Learning to Sight-reading Music:

Considerations and a Recommended

Training Program

Psych 7104

Fall 2016

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Introduction

Sight reading is sometimes defined as being able to read and play a piece of music without any prior rehearsal or experience. Others consider play-throughs of a piece that is not memorized to be instances of sight reading. For the purposes of this paper, only sight reading of completely unfamiliar material will be considered. Successful sight reading occurs when a performer is able to approximate correct performance of a piece, as written. This includes achieving acceptable tempo and expression. Some have considered sight reading in the context of simply reading through a piece in real-time and mentally rehearsing it; however, generally the task of physically playing the music is considered part of the skill. While many musicians can sight read, the extent to which sight-read performance is similar to rehearsed performance is a good way of characterizing sight-reading ability. Historically, being very skilled at sight reading was seen as coinciding with being a prodigy in other aspects of music (Lehmann and McArthur, 2002). There is evidence that sight reading is a skill that can become an automatic process for highly trained musicians (Stewart, Walsh and Frith, 2004). However, sight reading does not necessarily improve as music playing ability improves (McPherson, 1994), and deliberate practice accounts for only around a quarter of variance in sight reading performance (Kopiez and Lee, 2008). Thus, training programs that focus on playing ability or learning pieces for recital may not produce effective sight reading skills, and even programs that incorporate practice with sight reading but do not supporting training elements may not be sufficiently effective. For whatever reason, many who become proficient at music performance never reach proficiency with sight reading (Hargreaves, 1986), and this may be a prime reason for giving up their pursuit of musicianship (Mills and McPherson, 2006). As such, much research has been done on the difference between expert and non-expert sight readers, as well as on different instructional methods.

A sight reading training program: motivations

Sight reading requires that a person complete multiple tasks simultaneously. The complexity of the skill, and the extreme time constraints relative to human processing capabilities, are one reason why it is difficult to

master (Mills and McPherson 2006). Broadly speaking, the skill of sight reading involves two sets of skills: the set of reading-related skills and the set of execution skills (Wolf, 1976). The set of reading skills involve several mental activities: perception (decoding notes), memory (recognizing patterns), as well as problem solving (guessing at the identities of notes that one has no time to read). The set of execution skills involve coordinating the right motor programs to play notes, as well as being physically able to play notes. The present paper will focus primarily on the former components- the reading skills.

The goal of this paper is to provide an evidence-based training program for training novice sight readers so that they exhibit expert-like behavior as quickly as possible. While music education programs aimed at novices often focus on younger children, the present focus will be on adolescents and adults. While this program does not require the learner have any music background, it is designed in 'phases' such that an adult learner who has some relevant background may skip to a later phase if desired. This program assumes that the learner has knowledge of the notes on their target instrument, and assumes that the instrument is a piano. The assumption is also made that the learner either has some manual playing ability or will be working to acquire that ability in parallel with the exercises described herein.

Sight reading as a reconstructive process

Sight reading has prominent perceptual skills that need to be developed to achieve expert status. These skills center around rapidly comprehending notes based on visual information.

Similar to reading words, expert sight readers exhibit shorter and fewer fixations, because each fixation allows they to encode more information (Waters, Underwood and Findlay, 1997). Less experienced sight readers tend to fixate on individual notes, while more experienced sight readers tend to focus on phrase and line boundaries (Goolsby, 1994). Additionally, Goolsby (1994) found that experienced sight readers often scanned ahead of themselves in the score, and returned to previous locations, while novices tend to exclusively look to the next note that must be played. This ability to look ahead/look around as well as acquire information about more notes with a

single fixation supports a higher 'perceptual span,' which in this case is instantiated as the 'hand-eye-span,' which is the number of notes that a musician can continue playing even after the sheet music has been removed. Similarly, Penttinen (2013) found that expert eye gazes tend to follow the melodic contour. These larger perceptual spans are often partially attributed to the ability to form larger chunks in working memory, which relates to the rapid recognition of some sort of musical pattern. The patterns that enable formation of larger chunks come from a variety of structural features of a musical score. These include chords (Waters, Townsend and Underwood, 1988), tonality and sequential pitch structure (MacKenzie et al., 1986; Waters and Underwood, 1999), phrase structure (Sloboda, 1977), and rhythmic structure (Waters and Underwood, 1999). Penttinen and Huovinen (2011) found that novices do have some systematic patterns in their eye movements; they tend to focus on large melodic interval skips, rather than passages of small steps that can be easily chunked. Nine months of instruction in music theory concepts such as intervals, meter, scales, and triads led to a reversal in this behavior. Experts even have the ability to vary their hand-eye spans based on the presence of nearby structural divisions in the music (Sloboda, 1984). Specifically, if the end of a phrase (often, four measures, with the fourth being an ending of a musical idea) is coming up, the eye-hand span of experienced sight readers will grow to encompass the end of the phrase. In sheet music, the end of a phrase is often characterized by a 'repeat' or other change. As such it is a meaningful task boundary, and expert perceptual grouping behavior is responsive to this.

