (*e*)).

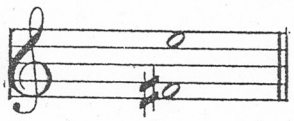
Inferential Evidence

Apart from actual studies of vocal pitch range in children, other studies connected with the ability to sing provide evidence that certain pitch levels are more significant than others. For example, Joyner (1969) found that his subjects sang more accurately when they were asked to sing the *National Anthem* a sixth lower than usual (*i.e.* in B♭) Sixteen of his 32 subjects were affected by this transposition (*op. cit.*, p. 116) (Fig. 6 (*a*)).

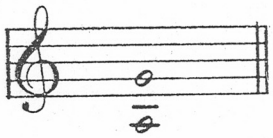
Similarly, Jones (1971) reports that the range matched most frequently on her vertical keyboard by her subjects was the octave b–b′ (*op. cit.*, p. 193) (Fig. 6 (*b*)). She further reports that the individual ranges of her uncertain singers vary only slightly from this group norm.

Roberts (1975) reports that out of his 90 poor pitch singers: "the remedial training group showed greater improvements than the other two groups on two tests—single note production and interval production" (*op. cit.*, p. 236). An analysis of his single note production test shows the subjects listened to a note played twice, and then the children were asked to sing it (*op. cit.*, p. 230). The range explored was from a to c″: "and it was within this range that the remedial group showed the greatest improvement" (Fig. 6 (*c*)). This range closely resembles that reported by Thurloway as the "natural" range of children's voices, *i.e.* the range most commonly used in spontaneous play situations (Thurloway, 1977, p. 124), being a to b′.

Also there is some neurological evidence to show that the notes around the middle c♯ frequency elicit the strongest response from subjects. If c, c♯, and d′ make up the pitch band at the centre of the child's natural voice (as has been argued in this paper), it is logical to expect these notes to be those most frequently used in the child's vocalising. The evidence provided by Thurloway supports this view; thus one would expect the neural pathways used in the auditory

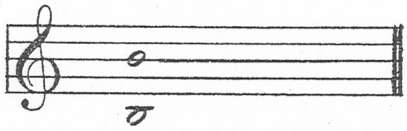
a. 

Normal range of National Anthem (Key of G major).



Range at which most subjects were successful in reproducing National Anthem.

Joyner D. (1969)

b. 

Most frequently matched range.

Jones M. (1971)

c. 

Range of greatest improvement.

Roberts E. (1975)

Fig. 6.

processing of this pitch band to be very strong, Bruner's notion of "enactive representation" agrees with this (1967). His model of intellectual development suggests the child builds up mental structures first through motor responses. Repeated encounters with the regularities of the environment build up virtually automatic patterns of motor activity. The patterns of muscle control in speech will constantly be reinforced through the same encounters with the environment. Hebb (1966, pp. 67–73) believes that sense receptors, located in the sense organs, pass the incoming stimuli through a large number of interconnected nerve cells, or neurons. The points of contact between neurons are known as synapses, and as a result of activity being transmitted across a particular synapse, future transmission is somewhat facilitated. The effect of repeating a given sensory input is to create within the nervous system a "preferred" set of networks which is the outcome of repeated inputs acting on previously facilitated paths.* It is possible to judge the strength of a particular network by seeing which input

*For example, see the electron photomicrographs of synapses contained in the article "Microcircuits in the Nervous System" by Gordon M. Shepherd, from *Scientific American*, February 1978, pp. 93–103.

from a series of inputs, elicits the most excitation or elicited activity. This was done by Wang, Marple, and Carlson (1975):

> E.E.G. waves were recorded while subjects were to remember a given reference tone and later identify as part of a series of neighbouring pitches (*op. cit.*, p. 197).

Four pitches—165, 220, 311, and 466 Hz—were used as reference tones, each presented with 12 contrasting tones at four difficulty levels. They report:

> In spite of the fact that each of the four reference pitches was used once in all difficulty levels, subjects made the fewest mistakes when 311 Hz was the reference tone. Moreover, those series acquired the greatest amount of average [alpha] blockage.

