sempre:
Society for Education, Music and Psychology Research

Original Empirical Investigations

Psychology of Music
2023, Vol. 51(1) 119–139

Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/03057356221087444
journals.sagepub.com/home/pom
SAGE

Building a mental toolbox: Relationships between strategy choice and sight-singing performance in higher education

Justine Pomerleau-Turcotte[1], Francis Dubé[1], Maria Teresa Moreno Sala[1] and Francois Vachon[2]

Abstract

Sight-singing is an inescapable component of music training in higher education and is often challenging for students. However, some strategies could help students perform. Yet, the extent to which students can use strategies to improve their sight-singing performance remains unclear. This article asks two questions to fill this gap: (1) Which strategies do students use when sight-singing? (2) Does the application of some types of strategy predict performance? We recruited 56 postsecondary music students and asked them about their musical backgrounds. They then sight-sang a short melody while we recorded their eye movements. After that, we conducted semi-structured retrospective interviews, using eye-movement videos and attention distribution heatmaps to help participants remember the strategies they used. We analyzed the interview transcripts to identify the strategies students used and regrouped them into categories. We extracted seven categories and discovered that using body movements predicted rhythm scores, that using musical knowledge predicted pitch and combined scores, and that relying on automatic skills predicted all dimensions of sight-singing performance. We recommend that aural skills instructors teach strategies explicitly and help students develop robust musical knowledge, as they are required to build strong automatic skills.

Keywords

aural skills, sight-singing, higher education, cued retrospective reporting, eye-tracking, strategies

Aural skills are a compulsory course in most, if not all, postsecondary music programs (College Music Society, 2020). Classes in this field usually include musical dictation and sight-singing[1] (e.g., Cleland & Dobrea-Grindahl, 2010; Karpinski, 2006). Although there is a lack of data

[1]Faculté de musique de l'Université Laval, Québec City, QC, Canada
[2]École de psychologie de l'Université Laval, Québec City, QC, Canada

Corresponding author:
Justine Pomerleau-Turcotte, Faculté de musique de l'Université Laval, Pavillon Louis-Jacques-Casault, 1055, Avenue du Séminaire, Québec, QC G1V 0A6, Canada.
Email: justine.pomerleau-turcotte.1@ulaval.ca

regarding the direct impact of those two tasks on in-training and professional musicians, some studies point out these skills can be useful in some contexts. For instance, in high school, musical dictation success is linked to performance, composition, and sight-singing scores (Rogers, 2013). In college, interval identification skills, which students often develop through aural skill classes, predict scores in a melodic error detection task among preservice music teachers (Stambaugh & Nichols, 2020). Aural skills are also fundamental for in-service music teachers who consider these classes a valuable part of their training: for example, ensemble directors rely on their aural skills on a daily basis (Groulx, 2016). In addition, a meta-analysis conducted by Mishra (2014) suggests that aural skills interventions improve instrumental sight-reading ability, which is crucial for many professional musicians (Lehmann & McArthur, 2002). Therefore, improving this ability seems relevant to musicians' everyday life.

Students who choose to study music in college come from various backgrounds, and some face obstacles that are difficult to overcome. Fournier (2015) reported that between 2011 and 2013, in a college in the province of Quebec (Canada), 45% of new students were registered in the weakest sections of aural skills classes because of poor admission tests results. Indeed, in a survey administered to classical music students in a high-level program, aural skills classes were the most prone to cause delays in the curriculum (Mennen & van der Klink, 2017). However, despite these difficulties, data from a Reddit survey suggest that students value solfege as an essential ability to acquire (Gutierrez, 2018).

The main objective of the present study is to identify whether the use of strategies can predict sight-singing scores. In this article, we define strategies as actions (Bégin, 2008) or cognitive processes (George, 2011) used to reach a goal. Knowing this could help instructors teach the most appropriate strategies to successfully sight-sing and target specific categories of students who need more support to succeed in their aural skills classes. The following subsections of our literature review will focus on strategies used in two different contexts: instrumental sight-reading and sight-singing. We chose to address these settings separately because despite their similarities, they require different mental operations. For example, sight-singing forces musicians to have a precise mental representation of sounds to succeed. However, evidence suggests that musicians can use similar cognitive strategies in both tasks (Bogunović et al., 2020). Consequently, some of the strategies that were either documented or tested in an instrumental sight-reading context can help us build hypotheses about what could benefit sight-singers.

Instrumental sight-reading strategies

Many musicians are familiar with the recommendation to read ahead while sight-reading. However, this approach does not always reflect on the achievement, at least in a sample composed from music education and performance university students (Penttinen et al., 2015). After their study of piano majors with professional experience, Lim et al. (2019) even suggested that longer eye–hand spans[2] should be seen as a manifestation of a strategy—reading ahead—rather than as a performance indicator. This result is coherent with the findings of Aiba and Matsui (2016), who found that professional pianists who reported focusing on reading ahead did not perform better than those who preferred to memorize sounds before playing. Furthermore, they conclude that knowing common harmonic patterns could be more beneficial than any of these two strategies. It could explain why chunking, namely, grouping notes into structural units, was helpful for beginning pianist sight-readers (Pike & Carter, 2010). Also, expert sight-readers—selected based on their performance at a sight-reading exercise—tended to use more analytic strategies when playing (Kim et al., 2020). Analyzing music often requires understanding harmony, which can facilitate chunking because melodies can often be divided into chords.

In short, research about instrumental sight-reading performance suggests that while reading ahead can be helpful in some instances, trying to find harmonic patterns to create schemas, or chunks, is probably more beneficial to accomplish this task. Even if sight-singing requires an additional step than sight-reading, that is, inevitably mentally hearing which sound is coming next, those strategies could benefit that task as well.

Sight-singing strategies

One approach to studying sight-singing strategies is to list which ones musicians report using. For example, Bogunović and Vujović (2012) administered a questionnaire to 89 music students. They found that sight-singing strategies they used could fit into three categories: cognitive (e.g., relying on the tonal function of pitches or creating a mental representation of sounds), intuitive (either using knowledge retrieved from memory or not thinking while sight-singing), and no strategy (beginning to sing without any preparation). The authors later conducted a similar study to include metacognitive strategies and found strategies for each phase of sight-singing: preparation (e.g., general overview, inner hearing), setting-goals (e.g., fluency control), and performance (e.g., intuitive performing; Bogunović et al., 2020).

Fournier et al. (2019) provided another example of classification. They analyzed the content of research articles, books, sight-reading manuals, and interviews with students and aural skills instructors and came up with an inventory of 72 sight-singing strategies. They then regrouped these strategies into four categories: reading mechanisms, sight-singing (performance and preparation), reading skills acquisition, and learning support. Each category includes subcategories regrouping various cognitive strategies. For example, reading mechanisms include three subcategories: pitch decoding (e.g., relate to scale degrees), pattern building (e.g., group notes to create chords or arpeggios), and validation (e.g., listen carefully to identify mistakes).

The classifications described previously (Bogunović & Vujović, 2012; Bogunović et al., 2020; Fournier et al., 2019) suggest that any action a musician needs to do to sight-sing can rely on specific strategies and that these strategies can adapt to students' preferences and levels of understanding. However, in these studies, participants answered questions about the strategies they knew about, but not about the strategies they actually apply during a specific sight-singing task. In the latter case, their answers could vary depending on context and their ability to use strategies. Consequently, these studies, while giving insights on the strategies students know, do not contribute to knowledge about the strategies students use in an in situ sight-singing task, nor how these strategies contribute to performance.