These findings are evidence that sight reading is a 'reconstructive' process, similar to text reading (Lehmann, Sloboda, and Woody, 2007), rather than a stimulis-driven perceptual process. In order to overcome the perceptual bottleneck of needing to visually attend each note, skilled sight readers seem to rely on retrieval structures that allow for rapid pattern recognition with only a few fixations. To test this, Waters, Underwood and Findlay (1997) had novice and expert sight readers sight read and play a piece. While experts were faster than novices, as one would expect, experts were much more susceptible to disruptions due to the randomization of music score elements that would otherwise generally conform to a predictable structure. Sloboda (1976) had

pianists sight read classical music pieces, into which errors had been introduced that violated rules required to maintain harmony. Pianists tended to 'correct' these altered notes to the original notes, despite being asked to play the piece as written. When asked to play the piece again, the number of corrections was higher, which the author attributed to their having stronger expectations of what the note should be. Penttinen (2013) tracked the eye movements of experts and novices sight-reading either music with familiar structure, or music with melodic alterations. It was found that differences in the expert eye movements that were evidence of chunking and greater eye-hand span disappeared for the sections of the music that had been altered. Stanzione et al. (1990) described a case in which a musician with brain injury lost the ability to use these structure-dependent strategies, and instead had to read each note individually, which led to impaired sight reading performance.

The fact that expert sight readers can be disrupted in this way is further evidence that expert sight-readers are not, in fact, directly translating visual input for single notes into motor programs, at speed. Instead, expert sight readers are actively reconstructing what the music should probably look like, given perceptual information that is often necessarily incomplete due to the extreme time constraints relative to their perceptual processing and psychomotor abilities (Lehmann, Sloboda, and Woody, 2007).

Determinants of sight reading ability- trainable and non-trainable elements

Sight reading performance is also related to a variety of capacities that present either reflect skills that can be trained or limitations that need be circumvented. Kopiez and Lee (2006) proposed a dynamic model of sight reading, which incorporated a variety of predictor variables. It also postulated that the impact of these variables (including deliberate practice) would change demanding on the difficulty of the sight reading task. At low levels of difficulty, general expertise at playing an instrument was predicted to be sufficient. At moderate difficulties, individual differences in psychomotor speed, information processing speed, inner hearing ability, as well as the amount of deliberate practice specifically in sight reading, became more important. Finally, when to-be-read material is extremely difficult, individual differences in psychomotor speed became most important, followed by

expertise specifically in sight reading. Hayward and Gromko (2009) measured the abilities of wind instrument musicians in terms of auditory, perceptual, motor and spatial abilities. They conducted a factor analysis, and found that aural pattern discrimination abilities and spatial-temporal reasoning loaded as a factor separate from a factor describing technical proficiency at playing their instrument. The authors suggested that a sight reading training program should include having students sing tonal patterns and clap pitches to teach them to become attuned to melodic and rhythmic structural elements of a score. Kopiez and Lee (2008) measured a variety of possible predictors of sight reading ability across difficulty levels, including a set of cognitive, perceptual and motor capacities, as well as specific trainable skills germane to sight reading. Memory abilities were measured in terms of working memory (a digit manipulation involving verbal as well as spatial and task-switching capacities), as well as short term memory and music-specific short term memory (free recall tests after a short interval). General intelligence was measured via a subset of the Ravens Progressive Matrices (Raven and Court, 1988). Simple audio and visual reaction times were measured through basic stimulus onset tasks. Perceptual processing speed was measured through a digit-sorting task ('number combination'). Psychomotor ability was measured through a 'speed trilling' task requiring rapid repetitive hand movements, as well as a speed-tapping measure in which participants were tasked with repeatedly hitting a button as fast as possible. The first skill that was measured was inner hearing, via a task in which participants heard a melody, had to hold the melody in auditory working memory (without humming) for a short interval, and then were presented with a new melody and asked to indicate whether the new melody included the to-be-remembered melody. The amount of practice in sight reading and piano in general was calculated based on participant self-report. First, each the outcome variable of sight reading score was regressed onto each predictor variable individually. Somewhat surprisingly, speed trill ability for the middle and ring finger (psychomotor ability) accounted for a larger percentage of variance (almost 32%) then the amount of deliberate practice, although the latter accounted for almost 25% of the variance. Perceptual/ information processing speed and inner hearing ability also accounted for large portions of the variance. Other

measurements, including general intelligence and working memory capacity, did not have statistically significant correlations with the outcome variable. The authors then conducted a stepwise predictor entry procedure, and created that a model that incorporated psychomotor speed (speed trill ability) with the ring and middle fingers, amount of deliberate practice with sight reading, perceptual/information processing speed, and inner hearing ability, in that order. This model explained 59% of observed variance in sight reading ability, across difficulty levels. The authors recommended that music education focused on sight reading would focus on the learner becoming lightly familiar with a wide variety of pieces, each containing a wide variety of tonal, melodic, and rhythmic structures, so that those elements can be encoded as generalized retrieval structures and brought to bear when sight reading a new piece. Having these relevant retrieval structures subsequently will allow the learner to create larger chunks and have a larger eye-hand span, which will circumvent perceptual and psychomotor bottlenecks and allow for faster sight reading.

New training programs- circumventing psychomotor and perceptual bottlenecks

In order to open the possibility of sight reading to more people, and reduce dropout, sight reading training programs should be adapted to accommodate the impact of individual differences in psychomotor and perceptual speed. While these capacities themselves cannot be improved through training, practice in pattern recognition and chunking of events in the sheet music should be able to reduce the strain on perceptual processing by requiring fewer fixations and giving more time to process each. Additionally, spending less time in saccades and more time fixating (and accordingly processing notes in larger chunks) should allow a musician more time to generate motor programs as well, mitigating the effect of slow psychomotor faculties. This is somewhat similar to the 'quiet eye' effect in which expert aimers fixate on a single point just before conducting a targeting activity, which is thought to allow for more time to compute ballistic information (Vickers, 2007).

