The role of inner hearing in sight reading music as an example of inter-modal perception

Ji In Lee

Abstract

In this paper, sight reading excellence is reviewed as an example of inter-modal perception, and more than just visual perception. Eye-hand span in sight reading has been investigated, but this is not enough to predict sight reading achievement. Inner hearing being a significant predictor for sight reading achievement has been discussed in previous studies, but the weaknesses in the experimental design and the difficulty in assessing sight read-
ing performance have made the validity of the findings questionable. In this study, 52 pianists participated in an experiment which consisted of five levels of sight reading complexity and five inner hearing tasks. Pre-recorded pacing melody paradigm was used for the sight reading stimuli, while the embedded melody paradigm, using the same-different forced choice paradigm, was used for the inner hearing test. Sight reading performance was assessed with software that compares the performance by the subject to a "perfect" recording within the defined time window. The number of matched, mismatched and extra notes for both hands was determined by the software. Correlation analysis results show that sight reading achievement and inner hearing do have a significant correlation. Speed-related factors play an important role in inner hearing, which in turn has an effect on the sight reading achievement. Sight reading excellence is determined by closely related use of the eye, ear and hand.

1. Introduction

Glenn Gould was known for using his mastery of inner hearing ability. He once had the experience of learning a piece while someone was vacuuming and found that it was easier to learn. He took this method a step further and found it easier to learn a difficult piece by Schoenberg while listening to two different radio stations at the same time. His deduction was that the inner ear of the imagination is a far more powerful stimulant than any amount of outward observation.

Sloboda (1978) recognised the importance of being able to hear melodies in the head while sight reading, but was hesitant to support the method of testing audiation skills. His scepticism had a number of reasons. The music to be sight read was usually from available literature and the sight reading was evaluated with "musicality" being taken into consideration, and hence the validity of the evaluation method was questionable because of the subjectivity of evaluating "musicality".

In this study, questions such as the relevance of inner hearing in sight reading achievement and how inner hearing works will be discussed and the different paradigms to measure inner hearing will be reviewed. This study uses a valid method of inner hearing evaluation plus a valid method of evaluating sight reading achievement without evaluating "musicality", and hopes to shed some light on to the conundrum of inner hearing and its role in sight reading music. Sight reading researcher, such as Sloboda (1974), have focused on sight reading achievement or the lack of achievement due to the eye-hand span problem, which is the how much ahead the eye sees before the hand plays, which leaves out inner hearing. However, the results from Lee's (2004) thesis point out that the sight reading is not a problem of eye-hand co-ordination but of eye-ear-hand co-ordination; which includes the role of inner hearing in sight reading achievement.
2. Available research in inner hearing

The term "audiation" (often used as a synonym for inner hearing) was first coined by Edwin E. Gordon in 1976 to describe the aural-mental process by which humans assimilate music. It refers to the inner hearing of sounds not immediately audible, but which through recall can be predicted, or conceived. For the listener, audiation typically involves the organisation of perceived sounds into meaningful patterns, the comparison of those patterns with other currently heard sounds or with previously heard sounds, and the prediction of imminent sounds.

Schleuter’s (1993) study was the first to find that a significant correlation exists between audiation and sight singing ($r = .25$). Tonal scores of the audiation test correlated significantly with dictation ($r = .45$), and combined sight singing and dictation scores ($r = .45$). It was shown that Gordon's Advanced Measures of Music Audiation (AMMA) rhythm and total scores correlated significantly with sight singing ($r = .32$), dictation ($r = .40$), and combined sight-singing and dictation scores ($r = .44$). Schleuter also confirmed that the composite AMMA score does have a moderately significant predictive value for combined sight singing and dictation scores after one year of training ($r = .45$). The predictive validity of AMMA for sight singing and dictation scores after one year of training was $r = .45$ and accounted for 20 percent of the variance.