There are different ways subjects can analyze melodies before and while sight-singing. Indeed, according to Neto and de Oliveira (2019), individuals can make sense of melodies either as sequences of intervals (i.e., distances between pitches) or as scale-steps (i.e., perceiving pitch functions in the scale). This division resonates in the classification of strategies suggested by Fournier et al. (2019): Reading mechanisms include a subcategory to regroup decoding strategies, which includes two strategies that reflect this distinction, namely, relating to scale degrees and relating to intervals. In musical dictation tasks, some researchers argue that trying to hear scale degrees is associated with enhanced performance (e.g., Beckett, 1997; Buonviri, 2014; Cruz de Menezes, 2021; Hoppe, 1991; Potter, 1990). In a study conducted by Lovorn (2016), choir singers who wrote solfege syllables on the score or used Curwen signs[3] all got better sight-singing results after a 6-week training. Therefore, it seems that linking notes with their scale degrees could be beneficial, either in a written form or with hand signs. Moreover, movements themselves, like those used by individuals using Curwen signs, can lower the load on working memory (Pouw et al., 2014; Sepp et al., 2019) and the mental workspace allowing information retention and processing (Baddeley, 2007; Baddeley & Hitch, 1974; Wickens & Hollands, 1999). It could mean a decrease in the mental effort required to perform the task.

In addition to understanding melodies either as distances (intervals) or functions (scale degrees), musicians can also analyze melodies harmonically, which has been correlated with sight-singing performance (Nikolić & Kodela, 2020). Yet, most choir textbooks do not include such strategies (Floyd & Haning, 2015), which could mean musicians who would benefit from them do not learn these techniques.

Finally, Killian and Henry (2005) investigated the strategies used by high school choristers while sight-singing. Some strategies used by the best sight-singers are similar to some of those mentioned above. For example, during the preparation phase, tonicizing (singing chords to strengthen tonality awareness), using hand signs, and physically keeping the beat were related to better performance. During the execution, using hand signs, physically keeping the beat, and maintaining a steady tempo were also associated with better outcomes. This result suggests that a variety of strategies can contribute to sight-singing performance.

The current study

Although knowing many strategies could potentially help musicians to sight-sing better, the strategies they actually use in situ and their contribution to sight-singing performance are still unknown. Indeed, even if Fournier (2020) found that students who reported using some performance strategies in questionnaires about their sight-singing habits had better scores in their sight-singing tests, we do not know if we could obtain similar results while using retrospective verbal reports immediately after a sight-singing performance. In other words, there could be a discrepancy between what students report doing and what they do.

The present study aims to list and classify the strategies students use when sight-singing in a context similar to their aural skills tests. We also wanted to examine whether using some strategies can predict sight-singing scores. More precisely, we wanted to answer these two research questions:

1. What strategies do postsecondary music students use when sight-singing a medium-difficulty melody?
2. Which categories of strategies predict sight-singing performance?

To answer these questions, we asked participants to sight-sing a melody, then applied a cued retrospective verbal protocol to investigate strategy use. In other words, we asked participants about the strategies they employed to sight-sing while showing them two cues: a video of their eye movements on the score and a visual representation of their attention distribution on the score, both obtained with an eye tracker. Using a cue can elicit a better recollection of what happened during the task (van Gog et al., 2006). Eye-movement videos were previously used in various studies with retrospective verbal protocols (e.g., Bender et al., 2021; Greussing et al., 2020; Muntinga & Taylor, 2018; Penttinen et al., 2013) and efficiently helped subject recall their cognitive processes. Cued retrospective interviews were used in previous studies about strategies used by musicians during improvisations (Després et al., 2017; Norgaard, 2011), which led us to believe this approach was suitable for another in situ musical task, a sight-singing exercise presented in a context similar to end-of-semester aural skills evaluations in higher education.

Methods

Participants

After obtaining ethical approval from the authors' university, we recruited 56 participants from three postsecondary institutions offering music concentration programs. Recruitment comprised three phases: (1) we advertised the targeted institutions' hallways; (2) we sent an email to students and a follow-up 2 weeks later; and (3) finally, we recruited students in person, in aural skills classes for two of the institutions, and during a meeting for the other one.

The youngest participant was 17, and the oldest was 67 ($M = 22.88$, $Mdn = 19$, $SD = 11.03$). They accumulated between 3 and 26 years of musical experience when accounting for interruptions ($M = 10.61$, $Mdn = 10$, $SD = 5.22$). They began learning music between 4 and 40 years old ($M = 9.41$, $Mdn = 9$, $SD = 5.05$). They all had a normal or corrected-to-normal vision. The first author offered them free optional aural skills tutoring to suit their specific needs as compensation for their participation. This tutoring usually took place immediately after the experiment or at another moment, depending on participants' preferences.

Materials

Questionnaire. We used a questionnaire to obtain general information about our sample (age, gender, musical background, absolute pitch, learning difficulties, etc.). Questions were written by the authors. The questionnaire was automated and administered on a Dell Precision T5810 computer with Google Forms.

Sight-singing task. To create our task (Figure 1), we used an eight-bar melody from École préparatoire de musique de l'Université Laval (1999) that we transposed and altered slightly, so the key would be familiar to more participants. Indeed, participants who begin postsecondary music degrees are typically expected to know tonalities with four alterations or less (Cégep de Sainte-Foy, 2017), but the original melody was in C-sharp major, which requires seven alterations. Consequently, we opted for a transposition to D major, a tonality with two alterations. We also made sure less experienced students could recognize all rhythmic figures. This is why we replaced the first beat in the melody, a 16th note followed by an 8th note and a 16th note, by an 8th note followed by two 16th notes.

We based our decision on length and difficulty. Indeed, we chose a short eight-measure melody to have plenty of time to discuss its execution while keeping the whole procedure relatively short and collecting sufficient data about performance quality and strategies. This focus on the quality of the interviews is why we chose to use only one melody in our task. We also wanted to choose a melody that would be challenging enough to avoid a ceiling effect while ensuring that most participants could keep singing without stopping until the end, despite eventual difficulties. The melody includes a skip that can be tricky to sing by beginners on Measure 3, but stays harmonically simple, mostly using notes from the tonic chord and the dominant chord. We piloted the study with three participants with different levels of expertise, which confirmed that our choice of melody was appropriate.

Eye-tracking. Eye movements were recorded with a Fovio eye tracker, positioned on a desk, below the computer monitor. EyeWorks (EyeTracking Inc.) generated eye movements' video capture and heatmaps at a sampling rate of 60 Hz. The fixation duration threshold was 75 ms.

Interviews. We conducted semi-structured cued retrospective interviews based on a framework by Laforest et al. (2009). Our interview grid consisted of four sections: one main question

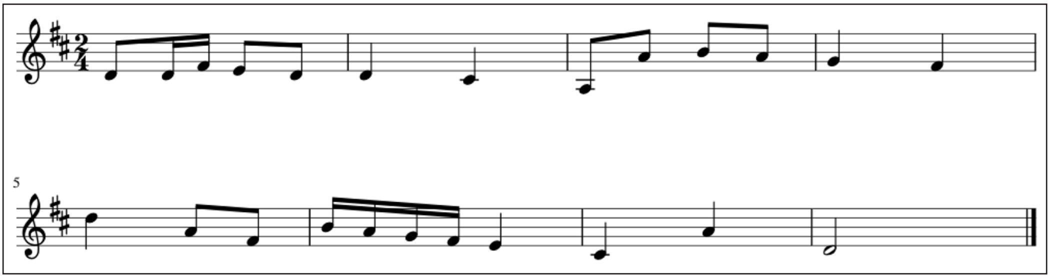

Figure 1. Sight-Singing Task.