Increased training in pattern recognition and chunking behaviors could also lower washout rates in those with slow perceptual processing. Mishra (2013) conducted a meta-analysis of 92 quasi-experimental research

studies on sight reading training methods and found that a variety of different training activities had positive effects on sight reading ability. Major influences included 'aural training', 'controlled reading', 'creative activities' (such as composition or improvisiation), as well as 'singing/soflege' (studying associations between notes and pitched phonemes). Thus, a modern training program should incorporate this variety of components, with the goal of developing the variety of related skills that support expert performance, over and above the simple ability to quickly associated an individual written note with an action of the body.

Considerations of a modern sight reading training program

Explicit Training for recognition of structural elements and chunking

A variety of efforts in sight reading learning research have focused on evaluating whether learners would benefit from a focus on the variety of structural cues that support expert sight reading performance, over and above the perceptual ability or recognizing individual notes in isolation. Grutzmacher (1987) trained one group of novice learners via a note-focused instruction method, and another group via a method that emphasized tonal patterns. The group that received the tonal structure instruction performed better on a sight reading test. Similarly, MacKnight (1975) trained one group of novice sight readers to recognize pitches via naming, sound and fingering, and another group to read pitches based on tonal patterns. Once again, the group that received instruction in the tonal patterns performed significantly better on a measure of sight reading skill. Gaynor (1995) developed two different training programs aimed at improving sight reading, and gave them to novices and experts. In one program students were given exercises aimed at teaching them how to chunk groups of notes via training in eye movement patterns and memory recall, in addition to 'melodic prediction,' while another group was given extensive training with melodic prediction alone. The melodic prediction component was an exercise in which students were asked to predict notes that had been removed, and play the melody as if those notes had not been removed. The researcher engineered these missing notes so that they would require that students become sensitive to phrasing, tonality, melodic contour, melodic patterning, modulation, and rhythmic patterning. The researcher

found that melodic prediction exercises had a large effect on sight reading performance, but that explicit chunking instruction did not have as large of a benefit. The reader may note that some of these effects may apply differently to adult or adolescent learners versus younger children. Young children are often able to learn to recognize individual notes, but often unable incorporate structural cues (Tommis and Fazey, 1999). However, since the present program is focused on adolescents and adults, structural recognition will be emphasized.

Harris's popular sight reading program (Harris, 1994), responsive to some of these findings, requires that learners look for both rhythmic and melodic patterns in various materials crafted specifically for this purpose. While learners may also play these short 'songs,' this is done as a separate, distinctly focused activity. Also included are reflection questions aimed at causing the learner to recognize specific aspects of musical structure: for example 'how is it like a conversation?; what particular pattern do you see in bars 1 and 2?' In this way the learner is scaffolded toward being able to recognize these elements on their own.

Incorporating breadth, not depth in music exposure

Lehmann and Ericsson (1996) studied advanced student pianists, and found that the breadth of their 'accompanying repertoire,' which is the set of pieces they would be comfortable accompanying other musicians to play, at short notice, was predictive of how well the students sight-read. They noted that these students spent their time actively seeking out harder and harder pieces, in order to be able to play with different people and different groups such as choirs, friends, or churches. The reader may note that these are not pieces that were memorized for solo performance. Indeed, music education that focused on solo performance by having the learner learn a few pieces very well, for solo performance, may not be conducive to sight reading.

Training inner hearing ability

The training of 'inner hearing 'explicitly is not well defined, solfege is generally incorporated into music education. Inner-hearing predicts sight reading sight reading, and traditional solfege training improves sight

reading ability across studies (Mishra, 2013). Such training is often incorporated into sight-reading and music education programs with notable success (Bernard, 2002). As such it should be included in the present program.

Training Rhythm keeping

The ability to 'keep time,' which involves generating and maintaining an internal representation of musical metre (Sloboda, 1983), is highly correlated with sight reading success (Boyle, 1970). As such, a sight reading music training program should include elements of time-keeping, as this is a component of the task. Various methods exist to train the ability to maintain an internal representation of rhythm. Boyle (1970) found that encouraging foot-tapping during sight reading increased performance level. Salzberg and Wang (1989) found that foot tapping and 'mark the beat' methods tend to be effective for adolescents, but may be less effective for elementary school students.

Training note-for-note identification

While focusing only on note-for-note identification has been shown to be for a modern training program, and training needs to incorporate pattern recognition and chunking behaviors early and often, individual notes do still need to be recognized. Traditionally, music educators have often started with verbal-sequential mnemonic devices such as 'Every Good Boy Does Fine' for learning and remembering the identities of notes on the staff (Coutts, 2012). However, this is an extraordinarily slow method, and means that higher notes take longer to be recognized. Additionally, these mnemonics do not correspond to the music itself in any meaningful way, or correspond to any kind of spatial or structural understanding of the music. As such, current thinking in music education is to eschew these entirely, in favor of methods that engender creation of a spatial understanding of the staff (Coutts, 2012).