Kornicke (1995) went further and stated that auditory imaging is the highest predictor, explaining 15 percent of the variance for sight reading achievement. She was not surprised by this result of her study because her assumption was that "the relationship of aural imagery to music reading is logical since music involves the conversion of printed notation into sound. It would appear that individuals who could more easily form a mental image of the sound from printed notation would have an advantage in sight reading musical scores" (Kornicke 1995, p. 72). Kornicke also emphasised the importance of auditory imaging by suggesting that there should be more focus on teaching aural imagery as a separate skill from ear training.

Banton (1995) examined the role of auditory and visual feedback during sight reading of a short piece of piano music with 15 subjects. Subjects were required to sight read three different pieces under three different testing conditions: normal sight reading, without the view of the keyboard, and with the keyboard sound switched off. These pieces were taken from the same level of sight reading examination: grade 5 of the Associated Board of Music Sight reading. Self rating of subjects and the computer notated score of each of subjects’ sight reading performance were compared to the original scores of the test material. Results indicate that auditory feedback does not appear to affect the accuracy of movement during sight reading and is used to monitor the performance. Furthermore, the use of auditory feedback seems to be dependent on the skill level of the pianist. A possible explanation for this could be that less skilled sight readers are unable to use their auditory imagination to construct a mental representation of the performance before playing the notes in the score.
In 1998, Waters, Townsend & Underwood (1998) investigated the role of inner hearing (auditory representation) in sight reading with the "same-different" paradigm. 30 subjects were shown a bar of music notation (30 trials) for ten seconds and then an auditory stimulus which was either identical or different from the visual stimulus. If subjects stated that it was different, then they had to specify the cause of the difference. The results indicate that there is a significant correlation of $r = .52$ between this task and sight reading score, and this was explained due to the importance of auditory priming for sight reading achievement.

A very important question that was not asked in these studies is: how does inner hearing work? Smith, Reisberg & Wilson (1992) investigated the source of inner hearing. They set out to answer the question of the interaction between the inner ear and the inner voice. They did experiments with music as stimuli by presenting subjects with a list of well-known songs and asked them to judge whether the melody rises or falls in pitch from the song's second note to its third. When subjects had to imagine the song without any interference, they were correct for 83 percent of the trial, but with auditory distraction to disrupt the use of the inner ear, the score dropped to 69 percent. When subjects were required to perform irrelevant speech articulation to disrupt subvocalisation, the performance was at 66 percent, and under the condition of both auditory and subvocalisation disruption, subjects were 68 percent correct. It seems that subjects subvocalise (kinaesthetic cues resulting from the covert lip and tongue movements) the songs and then they "listen" to what they have produced to confirm their performances. Therefore, inner ear and inner voice are used concurrently in music audiation.

The best study so far is by Brodsky et al. (1998). His method of using "embedded" melodies might prove to be the best way of testing audiation skills because most of the traditional test methods deal more with short-term memory than with audiation skills. The embedded melody paradigm uses well known themes which have been visually disguised by compositional techniques of theme and variation. These techniques include certain notes being displaced in different octaves, having shortened duration or added notes. Subjects were required to read the score of an embedded melody silently, and then an auditory stimulus was heard after the notation was removed from sight. They were then required to state whether the auditory stimulus was hidden in the read score or not. Brodsky et al. (2003) used this method to test 18 expert musicians under different reading conditions: normal non-distracted reading, concurrent rhythmic distraction (subjects were asked to finger tap a steady beat while the experimenter tapped a task-irrelevant rhythmic pattern using a metal pen on the table top), phonatory interference (subjects were asked to sing the melody of a well known traditional Israeli folk song throughout the score reading) and obstruction by auditory stimuli (the singing was recorded for each subject and they were required to listen to their own singing during score reading). Phonatory interference resulted in longer reaction time to decide if the auditory stimuli was the original or not and the success rate of correct answer was the lowest compared to other conditions.
Phonatory interference hindered the recognition of original themes more than the other conditions, indicating that inner hearing elicits kinaesthetic-like phonatory processes. Therefore, he not only used a valid method of testing inner hearing but also investigated the role of the inner ear and confirmed the role of subvocalisation (inner voice) in inner hearing.