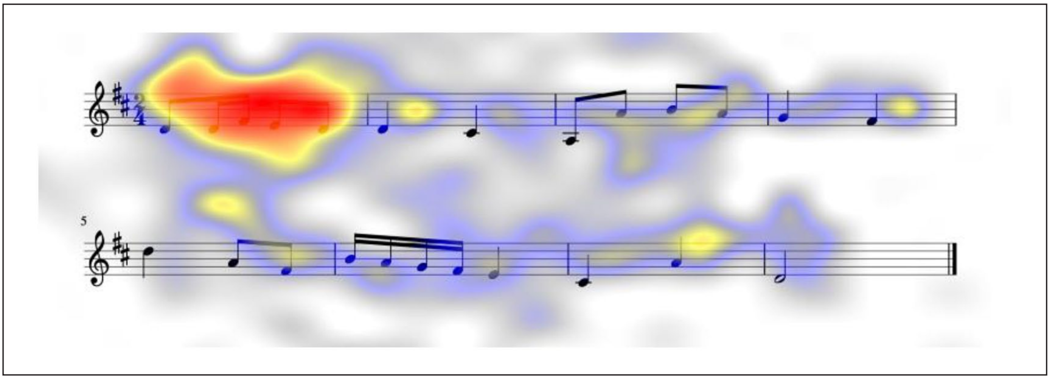

Figure 2. Example of a Heatmap Showing Attention Distribution. Red Zones Are the One Where There Is the Most Important Fixation Density (Number and Duration), While Blue Zones Reveal the Opposite.

("Which strategies did you use?"), complementary questions (e.g., "Which sections were the most challenging?"; "What strategy did you use there? Did it work?"), follow-up questions (e.g., "Can you please clarify your thought process here?"), and a closing question ("Is there anything else you might share to help me understand the strategies you used?").[4] The discussion around the main question also included four phases: (1) questions about the preparation phase; (2) questions about the sight-singing execution; (3) observation of eye movements with participants to complete or correct what they said previously; and (4) observation of attention distribution heatmaps (Figure 2) to complete or correct what they said previously. We also asked all participants if they used conducting gestures to keep the beat, because we thought that the videos could not necessarily help participants remember this strategy, as it does not emerge from the score.

Procedure

The first author met with each participant individually. After participants heard a summary of the procedure and gave their written informed consent to participate in the study, they first completed the questionnaire designed by the authors and described above, which took approximately 15 min. The participants were alone in the room to ensure privacy. Then, the experimenter came back into the room to explain the sight-singing task and launched EyeWorks Records. This component of the EyeWorks software allowed us to record eye movements and audio record participants' performance. Participants were also alone in the room for this step to avoid them being stressed by the experimenter's presence. After a calibration of the eye tracker using nine points on the computer screen, EyeWorks displayed the sight-singing task. Participants could prepare silently for as long as they wished but could only play the starting pitch on the Yamaha NP11 keyboard placed in front of them. Once they were done, usually after 5–10 min (which included the calibration process and the mental preparation), the experimenter came back in the room for the interviews, which lasted between 10 and 15 min and were recorded on an iPhone 6 with the Dictaphone app. During these interviews, participants watched a video to hear their performance and see their eye movements on the score. They could also look at heatmaps showing how their attention was distributed on the score. EyeWorks Analyze automatically generated heatmaps.

Sight-singing performance scoring

We evaluated the sight-singing performances objectively. Each note was worth two points, one for pitch height and one for duration. This approach is similar to the scoring methods used by Henry (2011) and Petty and Henry (2014) and allowed us to assess performance objectively. We evaluated pitch height in an absolute manner, with no relation with the pitches sung before, as seen in a study by Reifinger (2012). The experimenter scored recordings of their performance. A college aural skills teacher and researcher, who was a PhD candidate in music education, scored 10 performances chosen randomly. Despite this small sample, grades were distributed normally for both raters. We conducted a Pearson correlation and found a strong, significant relationship between ratings, $r(8) = .989$, $p < .01$, and therefore considered the scoring as valid.

Data analysis

We made a content analysis (Braun & Clarke, 2019; Krippendorff, 2013) of the interviews to identify the strategies used by participants with NVivo 12 (QSR International, 2019). To ensure we identified in situ strategies rather than strategies that subjects could have used in other circumstances, we only coded strategies unambiguously used during the sight-singing task. Consequently, we did not code statements suggesting a strategy was usually adopted but not necessarily for the present task. In some instances, we asked questions about strategies that we observed during the cued retrospective interviews (e.g., looking back at the last occurrence of a specific note), but only coded them when subject participants remembered using this strategy.

This content analysis resulted in a list of strategies that we analyzed to create thematic groups (Paillé & Mucchielli, 2016) or, in this study, categories of strategies. To make these categories, the first author identified similarities between strategies regarding cognitive processes, or "mental steps" required to sight-sing, and she wrote precise and exclusive definitions for each category of strategies. Subsequently, the second author, who was provided with these definitions and the strategies coded under each thematic group, analyzed four representative interviews: a particularly elaborate one, two that contained ambiguities, and one on the middle ground. After some discussions to clarify some strategies' definitions, the first and second authors reached an excellent Cohen's kappa ($\kappa = .86$). Therefore, the strategy classification was considered valid and could be used for the statistical analyses we needed to answer second and third research questions.

We analyzed quantitative data with RStudio (R Core Team, 2019), using the packages *lsr* (Navarro, 2015), *olsrr* (Hebbali, 2020), and *BayesFactor* (Morey & Rouder, 2018). We coded strategy groups as categorical variables to include in our quantitative analyses. We first used stepwise regression analyses to find if some categories helped predict performance and then confirmed these strategies were linked to better scores with independent-samples *t*-tests and Bayes factor analyses.

Results

Strategies reported in interviews

We listed a total of 82 strategies and regrouped them into seven categories. They are displayed in Table 1. The first category, *managing attentional resources*, was used by 21 participants. When sight-singing, like in any other cognitively demanding task (Wickens & Hollands, 1999), students have limited attentional resources to process multiple information. Consequently, they need to prioritize some musical elements and sections and regulate negative emotions (e.g., stress). In this category, we included instances where the strategies were used to deal with difficulties rather than to prevent them. The most frequent strategy was to spend more time preparing the first measures, for example, because this would benefit the whole exercise: "Well, I tell myself that if I start [the sight-singing tasks] right, it will go well after" (Participant 10). As for every other category, the verbatims were central to our decision process. For instance, Participant 5 explained that when something was too difficult to sing, "[their] brain just goes 'oh no!' and just jumps to the next note," which was coded as the strategy "Skipping to the next note or next difficulty." In other instances, we relied on verbatims' context to assign categories, namely for the "Prioritizing the preparation of difficult passages" strategy. Indeed, Participant 56 said they did so because they did not want to "waste mental resources on something easy."

The second category, *decoding notation*, was used by 48 participants, which means that most participants took some actions to make sense of the score no matter their proficiency levels. In some instances, participants did not provide details about the specific ways they coded. However, it appeared to be an essential step to obtain the first level of understanding of the melody. The most prevalent strategy under this category was decoding rhythmic elements ($n = 20$), followed by identifying intervals ($n = 19$) and identifying pitches ($n = 15$). We also included a strategy mentioned by Participant 5 who, although instructed to prepare silently, hummed the melody as a way to understand it despite her inability to hear it mentally.

The third category includes strategies to *anticipate upcoming content and potential difficulties*, which 25 participants did. It includes actions taken to prepare for challenges or correct mistakes occurring during the task. The most mentioned strategy was to read ahead ($n = 11$), followed by choosing an adequate tempo ($n = 6$). Most strategies under this category were described by only one subject, as they depend on the specific experiences of participants.