For this latter approach, (Watkins, 2016) recommends several options. The first is the 'middle C method' in which a student learns middle C on the staff and instrument, and simply counts intervals up and down from this point. This method is still relatively common, although it is quite slow. Somewhat harder to learn, but faster, is the

'intervallic reading' method (Clark, 1995). Here, the student memorizes a few 'landmark notes' by rote, and then begins sight reading practice by considering the intervallic distance between a target note and the nearest landmark note. This method helps the student begin considering structure in the music early and often.

Finally, instructors do recommend use of note identification exercises, in which more notes are gradually introduced to the training set and the learner eventually is capable of identifying each note on the staff (Watkins, 2016). Clark (1995) pointed out that while it is beneficial to know the identities of notes, either as declarative knowledge or as a somewhat automated perceptual skill, sight-reading should not actually be conducted in this way, as it makes reading disjointed and slow. Thus, while there is a place for the 'whole keyboard approach,' current recommendations lean toward teaching through intervallic methods, as well as other methods that get the musician accustomed to attending to structural elements in order to identify the note.

Increasing feedback for note identification

Several studies have focused on using feedback to augment learner abilities. These have largely been unsuccessful in changing learning outcomes. Rogers (1991) trained some students using color-coded notes, and others with conventional black notes. This additional code did not lead to significant differences in sight reading ability after completion of training. Lee and Choi (2013) used haptic feedback to teach sight reading in a manner that directly created motor links. They had drummers attempting to sight read wear haptic devices on their arms that would vibrate prior to the reading of a given note, to indicate what sort of motor action the learner should do ('tactile cuing'). They also tested a version that used auditory cuing, and a version with post-note visual indications of whether a note was correct or not. There were no significant differences between these different feedback types in a sight reading/ playing task. The authors attributed the results in part to the fact that skilled sight readers read more than one note simultaneously and at high speed, while the augmented cues were only able to cue one note.

Training for performance anxiety and inward focus

Vickers (2007) described the phenomena of 'choking,' which was described as a failure of a person to perform up to their true skill level (Baumeister, 1984). They authors noted the connection between 'self-focus' behaviors and choking, in which focusing on internal experience and meta-assessment of one's performance leads to a disruption of automated skill components being allowed to run their course. Wulf et al. (2002) found that athletes who are able to maintain an 'external focus' on task elements, rather than an 'internal focus' on their own feelings and performance, are higher performing. Wulf et al. (2010) authors demonstrated that feedback systems that provide externally focused feedback lead to better performance outcomes compared feedback systems that incorporate internal focus. As such, a sight-reading program could include training involving attending to external feedback rather than internal feedback. This should provide some resilience against performance anxiety and the dangers of becoming introspective.

Vickers (2007) noted the impact of 'cognitive anxiety on choking behaviors, as well. Cognitive anxiety describes negative feelings deriving from expectations about one's performance, and potential consequences. Experiencing cognitive anxiety is detrimental to performance (Hardy and Fazey, 1987). Thus, a sight reading training program could include an element of mindfulness training, which has been shown to mitigate cognitive anxiety and improve performance in athletes (Kaufman, Glass and Arnkoff, 2009).

Training for multi-tasking and resilience to interruptions

Another possible cause of 'choking' is dynamically occurring distractions, in which a person's attention may be pulled away from the task at hand, toward distractors, lowering the cognitive capacity available to perform the task (Vickers, 2007). To mitigate this effect, a sight reading program could incorporate exercises with deliberate distracting elements. Cades, Boehm-Davis, Trafton, and Monk (2011) found that in multi-task situations, participants can be trained to be resilient to distracting interruptions if they have training in specific

combinations of tasks. Sight reading often occurs in dynamic environments where other band members are present. There may be a conductor, an audience, or environmental aspects. While many of these will not be 'interruptions' per se, training needs to occur in environments such as these in which more is going on that could occasionally distract the performer from their task.

Spacing of Practice

Schmidt and Lee (1988) provided an overview of the spacing of practice. They noted that, at large time scales, a trade-off exists- *massed* practice will be less efficient in terms of performance improvement and retention per unit of practice, but in a sense may take less total time (including rest intervals). Conversely, *distributed* practice provides greater performance improvement and improved retention per time unit of practice, but may take more total time. Fatigue is also a factor in performing the full sight reading task. However, there are many other components to a modern sight reading training program, that are not as fatiguing. These include listening to and studying a variety of pieces, learning music theoretic elements.

Variability of Practice

Schmidt and Lee (1988) described concerns relating to variability of practice, with findings generally indicating that varying practice conditions leads to better transfer outcomes. This is highly important in sight reading. Exposure and light familiarity with a variety of musical patterns has been found to correlate with sight reading ability (Lehmann and Ericsson, 1996). As such, practice tasks should be varied, but only as broadly as the set of types of music the musician is interested in training.

Speed-Accuracy Tradeoff

Sight reading includes a speed-accuracy tradeoff. In general, learners should be instructed to avoid putting an artificially high priority on accuracy (Schneider, 1985). Ultimately, high performance in sight reading depends on the ability to guess and make plausible-soundig mistakes (Lehmann and McArthur, 2002).