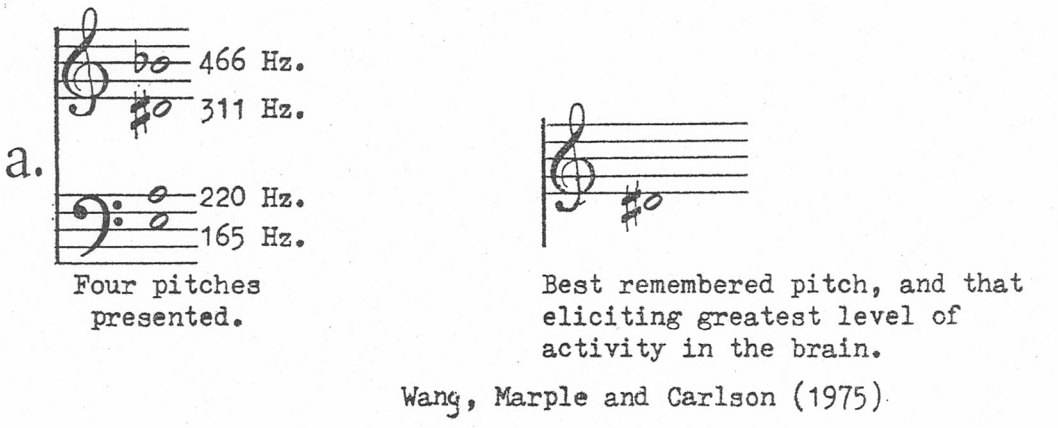


Fig. 7.

In other words subjects were able to remember best a tone approximating to d♯′ and this tone produced the greatest amount of excitement in the brain out of the four pitches given.

As this note is close to the vocal pitch band which centres around c, c♯, and d′, it has been taken as corroborative evidence that this band is indeed the natural centre of the child's singing voice. Finally, Greene (1972) after an extensive study of the voice and its disorders provides evidence that: "By five years the child's speaking voice settles under the influence of the environment at a median pitch in the region of middle c, or maybe two or three semi-tones higher" (*op. cit.*, p. 97). Thus speech and song have the same natural pitch centre.

Pitch Range of Music Used in Schools

Various researchers comment on the difference between the reported vocal pitch range of the child and the pitch range of music published for the child to sing. Reference has previously been made to Cleall (1970), Kirkpatrick (1962) and Plumridge (1972). The last provides the most elaborate evidence. Plumridge found 13 infant music publications in common to the six schools she sampled. She reports that each song book: "required use of a vocal range far higher than any exhibited by all but a small minority of the children tested" (*op. cit.*, p. 68). A summary of the pitch limits of the songs in these publications gives a lower limit of middle c, and an upper limit of e″ or f″ (Fig. 7 (*b*)). This is at least a third higher than is to be expected from the evidence of studies of vocal range.

In 1890, W. G. McNaught, the Assistant Inspector in Music to the Board of Education wrote to the *Musical Times*: "The wide range of many folk-melodies rendered them insuitable for young children's voices" (*Musical Times*, March 1890).

It would seem, nearly a century later, that the practice of fitting children's voices to the published repertoire, rather than the other way round, is still prevalent, and could be construed by the uncharitable onlooker as one of the prime causes of poor pitch singing.