The fourth category is *using the body to execute the rhythm*, which 32 participants did. The experimenter asked everyone if they used conducting movements while singing, which was the primary strategy ($n = 25$) classified in this group. It also includes less frequent strategies relying on movements, such as stamping feet ($n = 3$) or imagining conducting gestures ($n = 1$).

The fifth category is *building mental representations of sounds and relying on them*, mentioned by 47 participants. As described previously in the introduction, imagining sounds before singing them is indissociable from the act of sight-singing, and some strategies described by subjects bring details on how they do that. The most common strategy was to mentally sing the whole melody ($n = 24$), followed by making a mental comparison with a pitch sung previously ($n = 12$).

The sixth category was to *use musical knowledge*, which 25 participants applied. Some participants provided insights on how they use their knowledge to understand and sing the score.

Table 1. Occurrences of Strategies Participants Mentioned in Interviews.

Category	Definition	Strategies	*n*
1. Managing attentional resources (*n* = 21)	This category includes instances when participants prioritized some aspects of the performance to manage the task's demands during their performance. It also includes strategies related to emotion regulation, which also requires cognitive resources. This category is about reacting to events and challenges rather than preventing eventual difficulties	Prioritizing the preparation of the first measures	8
		Prioritizing pitches over rhythm	6
		Prioritizing rhythm over pitches	3
		Stop conducting	3
		Prioritizing the preparation of difficult passages	2
		Changing the inner dialogue to manage stress	1
		Going on despite difficulties	1
		Omitting singing pitch names	1
		Paying less attention to notes to manage stress	1
		Prioritizing notes names over rhythm	1
		Skipping to the next note or the next difficulty	1
2. Decoding notation (*n* = 48)	This category includes strategies used to understand and decode the score, either during the preparation phase or during the sight-singing performance. In some cases, participants only mentioned they identified score elements, without giving specifications on how they identified them. Strategies in this group were participants' first contact with the notation, as they were often the first steps that subjects took to sing	Decoding rhythmic elements	20
		Identifying intervals	19
		Identifying pitches	15
		Trying to get a general view of the melody	10
		Looking at the key signature	7
		Identifying the tonality	5
		Looking at the meter	5
		Looking at one or more sections of the melody	5
		Finding steps and skips	4
		Subdividing rhythmic figures	4
		Identifying the starting note	3
		Identifying rhythm figures	2
		Identifying the mode (major or minor)	2
		Finding the starting pitch on the keyboard	2
		Approximating the distance between two pitches	1
		Counting the number of repeated notes	1
		Humming the melody	1
		Identifying melodic direction	1
		Naming the pitches mentally	1
		Naming pitches mentally while following the rhythm	1
		Identifying the melodic contour	1
		Finding the tonic	1
		Trying to understand one or more sections	1

(continued)

Table 1. (Continued)

Category	Definition	Strategies	*n*
3. Anticipating upcoming content and potential difficulties ($n=25$)	This group of strategies describes actions taken either before or during the performance. They can be used to compensate for mistakes or to avoid future mistakes. This category is about preventing mistakes rather than merely reacting to them, which distinguishes it from Category 1	Reading ahead consciously	11
		Choosing an adequate tempo	6
		Finding the main difficulties in the whole melody	4
		Slowing down to prepare a challenging segment	3
		Finding the upcoming difficulties	3
		Changing the octave to better suit tessitura	1
		Paying attention to the intonation of specific pitches	1
		Making a pause to overcome a difficulty	1
		Going back from an easier landmark	1
		Repeating a note to correct a mistake	1
		Repeating a note to go back to the tonality	1
		Making sure to sing the right notes	1
4. Using the body, or a mental representation of it, to execute the rhythm ($n=32$)	This category comprises every strategy relying on movements that students used to keep the pulse steady and assist rhythm production	Conducting	25
		Stamping feet	3
		Physically marking the pulsation without conducting	2
		Clapping a rhythm on the desk to understand it	1
		Visualizing conducting patterns	1
5. Building mental representations of sounds and relying on them ($n=47$)	This category includes every mention of mental representation, either musical content from the sight-singing exercise or outside sources. In other words, this includes every strategy where a mental comparison with sounds, or groups of sounds, was required	Mentally singing the whole melody	24
		Making a mental comparison with a pitch sang previously	12
		Keeping the tonic in mind	9
		Mentally singing some segments of the melody	7
		Mentally singing the scale	7
		Comparing with the preexisting mental representation of intervals	5
		Adding an octave to a pitch	5
		Associating an interval with a song	4
		Mentally singing chords and arpeggios	4
		Referring to a known melodic motive	4
		Visualizing the pitches on a keyboard	3
		Referring to the memory of the mental preparation of the exercise	2
		Mentally singing intervals in the melody	1
		Mentally singing the pitches	1
		Mentally singing the rhythm figures, then the pitches	1
		Playing the starting pitch multiple times	1
		Referring to a mental representation of the scale	1

(Continued)

Table 1. (Continued)

Category	Definition	Strategies	*n*
6. Using musical knowledge (*n* = 25)	Participants needed to rely on musical knowledge, including analysis and schema generation, or use strategies from this category. It is different from decoding, which students can do if they know how to identify basic musical parameters (pitch, length, alterations, intervals) even if they do not analyze the score on a deeper, tonal level	Identifying scale degrees	20
		Identifying chords	15
		Identifying structural units (chunks)	6
		Thinking of possible harmonization	3
		Mentally harmonizing the melody	2
		Sorting structural notes from ornamental notes	1
7. Relying on automatic skills (*n* = 30)	To use strategies from this category, no conscious reference to a model was needed. We excluded statements suggesting that participants used no strategy or did "whatever." We did not consider these two examples as strategies and, therefore, did not code them	Singing steps intuitively	12
		Singing an interval after identifying it	8
		Using intuition and reflexes	8
		Relying on intuition built from experience	7
		Relying on tonal reflexes	4
		Relying on absolute pitch references	3
		Singing a rhythm figure without having to decode it	2
		Relying on scale degrees	1

The most prevalent strategy was identifying the scale degrees in the melody, which means they associated pitches with their tonal roles (*n* = 20). Other students also identified chords (*n* = 15) or chunks (*n* = 6). Some strategies included in this category (e.g., "identifying scale degrees") are similar to strategies included in the second category, *decoding notation* (e.g., "identifying pitches"). However, they differ: "identifying pitches" means that subjects decoded notes names, while "identifying scale degrees" means assigning pitches to their function in a diatonic scale, which requires deeper theoretical musical knowledge.

The seventh category was to *rely on automatic skills* (*n* = 30). To identify strategies in the interviews, we excluded instances when participants reported not doing anything or doing "whatever" but included descriptions of moments when they did not think before singing. It suggests this category englobes automatic skills created with previous musical experience, like singing steps intuitively (*n* = 12) or, more generally, using intuition and reflexes (*n* = 8).

Categories of strategies predicting performance

Table 2 includes descriptive statistics as well as those correlations between strategies and sight-singing performance dimensions. Three categories of strategies correlated significantly with sight-singing performance. Using the body is positively correlated with rhythm score and combined score, whereas using musical knowledge and relying on automatic skills both correlated with rhythm, pitch, and combined scores.

Consequently, we entered these three categories of strategies in forward stepwise regression models whose goal was to know which types of strategy could predict sight-singing performance. Table 3 shows details on the models for each step. For rhythm score, the strongest

Table 2. Descriptive Statistics and Pearson's Correlations: Strategies and Sight-Singing Scores ($n = 56$).