In this study, we used the same paradigm as Brodsky et al. (2003), but investigated the role of inner hearing in sight reading performance with a large number of subjects and five different levels of sight reading complexity to determine which predictors gain weight when the complexity increases.

3. Method

3.1 Subjects

52 piano major undergraduates and postgraduates, professional accompanists and chamber musicians from the Hanover University of Music and Drama (HMT) served as subjects for this experiment. The mean age of subjects was 24.56. 24 males and 28 females took part in this experiment. Subjects were paid for their participation.

3.2 Dependent variable: Sight reading material

For sight reading material, it was important to decide on pieces which were similar in length, unknown, possible to be recomposed so that a solo melody line could be added, and that the selection consisted of five different levels of increasing difficulty with two warm-up pieces. The paradigm by Lehmann & Ericsson (1993) of a pre-recorded melody was used in this study. This paradigm is ideal because the tempo of each performer can be regulated, which puts pressure on subjects to perform in real time. This is also vital for an objective method of analysis because it prevents tempo changes occurring, which would have produced a confounding variable.

Tasks for levels 1 to 4 are from the University of South Africa sight reading literature for Music Grade Exam purposes (UNISA, no date). UNISA pieces were written especially for sight reading purposes, unknown and similar in length, and could be recomposed for a solo melody and accompaniment. Level 5 is a piece which had been used for a sight reading competition at the Hanover University of Music and Drama. (see Table 1 for the source and the duration of each piece). The reason for level 5 was that a piece was needed to separate the outstanding sight reader from good sight readers. Level ratings were judged externally by two professors for chamber music and accompaniment. The second method was the physical surface complexity, which is the average number of notes in a bar which can be used as an index for complexity for objective methods to determine the increasing complexity from level 1 to level 5. These pieces were rewritten by a composer,
because of the need for a solo pacing voice. The solo voice was recorded separately by a professional violinist who played these melodies exactly in time while synchronising to a metronome through headphones (see Appendix 1 for the Warm-up piece number 1).

Table 1:
List of sight reading pieces and durations

<table>
<thead>
<tr>
<th>Levels</th>
<th>Composer</th>
<th>Source</th>
<th>Duration (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm-up 1</td>
<td>Anonymous</td>
<td>Minuet, Grade 5, No. 1, p. 1</td>
<td>00:46</td>
</tr>
<tr>
<td>Warm-up 2</td>
<td>Anonymous</td>
<td>A prayer, Grade 5, No. 2, p. 2</td>
<td>00:52</td>
</tr>
<tr>
<td>Level 1</td>
<td>Anonymous</td>
<td>The tease, Grade 5, No. 5, p. 5</td>
<td>00:45</td>
</tr>
<tr>
<td>Level 2</td>
<td>Anonymous</td>
<td>The crinoline days, Grade 6, No. 3, p. 11</td>
<td>00:52</td>
</tr>
<tr>
<td>Level 3</td>
<td>Anonymous</td>
<td>Unnamed, Grade 7, No. 4, p. 23</td>
<td>00:48</td>
</tr>
<tr>
<td>Level 4</td>
<td>Anonymous</td>
<td>Unnamed, Grade 8, No. 6, p. 6</td>
<td>00:50</td>
</tr>
<tr>
<td>Level 5</td>
<td>Ludwig Roselius (1902–1977)</td>
<td>Sonata in b-minor, op. 12 first movement</td>
<td>01:32</td>
</tr>
</tbody>
</table>

3.3 Independent variable: Selection of samples for the audiation test (Inner hearing)

Brodsky et al.’s (1998, 2003) embedded melody paradigm is constructed that way that subjects are firstly required to find the hidden/embedded melody in the piece which is shown to them and secondly, to listen to a melody and state whether the hidden/embedded melody is the same as the melody which they have heard.