Music Composition, Improvisation, and Sight reading Training

Guderian (2008) found that a program in which music students were asked to improvise and compose music pieces led to an increase in sight reading performance. Lehmann and McArthur (2002) noted that the ability to improvise is actually key to expert sight reading. Additionally, training in this way would require 'deep processing' of structural elements, which in general leads to better recall of those elements (Craik and Lockhart, 1972).

Motivation

Motivation has been considered as an issue in music education. Allowing the learner to select their own, material and to some extent set their own goals has been found to lead to improve retention (Brandstorm, 1995; Greco, 1997). Additionally, the presence of another person to supervise practice and provide support is beneficial to learning outcomes (Barry, 1992). Being able to play along with others with unfamiliar music is a valuable social activity and is the goal of many aspiring sight-readers (Lehmann and Ericcson, 1996). As such, these activities should be encouraged as soon as the learner is ready.

Part-task practice

Fabiani et al. (1989) tested two approaches to dividing up practice of complex skills. They found that performance was higher for participants that were trained in various sub-tasks, versus participants trained in the entire task from the beginning. However, participants training in the latter way were more resilient to practice effects. Training in sight reading presents a similar tradeoff- it's important not to overload the trainee's cognitive load (Sweller, 1994), but it's also important to provide experience with the ecological multi-task situation soon and often in order to create practice with disruption and time sharing (Cades, Boehm-Davis, Trafton, and Monk, 2011). As such, an incrementally expanding task approach will be recommended, starting with recognition of single notes and progressing to playing from sections of the staff, then one staff, then both staves, and finally playing both staves with environmental distractions. However, this last point should be reached as soon as possible, and

difficulty ramped up from there in the full task.

Measuring Progress

Sight reading performance. There are several formal tests of sight reading ability. The most common is the Melodic Sight-reading achievement test (Grutzmacher, 1987). However, these can be complicated to administer. As such, simply recording the time a musician is able to play music, compared to how long it should take, and estimating the number of mistakes, is recommended. For novices, number of mistakes may not be informative, so 'time taken' may be the only measure that is informative. These can be done with a standardized bank of similar-difficulty songs. The difficulty of songs that the musician is able to sight read above a threshold of time and accuracy is another measure of ability. Generally, music repositories are divided into difficulty levels that can be used to characterize this.

Music theory knowledge. Music theory is generally measured via the Iowa Test of Musical Literacy (Gordon, 2001).

Workload. The NASA TLX (Hart and Staveland, 1988) is generally a good measure of workload. In particular, it is diagnostic without requiring a large amount of expertise or time to administer (Rubio, Diaz, Martin, and Puente, 2004)- important for at training program in which the learner may need to self-administer frequently to assess progress. Workload can be a measure of automaticity. Performance may stay the same for periods of time, but workload may decline, indicating improvement.

Measuring hand-eye span. To measure hand-eye span, the learner must have an observer stop their performance and they must verbally recite the next few notes. The number of notes they can correctly recite is the hand-eye span.

A sight reading training program

The following program is designed to take place in 5-6 months. It is recommended that a learner carry out the program with cohort in order keep motivation and give opportunities to sight-read together. Trial and hour counts are included as suggestions, but a learner may adapt these to suit their time constraints and preferences.

Phase 1

Phase 1 is intended to take 2-4 weeks. The learner will create declarative knowledge about the identities of notes, without forming detrimental habits that often arise during this period. The learner will acquire basic music theoretic knowledge.

Note identification training. Note identification training will be carried out in a 'whole keyboard' method, but participants will be encouraged to use intervallic methods to recognize notes that they have not yet learned. Verbal-sequential mnemonics will not be used. For this section, C major can be used as a key signature. It is recommended that a piano or keyboard not be used for this phase, as it could overload the learner. Note identification training can be carried out using an online tool or flashcards. Learners should first memorize middle C, as well as the top, bottom and middle lines of each staff. Once these have been committed to memory, learners can use an online tool to perform note identification within half of each staff. Both staffs must always be kept in view to avoid confusion between staves. Learners should be instructed to utilize intervallic methods to deduce the identity of notes they do not know, based off of anchor notes. After around 2000 trials, spaced out over four sessions (500 per quarter of a staff), learners should explicitly pause and commit new 4 new notes to memory using flashcards. These notes can be evenly spaced in between the previous 'anchor notes.' After this point, 2000 more note recognition trials can be conducted. These trials should be either the entire treble clef or the entire bass clef, with intervallic methods being encouraged for unknown notes. Both clefs should always be shown at all times. For these trials, a keyboard or piano should be used, to start building cross-linked spatial understanding. The learner may at this time commit the remaining eight staff notes to memory via flashcards, as well as the four notes

just below or above the staves. Following from this, 2000 trials involving sight reading random notes from the grand staff may be conducted. Once the learner can achieve 80% accuracy with this task, without taking time to think, they are ready to move on. For these trials, a piano or keyboard should be used. It's important to note that note identification should not be presented as 'sight reading'- it's merely a knowledge base that will facilitate doing sight reading in the proper way.

Music theory education. Concurrently with initial note identification training, the learners should be given instruction in music theory via a music theory book. The details of this instruction are not the focus of the present effort; detailed music theory training programs have been covered elsewhere. Performance can be measured via the Iowa Test of Musical Literacy; students should be able to pass levels 1 and 2.