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Managing attentional resources	1.38	0.49	–									
2. Decoding notation	1.86	0.35	0.00	–								
3. Anticipating upcoming content	1.45	0.50	−0.03	0.06	–							
4. Using the body	1.57	0.50	−0.07	0.06	−0.09	–						
5. Building mental representations	1.84	0.37	−0.06	−0.18	−0.19	−0.08	–					
6. Using musical knowledge	1.44	0.50	−0.03	−0.04	−0.1	0.27*	0.20	–				
7. Relying on automatic skills	1.54	0.50	−0.39**	0.13	0.19	0.21	−0.02	0.48***	–			
8. Rhythm score	18.88	4.42	−0.16	−0.13	0.11	0.26*	0.12	0.32*	0.41**	–		
9. Pitch score	14.39	7.16	−0.21	0.00	0.25	0.20	−0.02	0.41**	0.48***	0.40**	–	
10. Combined score	33.27	9.82	−0.23	−0.06	0.23	0.26*	0.04	0.44***	0.53***	0.74***	0.91***	–

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3. Categories of Strategies Predicting Sight-Singing Performance.

Variables	Partial correlations	Model 1			Model 2		
		B	*SE B*	β	*B*	*SE B*	β
Rhythm score							
Automatic skills	0.244	3.64	1.09	0.42***	3.31	1.10	0.38**
Body	0.182				1.65	1.11	0.19
R^2			.17			.21	
Adjusted R^2			.16			.18	
F			11.23**			6.84**	
Pitch score							
Automatic skills	0.234	6.76	1.70	0.48***	5.15	1.90	0.36**
Knowledge	0.261				3.41	1.91	0.24
R^2			.23			.27	
Adjusted R^2			.21			.24	
F			15.76***			9.80***	
Combined score							
Automatic skills	0.297	10.41	2.25	0.53***	8.12	2.49	0.42**
Knowledge	0.263				4.81	2.50	0.25
R^2			.29			.33	
Adjusted R^2			.27			.31	
F			21.47***			13.13***	

** $p < .01$. *** $p < .001$.

predictor was relying on automatic skills, followed using the body. This model predicted 18% of the variance in rhythm score. For pitch score, the strongest predictor was also relying on automatic skills, followed by using musical knowledge. This model predicted 24% of the variance in pitch score. Similarly, the combined score was also predicted more strongly by reliance on automatic skills, followed by the use of musical knowledge. This model explained 31% of the combined score variance.

We then checked whether participants who used strategies obtained better scores. Mean comparisons for all sight-sing scores, along with the Bayes factor, are shown in Table 4. We found that participants who used their bodies to execute the rhythm obtained significantly higher rhythm and combined scores. However, according to the Bayes factor interpretation scale proposed by Kass and Raftery (1995), the evidence against the null hypothesis was very weak. Using *t*-tests, we also found that students who reported using musical knowledge and relying on automatic skills obtained significantly higher rhythm, pitch, and combined scores. Bayes factor analysis revealed that the effects of using musical knowledge and relying on automatic skills on rhythm scores provided moderate and strong evidence against the null hypothesis, respectively. Concerning both pitch and combined scores, those effects provided strong and decisive evidence against the null hypothesis, respectively.

Discussion

This exploratory study aimed to list and classify the strategies used by postsecondary level music students ($n = 56$) while sight-singing to find whether the adoption of some types of strategies could predict sight-singing performance. This study is the first, to our knowledge, to identify

Table 4. Scores Comparisons in Relation to Strategy Use.

Strategy	No		Yes		$t(54)$	Cohen's d	Bayes factor
	M	*SD*	*M*	*SD*			
Rhythm score							
1. Managing attentional resources	19.43	4.62	17.95	4.01	1.22	0.34	0.51
2. Decoding notation	20.25	3.20	18.65	4.58	0.95	0.36	0.50
3. Anticipating upcoming content and potential difficulties	18.45	3.91	19.40	5.01	−0.80	0.21	0.35
4. Using the body to execute the rhythm	17.54	4.30	19.88	4.30	−2.01*	0.54	1.41
5. Building mental representations of sounds and relying on them	17.67	5.79	19.11	4.15	−0.89	0.33	0.46
6. Using musical knowledge	17.61	4.27	20.44	4.16	−2.49*	0.67	3.32
7. Relying on automatic skills	16.92	3.43	20.57	4.53	−3.35**	0.90	22.45
Pitch score							
1. Managing attentional resources	15.54	7.59	12.48	6.08	1.57	0.43	0.76
2. Decoding notation	14.38	6.41	14.40	7.34	−0.01	0.00	0.36
3. Anticipating upcoming content and potential difficulties	12.81	6.55	16.36	7.52	−1.89	0.51	1.17
4. Using the body to execute the rhythm	12.79	6.71	15.59	7.36	−1.46	0.40	0.66
5. Building mental representations of sounds and relying on them	14.67	7.47	14.34	7.18	0.12	0.05	0.35
6. Using musical knowledge	11.77	6.62	17.64	6.56	−3.31**	0.89	20.35
7. Relying on automatic skills	10.77	5.03	17.53	7.31	−3.97***	1.06	114.49
Combined score							
1. Managing attentional resources	34.97	10.12	30.43	8.81	1.70	0.47	0.91
2. Decoding notation	34.63	8.57	33.04	10.08	0.42	0.16	0.38
3. Anticipating upcoming content and potential difficulties	31.26	9.10	35.76	10.28	−1.74	0.47	0.94
4. Using the body to execute the rhythm	30.33	9.43	35.47	9.67	−1.99*	0.54	1.37
5. Building mental representations of sounds and relying on them	32.33	10.17	33.45	9.85	−0.31	0.11	0.36
6. Using musical knowledge	29.39	8.14	38.08	9.73	−3.64***	0.98	47.18
7. Relying on automatic skills	27.69	7.00	38.10	9.41	−4.63***	1.24	797.53

*$p < .05$. **$p < .01$. ***$p < .001$.

strategies from an in situ sight-singing task. From the interviews, we listed 82 strategies and classified them into seven categories: (1) managing attentional resources, (2) decoding notation, (3) anticipating upcoming content and potential difficulties, (4) using the body to execute the rhythm, (5) building mental representations of sounds and relying on them, (6) using musical knowledge, and (7) relying on automatic skills.

Our classification of strategies seems to encompass a wide array of actions students can take to help them sight-sing and reflect on what they really did while performing because of cued retrospective interviews. For that reason, it is an interesting complement to the classification suggested by Fournier et al. (2019), who classified strategies from textbooks, papers, and interviews with students and teachers, but without referring to a specific sight-singing task. Even using a different method, our study found similar strategies. For example, Fournier et al. also listed relating to scale degrees, relating to intervals, and making comparisons with a note sung previously. The main novelty brought by our study is that we identified these strategies in a different context. It brings the focus around sight-singing, whereas Fournier et al. notably also focused on rehearsal and self-regulation during learning. Consequently, we found new strategies revealing what is going on during the sing-singing process, particularly regarding attentional resources management, like prioritizing pitches over rhythm, and mistakes and difficulties management, like slowing down to prepare for a challenging segment. Finally, both studies make important contributions to sight-singing pedagogy research and suggest that students can draw from a vast mental toolbox of strategies.