The difference between Brodsky et al.’s stimuli and ours is that they used well known themes and also had a composer write the variations for them. However, in our study, we used 21 less well-known themes and their variations from original compositions which were chosen by the author and then passed on to a composer. The composer chose 15 themes and their variations which he felt were useable for our purpose. The themes were used to compose a "lure melody", which is similar to the theme but is distinctively different and has a significant deviation from the underlying melodic structure of the melody. We relied on the expert’s (composer’s) judgement as we did in using the original variation. The purpose of the lure melody was to obtain a distribution of "same" and "different" answers for the d-prime (see MacMillan & Creelman 1991) in the forced-choice paradigm used in the inner hearing test. Therefore, there are three versions: theme, variation and the lure
melody (see Appendix 2). After a pre-test, it was decided to use two warm-ups and five samples out of the 15 themes, lures and their variations due to the time limit of the experiment (see Table 2).

### 3.4 The other 24 independent variables

In Lee’s thesis (2004), she used a total of 25 independent variables which were divided into three categories of general cognitive skills, elementary cognitive tests and expertise skills. Inner hearing comes under the expertise skills. Among the general cognitive skills were working memory test, short-term music-specific memory test, short-term non-music-specific memory test, number combination test (NCT) and Raven’s D Matrice. Among the elementary cognitive tests were visual reaction time test, auditory reaction time test, speed tapping with the performance hand for 30 seconds, speed trill using 1\textsuperscript{st} and 3\textsuperscript{rd} fingers of the right hand for 30 seconds, repetition of the 1\textsuperscript{st} and the 3\textsuperscript{rd} finger trill, speed trill using 3\textsuperscript{rd} and the 4\textsuperscript{th} finger of the right hand for 30 seconds and the repetition of the 3\textsuperscript{rd} and the 4\textsuperscript{th} finger trill. Among the expertise skills: accumulated hours of sight reading practise up to the age of 10, 15, 18 and total, accumulated hours of solo practise up to the age of 10, 15, 18 and total, and the accumulated years of piano lessons up to the age of 10, 15, 18 and total. See Lee (2004) for further details.

<table>
<thead>
<tr>
<th>Number</th>
<th>Composer</th>
<th>Composition</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm-up 1</td>
<td>Verdi</td>
<td>From Rigoletto, Act 3, „La donna e mobile“</td>
<td>By Brodsky</td>
</tr>
<tr>
<td>Warm-up 2</td>
<td>Beethoven</td>
<td>Six variations on one Swiss Song (Woo 66)</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Mozart</td>
<td>Variation for solo piano. Number 13, „Air varie“, (Communement dit Wilhelm van Nassau), KV 25</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Mozart</td>
<td>Ten Variations in G on the Aria „Unser dummer Pöberl meint“ from the Singspiel „Die Pilger von Mekka“ by Christoph Willibald Gluck. KV 455</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Sweelinck</td>
<td>„Unter der Linden grüne“</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Mozart</td>
<td>Variation for solo piano. Number 2. „Je suis Lindor“. KV 299a</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Mozart</td>
<td>Variation for solo piano. Number 4. „La belle Francaise“. KV 300f</td>
<td>5</td>
</tr>
</tbody>
</table>
3.5 Procedure of sight reading stimuli

Subjects were given 60 seconds to look at each piece before they were asked to play while listening to the recorded solo melody. Two warm-up pieces were prepared so that subjects could get used to the set up, and so that the dynamic level of the solo voice and the keyboard could be adjusted. Tempo was indicated for each piece by two full bars of clicks before the piece, and this was used as the cue for subjects to start playing. If the piece started with an upbeat, the exact number of clicks before the start of the piece was given to the subjects. A MIDI keyboard (with weighted action) was used to record the performances of subjects directly into the sequencing program CUBASE 5.1 (Steinberg 2000). After completing the warm-up pieces, they were required to sight read the stimuli from level 1 to level 5.