Phase 2

Phase 2 is intended to take about two months. The learner will learn to look for structural elements such as tonal patterns in the score, as well as continuing music theoretic education. They will develop the supporting skills of rhythm-keeping and inner hearing. Additionally, they will begin practicing the full sight-reading task, and work up to being able to play low-complexity music selected or developed for this purpose.

Note identification training. For phase 2, practice identifying notes in isolation should be tapered off, as ultimately this is not a desirable pattern of behavior for use when reading notes.

Music theory education. Education in music theory should continue through up through 'intermediate' level materials as assigned by the instructional material. The learner should be able to pass levels 3-6 on the Iowa Test of Music Literacy after this period.

Training in structural element recognition. Participants should be trained to recognize structural music elements. Chief among these should be tonal patterns. In the manner recommended by Grutzmacher (1987), Gaynor (1995), and MacKnight (1975), the learner should be tasked with recognizing particular tonal patterns, as well as harmonizing with them. Harris (1994) includes exercises in which the learner is presented with a sheet of

music and asked to identify rhythmic or melodic patterns. This music is intentionally prepared in such a way as to highlight particular rhythmic and melodic patterns; in addition, questions prompt the learner to identify rhythmic, melodic and other structural elements. These pieces also repeat these elements enough times so that a learner might create a representation of each pattern. This scaffolding is important, and may lead to faster acquisition compared to simple exposure to typical compositions and sight reading practice. As such, it is recommended that learners work through Harris (1994) levels 1-3, during this time. This aspect of training is important, and should form the bulk of phase 2 (around 20-30 hours).

Deliberate sight reading practice. Learners should work up to being able to sight read 'low complexity' musical pieces. These may have relatively few notes per measure, may involve fewer notes than the entire staff, and may have intentionally predictable patterns. Sight reading sites such as 'sight reading mastery' (Sight Reading Mastery, 2015) have a database of short songs, organized by difficulty, for this purpose. This training should account for a large amount of training time, at 20-30 hours. The learner should measure time taken as well as accuracy to play these songs, and should expect to be able to play the songs in roughly the amount of time required by the notation, accepting a possibly high error rate. The learner should measure their cognitive workload via NASA TLX. Workload on the 'low' difficulty songs should be lower than 8-10 by the time this phase is completed, indicating that the learner may have some spare capacity to begin taking on harder material. The learner should be instructed to strive to play as quickly as possible, while maintaining accuracy high enough for the song to be recognizable.

Exposure and annotation training. Alternately, learners can analyze the piece, recognizing patterns, scales and key signatures, and annotate these items. This should be a significant component of sight reading training at this stage, and should account for at least 10 hours of training, spaced out over the month.

Rhythm keeping training. Learners should be given practice in foot-stomping and other rhythm keeping improving devices, as well as special training via rhythm keeping activities. This should be done for about 5-10

hours over the one-month period. Harris (1994) provides exercises that should be conducted here, in which the learner 'keeps the beat' by tapping the pulse (each quarter note) with one body part, while tapping the notes themselves with another body part.

Soflege and vocalization training. The learner will spend time undergoing soflege training to develop their inner hearing ability. This may take around 10 hours of practice, and can be conducted in two parts. First, an online tool can be used to teach soflege, in order to give the learner some understanding of what notes should sound like. Next, the learner may perform note recognition exercises and limited 'sight-singing' or harmonization exercises (Bernard, 2002). It should be noted that the skill of sight-singing is difficult to master. As such, basic familiarity with solfege notes followed to harmonization exercises is recommended in this case. This may be done for 5-10 hours.

Phase 3

Phase 3 is meant to take about two months. The learner will become proficient at understanding the structure of musical pieces, and will work up to being able to sight read more difficult pieces.

Deliberate sight reading practice. Learners should continue practicing sight reading of various real songs, this time moving up to those marked as 'moderate complexity.' Learners should continue to measure task times and estimated error rates, and should expect task times to decrease close to the correct times based on the tempo. Again, this should take the bulk of the time, at around 40-50 hours. The learner can begin playing along with cohort learners, friends or teachers during this time.

Training in chunking. For this stage, the learner should be given explicit instruction in how to scan the music, as well as memory exercises, similar to Gaynor (1995). This training may be somewhat limited in utility and as such can be limited to about 5 hours.

Melodic prediction exercises. The learner should explicitly practice 'melodic prediction.' To do this, they should cover up notes from within a score, and attempt to play the score as it was written. The learner can

measure error rates for these notes, and grade their ability. Before exiting phase 3, the learner should be able to reach over 50% accuracy with melodic prediction. The learner may spend approximately 15-20 hours working on melodic prediction exercises.

Music composition and improvisation exercises. Finally, the learner should spend some time improvising on the piano, as well as composing their own simple piano works. Both of these will enhance attention to structural elements and common tonal patterns. This can be done for around 5-10 hours.

Phase 4

Phase 4 should take about one month. The learner will focus on being able to sight read moderate/high complexity pieces, while managing various distractions and sources of anxiety.

Deliberate sight reading practice in stressful or distracting contexts. Learners should continue to practice with moderate/ high complexity songs. They should introduce various distractors, such as having a friend look over their shoulder, cheering and making other kinds of feedback. This remains important, and should take around 40 hours. The learner should measure their cognitive workload via NASA TLX. Eventually, workload should decrease to the point where the learner might be able to hold a conversation while sight reading, without degrading performance. Hand-eye span should also be measured throughout the month. Hand-eye span should vary significantly, and should be in excess of 2-3 notes, generally.