Our second research question was about strategic predictors of performance. We found that relying on automatic skills was the main predictor of performance for rhythm, pitch, and combined scores. This result aligns well with research regarding cognitive load. Cognitive load is the quantity of mental resources needed for a task (Baldwin, 2012). Some tasks require fewer resources because they are partially or totally automated, requiring less cognitive control (Wickens & Hollands, 1999). Consequently, fewer automatic skills lead to a higher cognitive load (Brünken et al., 2010). As mentioned above, participants who can rely on automatic skills probably had many opportunities to strengthen their musical knowledge and repeat patterns commonly found in melodies, including sight-singing exercises. This is probably more common among students who began learning music early (Pomerleau-Turcotte et al., 2021). Automatic skills could have made the task easier because these participants could view the sight-singing exercise as a series of manageable chunks rather than 24 notes to be processed individually, which could have led to better scores. Participant 27 provides an example of how their experience led to automatic skills: "This is intuition, automatisms . . . I'm used to [. . .] read stuff like this. I know how an octave sounds like, how a third does too." In future studies, interviews could include questions to understand more precisely how automatic skills assist participants' sight-singing. For example, it could allow researchers to learn which musical elements on a score trigger automatic skills and how it relates to sight-singing results.

The best model predicting rhythm score also included strategies using body movements, such as conducting gestures. Furthermore, *t*-tests and Bayes factor analyses confirmed that, on average, participants who used strategies from this category obtained slightly better rhythm and combined scores. This result is consistent with Sepp et al. (2019), who suggested that movements could alleviate cognitive load, and with pedagogical recommendations formulated by Karpinski (2000). This conclusion also aligns with the embodiment thesis described by Foglia and Wilson (2013) because "the body intrinsically constraints, regulates, and shapes the nature of mental activity" (p. 319). From this standpoint, conducting gestures could assist rhythm execution in helping cognitive processing of this musical element. Embodied learning is also at the core of methods like Dalcroze, in which body movements assist music learning (e.g., Juntunen, 2020).

However, some questions remain about that strategy. For example, some subjects suggested that conducting was helpful because it freed some mental space, meaning it was automated and stocked in their procedural memory. Participant 28 said: ". . . because of conducting gestures, I don't really need to think about rhythm." On the other hand, a few participants, like Participant 7, reported a different experience: "Well, I used [conducting gestures], but I think I abandoned it quickly. It's the first thing that I let go of." If conducting is only applicable when automated, it would have implications on our classification of strategies. It would also suggest that conducting is a motor automatic skill rather than a strategy related to how music is embodied. Therefore, it would be relevant to compare the efficiency of various strategies based on movements, such as comparing clapping, stamping feet, and conducting, as they imply different cognitive processes despite their resemblances. Most participants who applied rhythmic strategies based on movement used conventional conducting gestures ($n=25$), while other approaches were less common (e.g., stamping feet was mentioned by three participants). This probably reflects pedagogical approaches used in our participants' aural skills classes. To compare these strategies, future studies could impose on participants specific ways to keep the pulse or conduct a study where different approaches are taught.

The best models to predict pitch and combined scores included strategies based on preexistent musical knowledge. This result suggests that understanding melodies requires more theoretical notions than understanding rhythm, which makes sense for different reasons. First, rhythmic difficulties in our sight-singing tasks and, more generally, in sight-singing exercises used in music higher education are usually less present than melodic difficulties. Second, understanding rhythmic figures is often more straightforward than reading and singing pitches, which requires students to view each note as related to the notes they sang before and to the tonal context of the exercise. It is probably why most strategies we listed were linked to pitch rather than rhythm in almost all categories, including the use of musical knowledge. This result is also consistent with findings from Nikolić and Kodela (2020), who found that results from a harmonic perception test correlated with sight-singing results. The authors also discovered that students who engaged in musical analysis also had greater success in sight-singing. These results could mean that a sufficient level of harmonic knowledge would be necessary to sight-sing accurately. For example, harmonic knowledge could be helpful to identify chords, anticipate possible patterns, and chunk portions of melodies, leading to more efficient processing and memorization.

Limitations

Although this study identified many strategies, we do not know precisely how participants used the strategies they mentioned. Future studies should include more follow-up questions to better understand what students wanted to say. Moreover, participants' strategies were self-reported, which is a limitation in itself because students can declare strategies they did not use, as Jiménez-Taracido and Manzanal-Martínez (2017) discovered. This reality inherent to the interview process highlights that having a clear portrait of strategic thinking is challenging and that even robust studies will only open windows on the complexity of participants' thought processes.

Because we wanted our participants to feel comfortable, we did not impose a limitation on the preparation phase, and because we wanted the task to look like a typical aural skills examination, we did not decide on a tempo. Consequently, participants differ a lot in the way they sight-sang: some of them took a lot of time to rehearse mentally, while other jumped right in; and some of them sang very slowly, while others chose a more challenging tempo. Therefore, although our study permitted us to identify many strategies, the conditions in which they were used vary greatly. Future studies could replicate our design with more homogeneity, which would allow comparisons between participants.

Another caveat of this study is that the sight-singing task we chose was probably too complex for some students with less experience with aural skills. This situation might have led to cognitive overload and made it difficult for them to choose and use appropriate strategies, or even to be aware of their strategies and report them in the interviews. In these cases, the information gathered from the interviews might not accurately represent their usual strategy adoption. A solution for future studies would be to use more than one sight-singing exercise with different levels of difficulty. That way, one would still avoid a ceiling effect in including a difficult exercise, but less experienced participants could share more strategies in easier melodies. Furthermore, it would make conclusions more generalizable.

Pedagogical recommendations

Although we cannot infer any causal relationship from this study, using musical knowledge appears to be an effective strategy and seems required to build strong automatic skills. Therefore, aural skills instructors should foster musical knowledge, like reading abilities, as suggested by Fournier (2020), and reinforce the relationship between sounds and symbols (Buonviri, 2017). Helping students develop automatic skills is probably also worth recommending but requires allocating time for multiple repetitions of similar exercises and patterns. Even if our results suggest that some strategies could be more effective than others, we cannot conclude that other strategies are harmful. Furthermore, we could view the use of automatic skills as a byproduct of other categories of strategies. This means that although decoding without using knowledge or being able to rely on automatic skills might not be optimal, this is probably a necessary step toward musicianship. Students can combine many strategies when sight-singing, and while more efficient strategies could compensate for less efficient ones, it does not mean that students should avoid specific strategies.

Moreover, mentioning strategies to learners is probably not enough. Instructors should probably teach them explicitly (Hattie, 2008), so students can choose the best ones for each situation and use them correctly. Teachers should also be aware that some students might lack the knowledge and expertise to use some strategies (e.g., identifying chords, relying on scale degrees) and plan their lessons, so that, students have enough time to develop skills. Finally, future studies could also inform us on the best ways to teach strategies in ways that learners can master them and choose them in accordance with musical contexts.

Conclusion

This study aimed to identify the strategies students use while sight-singing and at knowing whether some strategies are predictive of sight-singing performance. This study was the first, to our knowledge, to reach these goals using participants' results to an in situ sight-singing task. We found that students can use various strategies to sight-sing and that relying on automatic skills is the strongest predictor of performance. This study has implications for aural skills instructors, who might want to solidify their students' musical knowledge and help them foster automatic skills through repetition, so they can draw from a wider array of strategies when sight-singing.

Authors' note

This article describes a study embedded in a larger exploratory research project about factors explaining sight-singing results among postsecondary students.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: For this research, first author obtained a Joseph-Armand Bombardier Graduate Scholarship from the Social Sciences and Humanities Research Council and funding from Fonds de recherche du Québec – Société et culture.