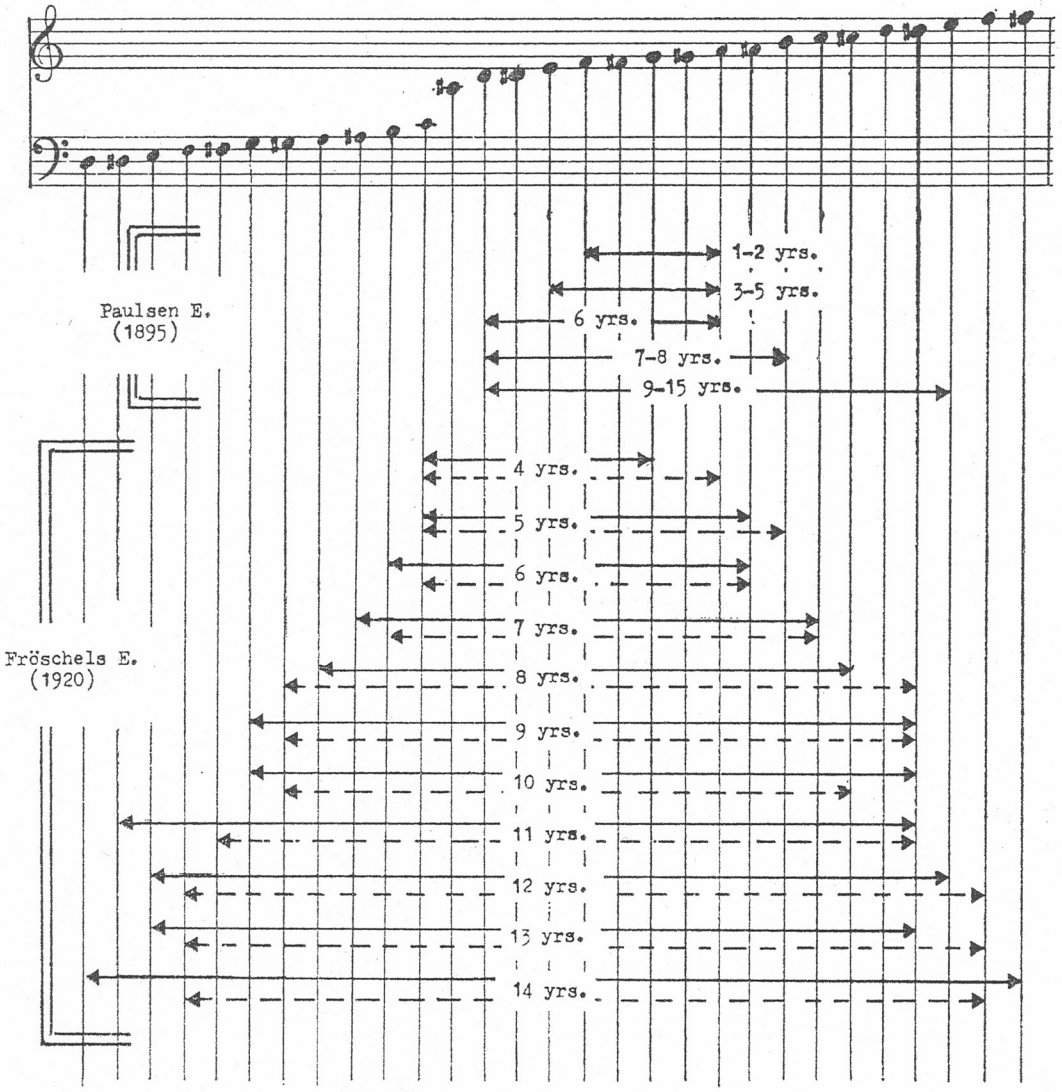


Fig. 8 a. Evidence of vocal ranges from early researches.

Boys ←——→

Girls ←– – – –→

Summary

The summary of this article is given in pictorial form below showing each reference in the order it appears in the text.

In addition, a summation of the recent vocal pitch range evidence is given. This shows the pitches reported as being common for each age group by aggregating the research findings (Fig. 7 (*c*)). The limits of this pitch band for primary children are "a to c'". This common pitch band is seen to be about a major third lower than the range in published vocal music.

The vocal range studies indicate that:

(*a*) The child's vocal range increases with age.

(*b*) There are slight sex differences with girls attaining a wider range earlier than boys.

(*c*) There is some evidence that social class factors are operating, poorer homes produce fewer singers.

(*d*) The child's comfortable vocal range is lower than the published music range.

