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PITCH PROCESSING AND PHONOLOGICAL AWARENESS

Jonathan Bolduc
Université Laval
Isabelle Montésinos-Gelet
Université de Montréal

The purpose of this research was to observe performance in the processing of pitch in relation to phonological awareness performance in kindergarten students. Thirteen students (N = seven girls, six boys), registered into the preschool program of the Québec school, made up the sample pilot study (average age = five years and six months). The tonal test from the *Primary Measures of Music Audiation* (PMMA, Gordon, 1979) was used to measure the performance in pitch processing. Phonological awareness skills were measured with the help of *l'Épreuve de métaphonologie* by Armand and Montésinos-Gelet (2001). In this research, the rhythm test (PMMA, Gordon, 1979) was also used as a control task. The results show a significant link between pitch awareness and phonological awareness performance. They also show that there is no relation between rhythm perception and phonological awareness skills.

In the past few years, many researchers have presented studies showing the benefits of music at the cognitive, kinesthetic and socioemotional levels (Atterbury, 1985; Costa-Giomi, 1999; Lamb & Gregory, 1993; Probst, 1985; Rauscher & Zupan, 2000). Despite this growing interest, few specialists have attempted to establish a link between performance in the processing of pitch and academic success, notably in the development of reading strategies. In contribution to this field, the present pilot study examines if the performance in the processing of pitch is related to phonological awareness performance at the kindergarten level. In this way, the results may be useful to other researchers in structuring their theories and designs.

It is a well-known fact that a child's sensorial experiences begins while still in the womb. Some studies in fetal perception reveal that during pregnancy, the child is already reacting to words and songs that are familiar (Lafuente, Grifol, Segarra, Soriano, Goba, & Montésinos, 1997). Trehub (2001) has even demonstrated that an eight-month child is capable of making the distinction between consonant and dissonant (quarter tone) melodic sound sequences.

Between the ages of one and five, children seem to develop a musical syntax that allows them to more or less classify musical sounds according to pitch. They also tend to associate sound pitch to certain types of voices, certain objects, or particular circumstances. This suggests that pitch awareness is an innate skill that allows frequency differentiation between two sounds having the same duration, intensity and even the same tone (Vignal, 1990).

According to Gordon (1971, 1979), children of about five or six years of age should be able to represent mentally musical units, to compare various sound sequences and judge if they are similar or different. This phenomenon

might also be linked to language acquisition. At the linguistic level, children adopt a positional spatial relation and express considerable interest in the order of words and in the position of the language units (Vion, 1978).

Several researchers (Ehri, 1980, 1992; Ehri and Wilce, 1987a; Reitsma, 1983) have demonstrated that phonological awareness could have a positive influence on the learning of oral and written language as early as preschool age. Phonological awareness would allow the child to establish distance in relation to language as a means of communication, to recognize speech as a sequence of discrete units of various sizes, and to perform certain operations with these units (Casalis and Lecocq, 1992).

The manipulation and analysis of a word's sound units therefore would have a positive influence on writing skills. According to some specialists (Ehri, 1992; Rack, Hulme, Snowling & Wightman, 1994; Reitsma, 1983) phonological awareness exercises would allow the preservation of a mnemonic trace of phonemes and graphemes. In addition to developing phonological memory, these exercises would allow the observation of the place letters occupy in a word. Then it would be easier for the child to associate them with specific situations.

In the same line of thought, Share, Jorm, MacClean and Matthews (1984) have concluded that phonological awareness exercises are the preferred methods for developing reading skills of kindergarten and first grade students. After having used diverse didactic methods, these authors have shown that students introduced to phonological awareness develop more efficient strategies and thus accelerate the acquisition and memorisation of new words. Phonological awareness therefore would be an essential tool for learning the written word.

To the present time, research establishing a link between performance in the processing of pitch and phonological awareness has been rare. In fact, only one study is very similar to the purpose of the present research. This study was conducted by Lamb and Gregory (1993) and involved five-year-old children. The authors suggested that a significant correlation might exist between prereading skills and the ability to discern pitch awareness. According to the authors, tests assessing performance in the processing of pitch might help establish a direct link with phonological awareness skills. They felt that tests of musical timbre and rhythm would have no influence at this level.