ORCID iD

Justine Pomerleau-Turcotte https://orcid.org/0000-0002-5999-5327

Notes

1. Despite potential regional and pedagogical variations in the use of these terms, in this paper, "sight-singing" designates an exercise which requires singing a melody that was not encountered previously (e.g., Karpinski, 2000), while "solfege" describes a specific way to sing, using "solfege syllable." Solfege syllables are used in the *movable-do* system. *Do* refers to the tonic (first degree), *Re* to the subtonic (second degree), and so on. Some people prefer to use numbers. In both cases, musicians hear the notes' functions rather than absolute pitch height or distances between pitches.
2. The eye–hand span is "the amount of material, measured in number of notes, that can be correctly played following the note on which the text was made invisible" (Sloboda, 1974, p. 5) or the length of time a musician can read ahead (Furneaux & Land, 1999).
3. Curwen signs are hand signs associated with pitch functions.
4. The interviews were in French. The examples were translated by the authors.

References

Aiba, E., & Matsui, T. (2016). Music memory following short-term practice and its relationship with the sight-reading abilities of professional pianists. *Frontiers in Psychology*, *7*, Article 645. https://doi.org/10.3389/fpsyg.2016.00645

Baddeley, A. D. (2007). *Working memory, thought, and action*. Oxford University Press.

Baddeley, A. D., & Hitch, G. (1974). Working memory. In G. H. Bower (Ed.), *Psychology of learning and motivation* (*Vol. 8*, pp. 47–89). Academic Press. https://doi.org/10.1016/S0079-7421(08)60452-1

Baldwin, C. L. (2012). *Auditory cognition and human performance: Research and applications*. CRC Press.

Beckett, C. A. (1997). Directing student attention during two-part dictation. *Journal of Research in Music Education*, *45*(4), 613–625. https://doi.org/10.2307/3345426

Bégin, C. (2008). Les stratégies d'apprentissage: Un cadre de référence simplifié. *Revue des sciences de l'éducation*, *34*(1), 47–67. https://doi.org/10.7202/018989ar

Bender, L., Renkl, A., & Eitel, A. (2021). When and how seductive details harm learning. A study using cued retrospective reporting. *Applied Cognitive Psychology*, *35*(4), 948–959. https://doi.org/10.1002/acp.3822

Bogunović, B., & Vujović, I. (2012). Metacognitive strategies in learning sight-singing. *Psihološka Istraživanja*, *15*(2), 115–133.

Bogunović, B., Vujović, I., & Protulipac, A. (2020). *Sight-reading strategies in singing and playing* [Proceedings]. PAM—IE Belgrade 2019. Psychology and Music—Interdisciplinary Encounters, Belgrade, Serbia, 24–26 October 2019.

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, *11*(4), 589–597. https://doi.org/10.1080/2159676X.2019.1628806

Brünken, R., Seufert, T., & Paas, F. (2010). Measuring cognitive load. In J. L. Plass, R. Moreno & R. Brünken (Eds.), *Cognitive load theory* (pp. 181–202). Cambridge University Press.

Buonviri, N. O. (2014). An exploration of undergraduate music majors' melodic dictation strategies. *Update: Applications of Research in Music Education, 33*(1), 21–30. https://doi.org/10.1177/8755123314521036

Buonviri, N. O. (2017). Successful AP music theory instruction: A case study. *Update: Applications of Research in Music Education, 36*, 53–61. https://doi.org/10.1177/8755123317724326

Cégep de Sainte-Foy. (2020). *Guide préparatoire à l'audition: 2021–2022* [Preparatory guide to the audition: 2021–2022] [Brochure].https://www.csfoy.ca/fileadmin/documents/Programmes/doc_preuniversitaires/Guide2021-2022_DepMus_23_oct2020.pdf.

Cleland, K. D., & Dobrea-Grindahl, M. (2010). *Developing aural skills: A holistic approach to sight singing and ear training*. Routledge.

College Music Society. (2020). *Directory of music faculties in colleges and universities, U. S. and Canada*.

Cruz de Menezes, R. (2021). *University music students' use of cognitive strategies in transcribing figured bass dictation and the possible influence of memory span on their performance* [Doctoral thesis, Université Laval]. https://corpus.ulaval.ca/jspui/handle/20.500.11794/69239

Després, J.-P., Burnard, P., Dubé, F., & Stévance, S. (2017). Expert western classical music improvisers' strategies. *Journal of Research in Music Education, 65*(2), 139–162. https://doi.org/10.1177/0022429417710777

École préparatoire de musique de l'Université Laval. (1999). *Solfèges mélodiques 10e degré* [Melodic Solfege Exercices, Grade 10].

Floyd, E. G., & Haning, M. A. (2015). Sight-singing pedagogy: A content analysis of choral methods textbooks. *Journal of Music Teacher Education, 25*(1), 11–22. https://doi.org/10.1177/1057083714539767

Foglia, L., & Wilson, R. A. (2013). Embodied cognition. *WIREs Cognitive Science, 4*(3), 319–325. https://doi.org/10.1002/wcs.1226

Fournier, G. (2015). *Recension, description et catégorisation des stratégies cognitives liées à la lecture à vue chantée et à l'apprentissage du solfège chez les étudiants en musique de niveau collégial* [Master dissertation, Université Laval]. CorpusUL. https://corpus.ulaval.ca/jspui/handle/20.500.11794/26527

Fournier, G. (2020). *L'apport des stratégies dans l'apprentissage du solfège chez les étudiants en musique de niveau collégial* [Doctoral dissertation, Université Laval]. CorpusUL. https://corpus.ulaval.ca/jspui/handle/20.500.11794/39089

Fournier, G., Moreno Sala, M. T., Dubé, F., & O'Neill, S. (2019). Cognitive strategies in sight-singing: The development of an inventory for aural skills pedagogy. *Psychology of Music, 47*(2), 270–283. https://doi.org/10.1177/0305735617745149

Furneaux, S., & Land, M. F. (1999). The effects of skill on the eye–hand span during musical sight–reading. *Proceedings of the Royal Society of London: Biological Sciences, 266*(1436), 2435–2440. https://doi.org/10.1098/rspb.1999.0943

George, C. (2011). Stratégie. In H. Bloch, R. Chermama, É. Dépret, A. Gallo, P. Leconte, J.-F. Le Ny, J. Postel, & M. Reuchlin (Eds.), *Grand dictionnaire de la psychologie* [Great Dictionary of Psychology] (3rd ed., pp. 896–897). Larousse.

Greussing, E., Kessler, S. H., & Boomgaarden, H. G. (2020). Learning from science news via interactive and animated data visualizations: An investigation combining eye tracking, online survey, and cued retrospective reporting. *Science Communication, 42*(6), 803–828. https://doi.org/10.1177/1075547020962100

Groulx, T. J. (2016). Perceptions of course value and issues of specialization in undergraduate music teacher education curricula. *Journal of Music Teacher Education, 25*(2), 13–24.

Gutierrez, J. A. W. (2018). Students evaluate music theory courses: A Reddit community survey. College Music Symposium, *58*(2), 1–27.

Hattie, J. (2008). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement* (1st ed.). Corwin.

Hebbali, A. (2020). *olsrr: Tools for building OLS regression models* (0.5.3) [R package]. https://CRAN.R-project.org/package=olsrr

Henry, M. L. (2011). The effect of pitch and rhythm difficulty on vocal sight-reading performance. *Journal of Research in Music Education*, *59*(1), 72–84. https://doi.org/10.1177/0022429410397199

Hoppe, K. M. (1991). *The melodic dictation strategies of musicians, and common pitch and rhythm errors* (Publication No. 9128254) [Doctoral dissertation]. ProQuest Dissertation Publishing.

Jiménez-Taracido, L., & Manzanal-Martínez, A. I. (2017). ¿Aplican los alumnos las estrategias de aprendizaje que afirman aplicar? Control de la comprensión en textos expositivos. *Educational Psychology*, *24*(1), 7–13. https://doi.org/10.5093/psed2018a2

Juntunen, M.-L. (2020). Ways to enhance embodied learning in Dalcroze-inspired music education. *International Journal of Music in Early Childhood*, *15*(1), 39–59. https://doi.org/10.1386/ijmec_00011_1

Karpinski, G. S. (2000). *Aural skills acquisition: The development of listening, reading, and performing skills in college-level musicians*. Oxford University Press.