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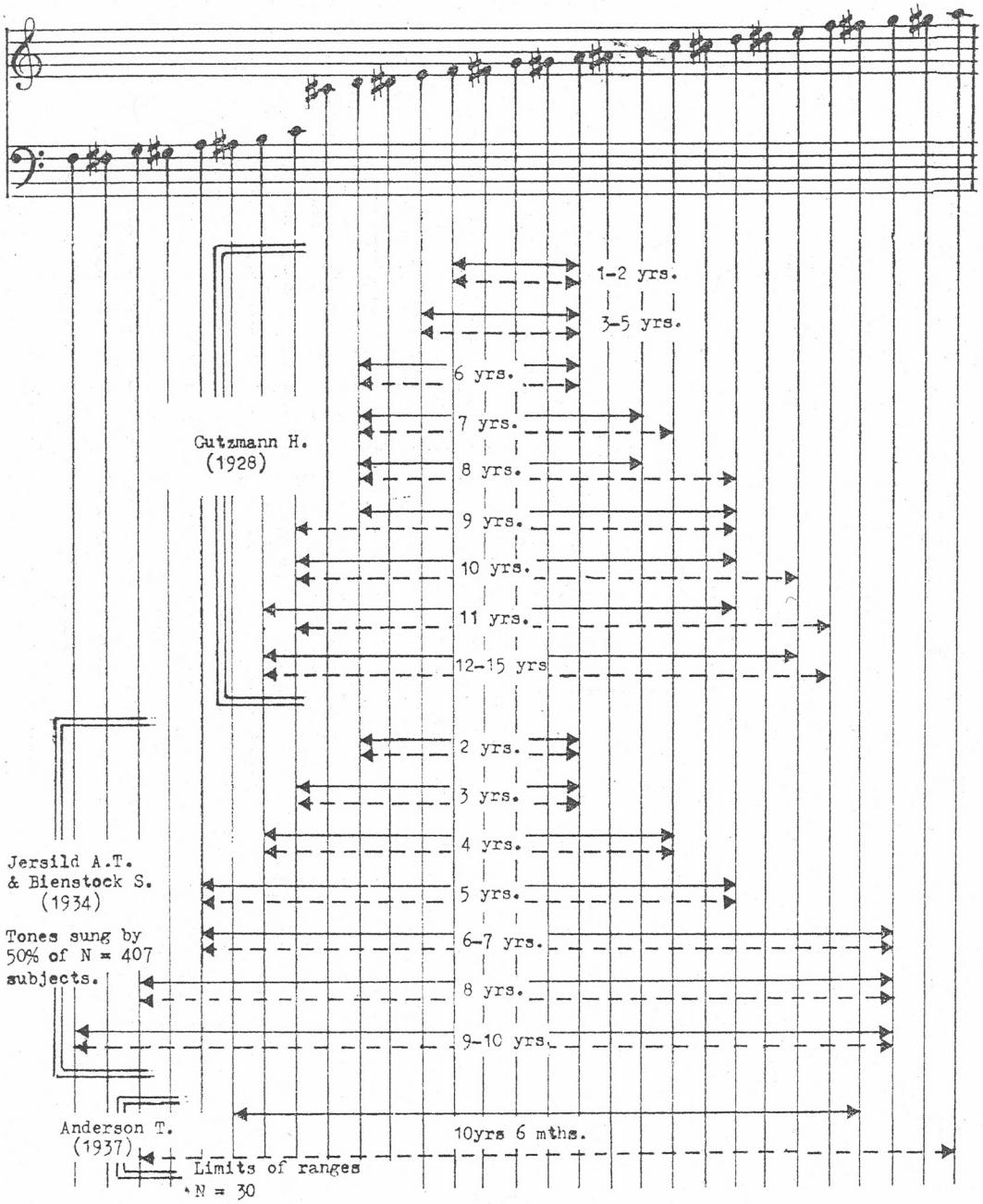

Fig 8 b. Evidence of vocal ranges from early 20th century researches.