Although little research has been done in this field, nevertheless it can be noted that a few correlative and experimental studies have tried to establish links between reading/writing skills and musical education in young students without necessarily taking into account their performance in the processing of pitch awareness.

On the same subject, Barwick, Valentine, West and Wilding (1989) have noticed that English-speaking children between the ages of 7 and 11 who obtained the best results in the Bentley (1966) musical skills test on tonal memory and chord analysis also had better reading skills (spoken reading

test). The authors discovered a significant correlation between the study of music and reading skills.

Atterbury (1985) also has compared musical talent in 7 to 9-year-old children and their level of reading skills. The author established that bad readers had defective tonal memory and rhythm production without, however, experiencing difficulties with rhythm perception. On the same subject, Doehring and Rabinovitch (1969) demonstrated that children with learning disabilities in regard to reading also performed badly in sound discrimination tests (pitch awareness) compared to students with no obvious reading problems.

Apart from these correlative studies, a few experimental studies also have shown that music can help develop reading skills and competence in preschool and elementary age children. In the same line, McMahon (1979) trained young children to recognize music chord pairs with three sounds where the second chord was reduced or raised by a half-tone. The results of this research clearly show that young subjects who learned to differentiate chords had less difficulty and were more comfortable with sequential phonological skills, reading, and word recognition tasks.

In a different context, Colwell (1994) also studied the effect of a musical education in whole language kindergartens. Her study demonstrated that music can facilitate the retention of academic material, allow the development of reading skills, and therefore increase student academic performance. Other studies argue in the same direction. According to Cutietta (1995, 1996), the study of music helps children to read and improves their basic reading skills, considerably increasing their language development.

More recently, Standley and Hughes (1997) conducted an experimental study in Florida with pre-kindergarten children. According to the authors, music develops skills related to prereading and prewriting. In classes where a special music curriculum was integrated into the program, young children seemed to perform better when given reading and writing tasks.

The present pilot study proposes to investigate whether a correlation exists between the performance of pitch and phonological awareness skills. In this respect, it is conceivable that kindergarten students with above average results in task of pitch performance also would perform better in phonological awareness tasks than the remaining students. Should this prove to be true, it would then be obvious, taking into account the wealth of research that has established a link between phonological skills and reading skills (Lecocq, 1991), to reconsider the place of a music education and its positive role on one of the major factors in learning to write.

Method

Sample

This pilot study involved a sample of 13 students (seven girls, six boys) registered in the preschool program of Saint-Michel School (Trois-Lacs School Board). At the time of the experiment (February 2002), the average age of the students was five years and six months. These students were taking part in a

musical awakening program (30 minutes every two weeks alternating with an art program) provided by the art education specialist of the school. Two students were registered in an extracurricular musical awakening program (30 minutes each week). The other subjects received no other formal music education outside school. It should also be specified that none of the subjects' parents were professional musicians.

The study's subjects had participated in very few phonological awareness activities in the schoolroom. Although they were introduced to the identification of syllables and assorted phonemes, the teacher had planned to concentrate more on phonological awareness skills in the last months of the school year (April and May 2002). It is important to mention that these students lived in the same demographic area and were of similar socioeconomic levels (i.e., middle class).

Tests and Procedure

Two tests were used for the present research. The pitch processing task (tonal test) and the control task (rhythm test) are from the *Primary Measures of Music Audiation Test* (PMMA, Gordon, 1979), specially adapted to French. The phonological awareness skills were assessed with the help of *l'Épreuve de métaphonologie* (Armand and Montésinos-Gelet, 2001).[1]

Pitch awareness. The performance in the processing of pitch was assessed with the help of the first part of the PMMA test (Gordon, 1979). This task, identified as a tonal test, consists of comparing two sound sequences (varying between two and five sounds) and judging if they are the same or different. In all, 44 excerpts, including the four practice items, are included in this test. The child does not need to know music, be able to read, or be familiar with numbers to take the test. On the answer sheet, each sound excerpt heard is represented by a picture under which there are two sets of faces: two smiling faces (first set), one smiling face and one sad face (second set). For example, after having heard the word "apple," if the two sound sequences heard are identical the subject must circle the two identical faces under the "apple;" if the sequences are not the same, the student must circle the set of faces that are different. Only the tonal test of the PMMA (Gordon, 1979) was used to measure pitch awareness processing.