Training in maintain external focus and managing cognitive anxiety. Instruction should be given on mindfulness procedures as well as how to focus on external feedback. This not of as high import but this knowledge needs to imparted, so around 5 hours can be set aside for these items.

Continued practice improvising and composing. The learner should continue to spend time composing novels works, as well as improvising over existing works. The focus need not be on quality, but on creating coherent compositions that adhere to musical convention (avant-garde composing may not be as helpful). Around 20 hours can be allotted for this.

Phase 5

Phase 5 encompasses continuing training in sight reading. The learner should continue to practice sight reading various songs, and should keep composing and improvising musical pieces.

Conclusion

Sight reading is a difficult skill to learn and master. However, modern training methods should be able to make it attainable for more people than ever before. Adhering to a training program of the sort described here, that focuses on supporting skills and training pattern-recognition ability in music, should produce desirable outcomes in adolescent or adult students who desire to learn to sight read.

References

Barry, N.H. (1992). The effects of practice strategies, individual differences in cognitive style, an gender upon technical accuracy and musicality of student instrumental performance. *Psychology of Music, 20(2).* 112-113.

Baumeister, R. F. (1984). Choking under pressure: self-consciousness and paradoxical effects of incentives on skillful performance. *Journal of personality and social psychology*, *46*(3), 610.

Bernhard, H. C. (2002). Singing in instrumental music education: Research and implications. *Update: Applications of Research in Music Education, 22*, 28-35.

Boyle, J. D. (1970). The effect of prescribed rhythmical movements on the ability to read music at sight. Journal of Research in Music Education, 18(4), 307-318. doi:10.2307/3344498

Brandstorn, S. (1995). Self-formulated goals and self-evaluation in music education. *Bulletin of the Council for Research in Music Education, 127.* 16-21.

Cades, D. M., Boehm-Davis, D. A., Trafton, J. G., & Monk, C. A. (2011). Mitigating disruptive effects of interruptions through training: what needs to be practiced?. *Journal of Experimental Psychology: Applied*, *17*(2), 97.

Clark, F. (1995). ABC Papers. Alfred Music.

complexity, and encounters. Music Perception 12, no. 1: 77 96.

Coutts, L. (2012). "But it's cheating!" – The musical way to read music. Music Teacher's Blog. Retrieved November 17, 2016 from http://blog.musicteachershelper.com/but-its-cheating-the-musical-way-to-read-music/

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal behavior,* 11, 671-684.

Fabiani, M., Buckley, J., Gratton, G., Coles, M. G., Donchin, E., & Logie, R. (1989). The training of complex task performance. *Acta Psychologica*, *71*(1), 259-299.

Gaynor, J. (1995). Music reading comprehension : The effect of aid to chunking and melodic predicting on sight-reading performance achievement of secondary school instrumental music students (Doctoral dissertation, University of San Francisco, 1995). Dissertation Abstracts International, 56, 4693.

Goolsby, T.W. 1994. Eye movement in music reading: Effects of reading ability, notational

Gordon, E. (2001). *Iowa tests of music literacy: manual*. GIA Publications.

Greco, V. (1997). *Investigation of the effects of student-selected repertoire on the practice habits of instrumental music students.* M.A. Action Research Project, Saint Xavier University.

Grutzmacher, P. A. (1987). The effect of tonal pattern training on the aural perception, reading recognition, and melodic sight-reading achievement of first-year instrumental music students. *Journal of Research in Music Education*, *35*(3), 171-181.

Guderian, L. V. (2008). *Effects of applied music composition and improvisation assignments on sight-reading ability, learning in music theory and quality in soprano recorder playing*. ProQuest.

Hardy, L. & Fazey, J. (1987). The Inverted-U Hypothesis: A Catastrophe For Sport Psychology? Paper Presented at the Annual Conference of the North American Society For the Psychology of Sport and Physical Activity. Vancouver. June.

Hargreaves, D. J. (1986). *The developmental psychology of music*. Cambridge University Press.

Harris, P. (1994). *Improve your sight-reading!: a workbook for examinations*. Faber Music.

Hart, S. G., & Staveland, L. E. (1988). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. *Advances in psychology*, *52*, 139-183.

Hayward, C. M., & Eastlund Gromko, J. (2009). Relationships among music sight-reading and technical proficiency, spatial visualization, and aural discrimination. Journal of Research in Music Education, 57(1), 26–36. doi:10.1177/0022429409332677

Kaufman, K. A., Glass, C. R., & Arnkoff, D. B. (2009). Evaluation of Mindful Sport Performance Enhancement (MSPE): A new approach to promote flow in athletes. *Journal of Clinical Sport Psychology*, *25*(4), 334.

Kopiez, R., & In Lee, J. (2006). Towards a dynamic model of skills involved in sight reading music. *Music education research*, *8*(1), 97-120.

Kopiez, R., & In Lee, J. (2008). Towards a general model of skills involved in sight reading music. *Music Education Research*, *10*(1), 41-62.

Lee, I., & Choi, S. (2013, April). Effects of multi-modal guidance for the acquisition of sight reading skills: a case study with simple drum sequences. In *World Haptics Conference (WHC), 2013* (pp. 571-576). IEEE.