Boys ←——→

Girls ←- - -→

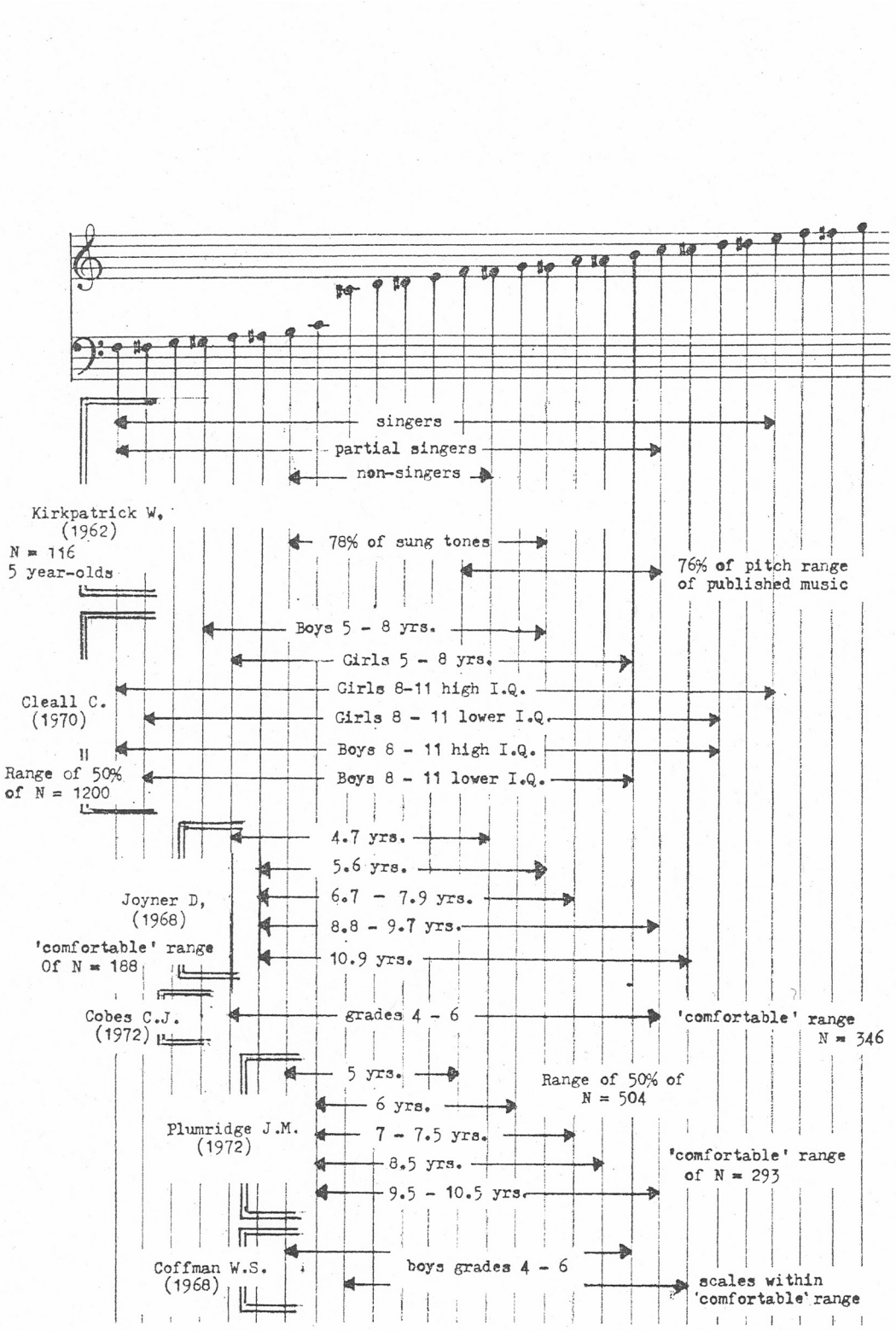

Fig. 9 a. Evidence of vocal ranges from recent researches.