3.6 Procedure of inner hearing test

Two warm-ups were used to demonstrate the method and to explain and to show how the hidden theme could be found in the shown melody. This part of the experiment was done using Power Point Presentation method. The variation of each theme was shown for 45 seconds and the theme or the lure melody was heard through the speakers, and could be repeated. A same-different forced choice paradigm was used and subjects were required to state if the melody heard was included in the melody seen (same) or not (different). The instructor filled out the answer sheet.

4. Results

4.1 Scoring of sight reading performance

Data analysis of sight reading performance was done using the software MidiCompare, developed by Dixon (2002). This program outputs the score matches (correct) and score mismatches (incorrect notes) for each hand and also the extra notes (doubled but correct notes), which were played by subjects within the chosen window of time in each direction. The influence of window size (time before and after a note) on the evaluation of performance was determined in a pre-test of the software on a selected number of subjects. The number of correct notes for both hands was calculated for four different windows of time: +0.25 seconds, 0.5 seconds, 1.0 second and 1.25 seconds before and after each note. It is possible that a subject will play slower or faster than the violin. If the time window is 0.5 seconds, that means that a note will be considered a score match if it is played within 0.5 seconds before and 0.5 seconds after, it is supposed to be played.

After comparing the data, it was decided to use the +0.25 seconds in each direction as the window of time for several reasons. The first reason is that
we wanted to have a cautious and objective approach to data analysis. Secondly, ceiling effects had to be avoided to obtain the maximum variances. Thirdly, it is musically unacceptable to play a note 1.25 seconds late. For example, the level 5 piece has a tempo indication of 60 crotchets per second. If a note is played 1.0 seconds late, that means that it is played a whole beat late which is aesthetically unacceptable. In total, our decision to use a very small time window for performance evaluation was determined by a conservative perspective. This means that observed effects tend to be underestimated. See Table 3 for the scores of the sight reading performances from level 1 to level 5 using the time window of +0.25 seconds.

### Table 3:
The scores of the sight reading performance from level 1 to level 5 and the total performance scores

<table>
<thead>
<tr>
<th>Levels</th>
<th>No. of subjects</th>
<th>Min. score (%)</th>
<th>Max. score (%)</th>
<th>Mean score (%)</th>
<th>St. Deviation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>52</td>
<td>50</td>
<td>100</td>
<td>87.95</td>
<td>14.23</td>
</tr>
<tr>
<td>2</td>
<td>52</td>
<td>21</td>
<td>99</td>
<td>72.12</td>
<td>22.96</td>
</tr>
<tr>
<td>3</td>
<td>52</td>
<td>28</td>
<td>96</td>
<td>80.38</td>
<td>16.66</td>
</tr>
<tr>
<td>4</td>
<td>52</td>
<td>8</td>
<td>99</td>
<td>49.42</td>
<td>27.63</td>
</tr>
<tr>
<td>5</td>
<td>52</td>
<td>8</td>
<td>95</td>
<td>39.50</td>
<td>23.10</td>
</tr>
<tr>
<td>Total average</td>
<td>52</td>
<td>27</td>
<td>97</td>
<td>61.55</td>
<td>17.34</td>
</tr>
</tbody>
</table>

**Figure 1:**
Correlation between total matches (%) and the d-prime scores from the inner hearing test.
4.2 Scoring of the inner hearing test

The inner hearing test consisted of two warm-ups and five tasks. Subjects were required to choose between "same" or "different", and the d-prime value was calculated (see MacMillan & Creelman 1991). Figure 1 shows a strong positive correlation [Spearman $r(52) = .427; p = .001, (1$-tailed)] between inner hearing d-prime scores and the total percentage score of sight reading performance.