Lehmann, A. C., & Ericsson, K. A. (1996). Performance without preparation: Structure and acquisition of expert sight-reading and accompanying performance. *Psychomusicology: A journal of research in music cognition*, *15*(1-2), 1.

Lehmann, A. C., & McArthur, V. (2002). Sight-reading. *The science and psychology of music performance*, 135-150.

Lehmann, A.C., J.A. Sloboda, and R.H. Woody. 2007. Psychology for musicians: Understanding and acquiring the skills. Oxford, UK: Oxford University Press.

MacKenzie, C. L., Vaneerd, D. L., Graham, E. D., Huron, D. B., & Wills, B. L. (1986). The effect of tonal structure on rhythm in piano performance. *Music Perception: An Interdisciplinary Journal*, *4*(2), 215-225.

MacKnight, C. B. (1975). Music reading ability of beginning wind instrumentalists after melodic instruction. *Journal of Research in Music Education*, *23*(1), 23-34.

Meinz, E. J., & Hambrick, D. Z. (2010). Deliberate practice is necessary but not sufficient to explain individual differences in piano sight-reading skill the role of working memory capacity. *Psychological Science*.

Mills, J., and G.E. McPherson. (2006). Musical literacy. In The child as musician: A handbook of musical development, ed. G.E. McPherson, 155 72. Oxford/New York: Oxford University

Mishra, J. (2013). Improving sightreading accuracy: A meta-analysis. *Psychology of Music*, 0305735612463770.

Penttinen, M. (2013). Skill Development in Music Reading. The Eye-Movement Approach.

Penttinen, M., & Huovinen, E. (2011). The early development of sight-reading skills in adulthood: A study of eye movements. Journal of Research in Music Education, 59(2), 196–220. doi:10.1177/0022429411405339

Raven, J. C., & John Hugh Court. (1998). *Raven's progressive matrices and vocabulary scales*. Oxford, UK: Oxford Psychologists Press.

Rogers, G. L. (1991). Effect of color-coded notation on music achievement of elementary instrumental students. *Journal of Research in Music Education*, *39*(1), 64-73.

Rubio, S., Díaz, E., Martín, J., & Puente, J. M. (2004). Evaluation of subjective mental workload: A comparison of SWAT, NASA-TLX, and workload profile methods. *Applied Psychology*, *53*(1), 61-86.

Salzberg, R. S., & Wang, C. C. (1989). A comparison of prompts to aid rhythmic sight-reading of string students. *Psychology of Music*, *17*(2), 123-131.

Schmidt, R. A., & Lee, T. (1988). *Motor control and learning*. Human kinetics.

Schneider, W. (1985). Training high-performance skills: Fallacies and guidelines. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *27*(3), 285-300.

Sight Reading Mastery: Master Sight Reading with Real Music. (2015). Retrieved November 17, 2016, from http://sightreadingmastery.com/

Sloboda, J.A. (1974). The Eye-Hand Span--An Approach to the Study of Sight Reading. *Psychology of music*.

Sloboda, J.A. (1984). Experimental studies of music reading: A review. Music Perception 2,

Smith, J. C. (2015). The effect of sight-reading instruction on performance achievement of high school band students. Visions of Research in Music Education 26. Retrieved from http:// http://users.rider.edu/~vrme/

Stanzione, M., D. Grozzi, and L. Roberto. 1990. Note-by-note music reading: A musician with letter-by-letter reading. Music Perception 7, no. 3: 273 84.

Stewart, L., Walsh, V., & Frith, U. (2004). Reading music modifies spatial mapping in pianists. *Perception & psychophysics*, *66*(2), 183-195.

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and instruction*, *4*(4), 295-312.

Tommis, Y., & Fazey, D. M. (1999). The acquisition of the pitch element of music literacy skills by 3-4-year-old pre-school children: A comparison of two methods. *Psychology of Music*, *27*(2), 230-244.

Vickers, J. N. (2007). *Perception, cognition, and decision training: The quiet eye in action*. Human Kinetics.

Waters, A. J., & Underwood, G. (1999). Processing pitch and temporal structures in music reading: Independent or interactive processing mechanisms?. *European Journal of Cognitive Psychology*, *11*(4), 531-553.

Waters, A. J., & Underwood, G. (1999). Processing pitch and temporal structures in music reading: Independent or interactive processing mechanisms?. *European Journal of Cognitive Psychology*, *11*(4), 531-553.

Waters, A. J., Townsend, E., & Underwood, G. (1998). Expertise in musical sight reading: A study of pianists. *British Journal of Psychology*, *89*(1), 123-149.

Waters, A. J., Underwood, G., & Findlay, J. M. (1997). Studying expertise in music reading: Use of a pattern-matching paradigm. *Perception & psychophysics*, *59*(4), 477-488.

Watkins, Stan. How to Learn to Read Music. (2016). Retrieved November 17, 2016, from http://www.stanwatkinspiano.com/blog/how-to-learn-to-read-music

Williamon, A. (Ed.). (2004). Musical excellence: Strategies and techniques to enhance performance. Oxford, UK: Oxford University Press.

Wolf, T. 1976. A cognitive model of musical sight-reading. Journal of Psycholinguistical Research 5: 143□72.

Wulf, G., McConnel, N., Gärtner, M., & Schwarz, A. (2002). Enhancing the learning of sport skills through external-focus feedback. *Journal of motor behavior*, *34*(2), 171-182.