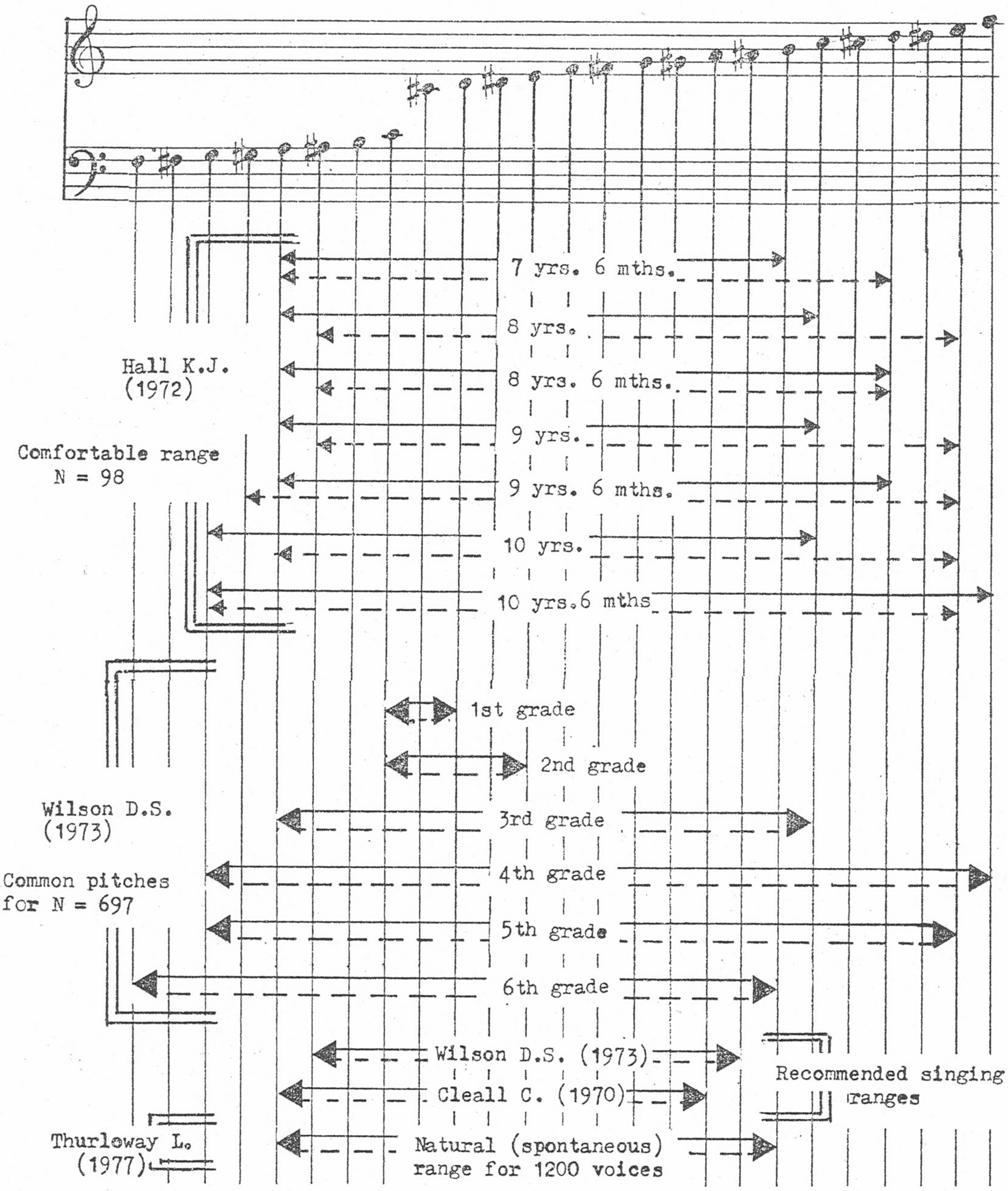

Fig. 9 b. Evidence of vocal ranges from recent researches.