We expected that due to the time restriction, inner hearing would not play such an important role in sight reading performance. However, there was a rather unexpectedly high correlation between inner hearing and sight reading. There are a few extreme cases in Figure 1 but it seems that the ability to audiate sounds before playing them plays a very important role in sight reading. Outliers could be explained due to sight reading skill being a complex combination of many component skills, which means that lack of one skill could be compensated for by another skill. Another reason could be that the small number of items in the inner hearing test causes this high correlation between sight reading and inner hearing. The next step was to analyse inner hearing with different levels of sight reading performance to find out if the increasing complexity of sight reading performance has a significant influence on the role of inner hearing.

In level 1, the inner hearing test score is non-significant, but it increases in significance from level 2 to level 4 and in level 5, where sight reading stimuli is pushed up to its limits, inner hearing correlation decreases slightly (see Figure 2 and Table 4).

![Figure 2](image)

*Figure 2:* Inner hearing and the $r^2$ values at levels 1 to 5 of sight reading performance
Table 4:
Correlation between inner hearing test results and performance from level 1 to level 5

<table>
<thead>
<tr>
<th>Sight reading</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>.205</td>
<td>.073</td>
</tr>
<tr>
<td>Level 2</td>
<td>.367</td>
<td>.004</td>
</tr>
<tr>
<td>Level 3</td>
<td>.355</td>
<td>.005</td>
</tr>
<tr>
<td>Level 4</td>
<td>.474</td>
<td>.000</td>
</tr>
<tr>
<td>Level 5</td>
<td>.344</td>
<td>.006</td>
</tr>
<tr>
<td>Total</td>
<td>.427</td>
<td>.001</td>
</tr>
</tbody>
</table>

Median splits were used to come up with boxplots to differentiate between the high and the low performers for each level of sight reading stimuli. This method indicates which independent variable scores have significant differences between the upper 50 percent and the lower 50 percent sight reading performers. Inner hearing test scores in level 4 [Mann-Whitney U (52) = 145.000; p = .000 (2-tailed)], level 5 [Mann-Whitney U (52) = 224.500; p = .033 (2-tailed)], and the total sight reading score [Mann-Whitney U (52) = 201.000; p = .010 (2-tailed)] showed significant differences between the high and low sight reading performances in inner hearing test scores (see Figures 3, 4, 5).

Figure 3:
Boxplots for the significant difference between high and low performers for level 4 sight reading performance and inner hearing test scores
4.3 Absolute pitch

We were interested to find out if inner hearing was a result of priming and set out to investigate the relationship between absolute pitch and inner hearing. There were 26 subjects with perfect pitch and 26 without absolute pitch.
in this experiment. A biserial correlation analysis was done due to the dichotomised variable, absolute pitch and subjects who have absolute pitch seem to do better at the inner hearing test than subjects who do not have it [Kendal tau-b: \( r(52) = -0.326^{**}, p = .009 \)]. Mann-Whitney U test result confirms the above finding [Mann-Whitney U (52) = 199.000; \( p = .009 \) (2-tailed)] and see Figure 6 for the boxplots for the significant difference in inner hearing test score of the subjects with and without absolute pitch.

![Boxplots for the significant difference between inner hearing test scores and subjects with and without absolute pitch](image)

**Figure 6:**
Boxplots for the significant difference between inner hearing test scores and subjects with and without absolute pitch