Karpinski, G. S. (2006). *Manual for ear training and sight singing*. W. W. Norton.

Kass, R. E., & Raftery, A. E. (1995). Bayes factors. *Journal of the American Statistical Association*, *90*(430), 773–795. https://doi.org/10.1080/01621459.1995.10476572

Killian, J. N., & Henry, M. L. (2005). A comparison of successful and unsuccessful strategies in individual sight-singing preparation and performance. *Journal of Research in Music Education*, *53*(1), 51–65. https://doi.org/10.2307/3345606

Kim, Y. J., Song, M. K., & Atkins, R. (2020). What is your thought process during sight-reading? Advanced sight-readers' strategies across different tonal environments. *Psychology of Music*, *49*, 1303–1320. https://doi.org/10.1177/0305735620942596

Krippendorff, K. (2013). *Content analysis: An introduction to its methodology* (3rd ed.). SAGE.

Laforest, J., Bouchard, L. M., & Maurice, P. (2009). *Guide d'organisation d'entretiens semi-dirigés avec des informateurs clés: Trousse diagnostique de sécurité à l'intention des collectivités locales—2e édition* [Guide to Semi-Structured Interviews With Key Informants: Safety Diagnostic Toolbox to Local Collectivities – 2nd edition]. Institut national de santé publique Québec [Public health expertise and reference centre] with the collaboration of Ministère de la sécurité publique [Ministry of Public Safety].

Lehmann, A. C., & McArthur, V. (2002). Sight-reading. In R. Parncutt & G. McPherson (Eds.), *The science and psychology of music performance* (pp. 135–149). Oxford University Press.

Lim, Y., Park, J. M., Rhyu, S.-Y., Chung, C. K., Kim, Y., & Yi, S. W. (2019). Eye-hand span is not an indicator of but a strategy for proficient sight-reading in piano performance. *Scientific Reports*, *9*, Article 17906. https://doi.org/10.1038/s41598-019-54364-y

Lovorn, T. (2016). The effect of writing solfège syllables into choral repertoire on the sight-reading ability of high school choir students. *Texas Music Education Research*, *15*(24).

Mennen, J., & van der Klink, M. (2017). Is the first-year predictive for study success in subsequent years? Findings from an academy of music. *Music Education Research*, *19*(3), 339–351. https://doi.org/10.1080/14613808.2016.1189524

Mishra, J. (2014). Improving sightreading accuracy: A meta-analysis. *Psychology of Music*, *42*(2), 131–156. https://doi.org/10.1177/0305735612463770

Morey, R. D., & Rouder, J. N. (2018). *BayesFactor: Computation of Bayes factor for common designs* (0.9.12-4.2) [R package]. https://CRAN.R-project.org/package=BayesFactor

Muntinga, T., & Taylor, G. (2018). Information-seeking strategies in medicine queries: A clinical eye-tracking study with gaze-cued retrospective think-aloud protocol. *International Journal of Human–Computer Interaction*, *34*(6), 506–518. https://doi.org/10.1080/10447318.2017.1368949

Navarro, D. J. (2015). *Learning statistics with R: A tutorial for psychology students and other beginners* (0.5) [R package].

Neto, P. A. S. O., & de Oliveira, G. A. D. (2019). Differences between scale steps and absolute interval sizes: A new test for intervallic awareness. *Psychology of Music*, *49*, 413–425. https://doi.org/10.1177/0305735619869456

Nikolić, I., & Kodela, S. (2020). Integral aspects of harmonic hearing in the process of sight-singing. *Facta Universitatis, Series: Visual Arts and Music*, *6*(1), 049–060. https://doi.org/10.22190/10.22190/FUVAM2001049N

Norgaard, M. (2011). Descriptions of improvisational thinking by artist-level jazz musicians. *Journal of Research in Music Education*, *59*(2), 109–127. https://doi.org/10.1177/0022429411405669

Paillé, P., & Mucchielli, A. (2016). *L'analyse qualitative en sciences humaines et sociales* (4th ed.). Armand Colin.

Penttinen, M., Anto, E., & Mikkilä-Erdmann, M. (2013). Conceptual change, text comprehension and eye movements during reading. *Research in Science Education*, *43*(4), 1407–1434. https://doi.org/10.1007/s11165-012-9313-2

Penttinen, M., Huovinen, E., & Ylitalo, A.-K. (2015). Reading ahead: Adult music students' eye movements in temporally controlled performances of a children's song. *International Journal of Music Education*, *33*(1), 36–50. https://doi.org/10.1177/0255761413515813

Petty, C., & Henry, M. L. (2014). The effects of technology on the sight-reading achievement of beginning choir students. *Texas Music Education Research*, *23*, 23–28.

Pike, P. D., & Carter, R. (2010). Employing cognitive chunking techniques to enhance sight-reading performance of undergraduate group-piano students. *International Journal of Music Education*, *28*(3), 231–246. https://doi.org/10.1177/0255761410373886

Pomerleau-Turcotte, J., Moreno Sala, M. T., Dubé, F., & Vachon, F. (2021). Experiential and cognitive predictors of sight-singing performance in music higher education. *Journal of Research in Music Education*. Advance online publication. https://doi.org/10.1177/00224294211049425

Potter, G. (1990). Identifying successful dictation strategies. *Journal of Music Theory Pedagogy*, *4*(1), 63–71.

Pouw, W. T. J. L., de Nooijer, J. A., van Gog, T., Zwaan, R. A., & Paas, F. (2014). Toward a more embedded/extended perspective on the cognitive function of gestures. *Frontiers in Psychology*, *5*, Article 359. https://doi.org/10.3389/fpsyg.2014.00359

QSR International. (2019). *NVivo 12* (12.6.0) [Computer software].

R Core Team. (2019). *R: A language and environment for statistical computing*. https://www.R-project.org/

Reifinger, J. L. (2012). The acquisition of sight-singing skills in second-grade general music: Effects of using solfège and of relating tonal patterns to songs. *Journal of Research in Music Education*, *60*(1), 26–42. https://doi.org/10.1177/0022429411435683

Rogers, M. (2013). Aural dictation affects high achievement in sight singing, performance and composition skills. *Australian Journal of Music Education*, *1*, 34–52.

Sepp, S., Howard, S. J., Tindall-Ford, S., Agostinho, S., & Paas, F. (2019). Cognitive load theory and human movement: Towards an integrated model of working memory. *Educational Psychology Review*, *31*(2), 293–317. https://doi.org/10.1007/s10648-019-09461-9

Sloboda, J. A. (1974). The eye-hand span: An approach to the study of sight reading. *Psychology of Music*, *2*(2), 4–10. https://doi.org/10.1177/030573567422001

Stambaugh, L. A., & Nichols, B. E. (2020). The relationships among interval identification, pitch error detection, and stimulus timbre by preservice teachers. *Journal of Research in Music Education*, *67*(4), 465–480. https://doi.org/10.1177/0022429419885931

van Gog, T., Paas, F., van Merriënboer, J. J. G., & Witte, P. (2006). Uncovering the problem-solving process: Cued retrospective reporting versus concurrent and retrospective reporting. *Journal of Experimental Psychology: Applied*, *11*(4), 237–244. https://doi.org/10.1037/1076-898X.11.4.237

Wickens, C. D., & Hollands, J. G. (1999). *Engineering psychology and human performance* (3rd ed.). Prentice-Hall.