Boys ⟷

Girls ⇠ – – – ⇢

Boys and girls not reported separately

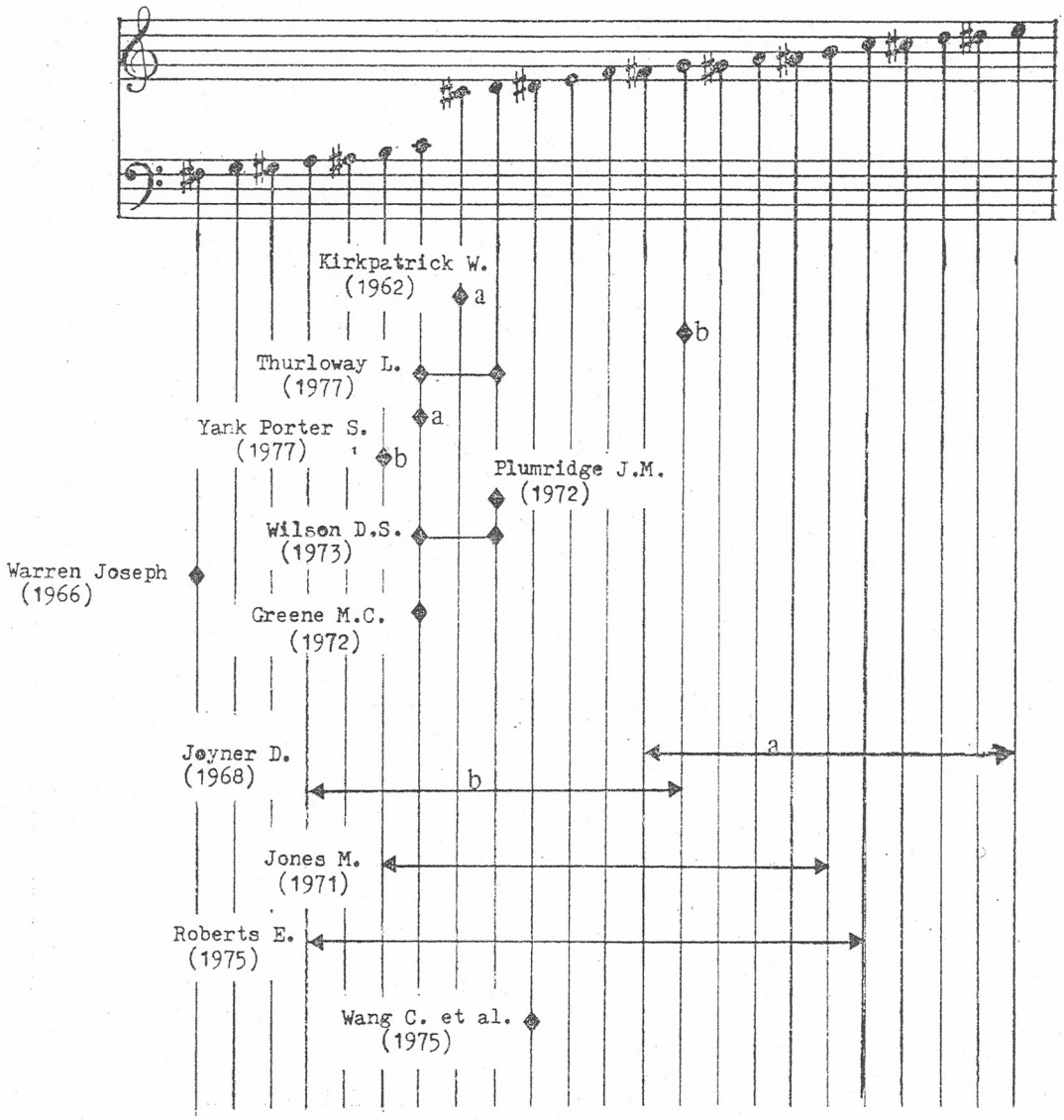

FIG. 10

Inferential and other evidence of vocal ranges.

Key:

Kirkpatrick—(*a*) Children aged 5 years preferred starting pitch.
(*b*) Most frequent starting note of melodies in song books published for young children.