### 5. Discussion

The validity of the role of inner hearing in sight reading was not apparent due to the weaknesses in the design of previous experiments and due to the difficulty of an objective method of scoring the sight reading performances. We used Brodsky et al.’s paradigm but the scoring, d-prime was used to eliminate the chance of guessing by the subjects and to validate our findings. Firstly, subjects with absolute pitch do better at inner hearing than subjects without absolute pitch. This could be explained as priming effect, that absolute pitch subjects can audiate the shown melody with exact pitch and can therefore compare the shown melody and the heard melody with more precision. Secondly, inner hearing in Lee’s (2004) thesis proved to have the 5th highest correlation \( r = .427 \) with the total sight reading performance score, and this confirms the importance of aural imagery as in the studies by Kornicke (1992) and Waters, Townsend & Underwood (1998). The present data empirically supports the view that there is a relationship between seeing written notation and being able to translate the symbol into an aural image. The significant relationship be-
between aural imagery, the Number connection test (ZVT) \((r = -0.361)\) and the speed trills (Speed trill 3–4–2; \(r = 0.335\)) indicates that aural imagery is linked to speed of processing and psychomotor speed. Due to our definition of sight reading, with time restrictions being placed, inner hearing must be performed in milliseconds if it is to be used at all. The use of inner hearing increases when sight reading complexity increases, and better sight readers also have better scores in the inner hearing tests. However, the question of how to improve inner hearing has not yet been dealt with in this paper.

Edwin Gordon is the authority on inner hearing and has published many books on how to improve inner hearing (audiation). Gordon (1987, 1990, 1993) states that to be able to audiate, students must firstly learn to discriminate and then to inference. Discrimination learning is rote learning and consists of audiating a listening and performance vocabulary of tonal patterns and rhythm patterns in different tonalities and meters using neutral, tonal and rhythm syllables. Students learn to name, to compare, to read and write tonalities, meters and familiar rhythm patterns by the use of neutral, tonal and rhythm syllables.

For inference learning, which is the ability make judgements and draw conclusions, students learn to differentiate, to perform, to read and write familiar and unfamiliar tonal and rhythm patterns, performed with a neutral, tonal or rhythm syllable, that sound the same and different. They must also learn to respond, to create, to improvise and to write tonal and rhythm patterns. Lastly, students learn technical aspects of music and why music is performed, constructed and interpreted as it is. Students may accomplish this by listening, performing, reading and writing specific aspects of series of familiar and unfamiliar tonal and rhythm patterns using a neutral syllable, tonal and rhythm syllables.

Sloboda (1974) and Bean (1938) have investigated the combination of the eye and the hand (eye-hand span) and have found that the eyes are only one bar ahead of what the hand is playing. However, this alone could not predict sight reading achievement. It seems that sight reading involves not only the ability to see and to play, but it is a combination of seeing, playing and listening (or subvocalising) in order to achieve sight reading excellence.

6. Summary

Sight reading is an ideal example of the significance of inter-modal perception due to the involvement of the visual perceptual information intake and subvocalisation of the inner voice. The motoric output consists of the performance by the musicians and auditory feedback, and all these factors are necessary to ensure a high level of sight reading performance. The aim of this study was to prove validity of inner hearing as a significant predictor for sight reading achievement. 52 pianist participated in this experiment which consisted of five levels of sight reading stimuli and two warm-up tasks and five test task of inner hearing. It was found that inner hearing plays a signif-
icant role in sight reading excellence and that sight reading requires not only eye-hand but eye-hand-ear co-ordination.

A crucial point of this study is the objective method of analysing the sight reading performances and having an approach which is cautious and conservative towards data analysis. Another worthy contribution of this study is the division of sight reading stimuli into five different levels of complexity, which means that conditions of variation were controlled in the dependent variable. By using sight reading literature and the pre-recorded melody paradigm, the sight reading definition as the performance of a piece of music without prior practise was honoured, and subjects were able to perform sight reading under almost real conditions. Sight reading stimuli being divided into five different levels with increasing complexity gave new insight into the dynamic model for predictors for sight reading achievement and the changing weight of inner hearing in this model.

Sight reading hypothesis is no longer based on the eye-hand span, but it is the co-ordination of eye-ear-hand which is the decisive factor in sight reading achievement.

References


UNISA (no date). Playing at sight (1–8). Pretoria: University of South Africa.
Appendix 1:
Sight reading warm-up number 1
Warm-up 1

Theme

Variation

Lure

Appendix 2:
Inner hearing test