Thurloway—Range of preferred spontaneous starting pitches for 1,200 children.

Yank Porter—(*a*) Mean comfortable starting note for 263 singers.
(*b*) Mean comfortable starting note for 80 uncertain singers.

Plumridge—Pitch successfully vocalised by 94% of 504 children.

Wilson—Most common range from 12-year study.

Warren Joseph—Most frequent lowest note for pre-pubertal males and females.

Greene—Median pitch of vocal speech range for 5-year-olds.

Joyner—(*a*) Normal range of *National Anthem.*
(*b*) Range at which most subjects successfully vocalised *National Anthem.*

Jones—Range of tones matched most frequently by voices to tones from a vertical keyboard.

Roberts—Range of pitches at which remedial programme for uncertain singers showed greatest effect.

Wang, Marple and Carlson—Pitch remembered with greatest accuracy in E.E.G. discrimination test, and where alpha blockage was greatest indicating high brain activity.

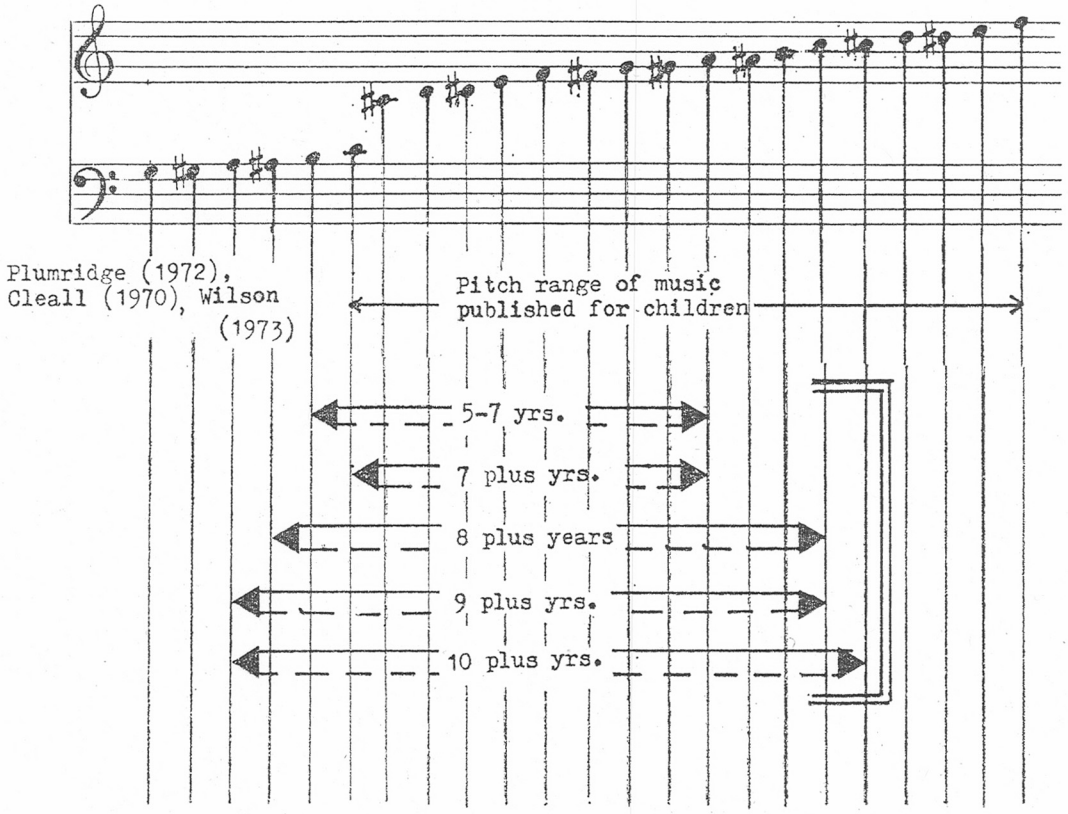

Fig. 11 Summation of evidence from researches into vocal ranges of children, 1895 - 1975.

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