Control Task (rhythm test). Several specialists (Colwell, 1969; Wing, 1961) have claimed that rhythm tasks fall within a cognitive process different from pitch processing. Therefore the rhythm test from PMMA (Gordon, 1979) was selected as the control task. This task is organized with the same guidelines as the tonal test, previously explained. On the answer sheet, each rhythm excerpt is represented by a picture under which are two sets of faces. After listening to the two rhythm sequences representing the picture, the subject must circle the two identical faces if the rhythmic sequences are identical; if the rhythmic sequences are different, the subject must circle the set of faces that are different. The task is also recorded on an audio tape and includes 42 excerpts, including the two practice examples.

Phonological Awareness Skills. Phonological awareness skills were assessed with *l'Épreuve de métaphonologie* by Armand and Montésinos-Gelet (2001). Six tasks were created to assess phonological awareness skills in preschool students. A computer was used to administer each task. Computer processing of data allowed for a faster tallying of the number of right and wrong answers for each of the items included in the six tasks. Before starting the phonological awareness tasks, the subject takes part in a few sound and visual control exercises to allow an exploration of the program and an explanation of the procedures. Then the six tests were administered. Each test consisted of five items, including one practice item to make certain the student understood the task. All six tasks were built on the same principle: The computer displays three pictures framed by different colors (red/yellow/blue) at the top half of the screen and specifies what they represent. A picture then appears on the lower half of the screen and its meaning also is given.

For the *Non Sequential Syllable Identification* task, the subject had to find which word among the three pictures at the top had one syllable that was the same as the one in the lower part of the screen. As soon as the answer was found, the student pressed on the keyboard key representing the same colour as the upper picture. The computer then processed the answer. An example is illustrated in Figure 1.

Non Sequential Syllable Identification task.

Chat (Cat) — **Coc**cinelle (Ladybird) — Poule (Hen)

Coq (Rooster)

Figure 1. Example of the phonological awareness test (Armand & Montésinos-Gelet, 2001).

For the *Initial Sequential Syllable Identification* task, the subject had to find which of the three upper pictures started with the same syllable as the picture below, and in the *Rhyme Identification* task the student had to find which of the three upper pictures had the same ending as the picture below. The *Initial Phoneme Identification* task required the subject to find which upper picture started with the same sound (phoneme) as the one at the bottom.

The *Categorization of the Initial Phoneme* task was different from the first four. The student observed only three pictures and had to determine which of the three pictures had a different beginning. The answer was given by pressing the colored keyboard key that matched the picture.

The *Initial Phoneme Suppression* task required the subject to suppress the first phoneme of the bottom picture in order to find the new word among the three upper pictures. When the answer was found, the student pressed on the keyboard key that represented the same color as the upper picture. An example is shown in Figure 2.

Initial Phoneme Supression task.

Rat (Rat) Âne (Donckey) Balle (Ball)

Bras (Arm)

Figure 2. Example of the phonological awareness test (Armand & Montésinos-Gelet, 2001).

General Procedure

Data gathering was completed over a two-day period. The experiment occurred during the usual class schedule and the subjects met on three occasions during a two-week interval. The pitch processing tasks and the control tasks were administered on the first day of the experiment while the phonological processing test was administered on the second day. The tests were given in two rooms near the classroom.

Pitch Awareness. For the two tasks of the PMMA (Gordon, 1979), the 13 subjects participating in this pilot study were divided into four homogeneous subgroups and met early in the day. For this occasion, two administrators who are music specialists were chosen to give the test. Subgroup one (administrator one) and subgroup two (administrator two) first met for processing pitches. In each testing room, the test administrator placed subjects so that it was impossible for them to copy a neighbor's answer. After having explained the rules and making certain each student understood the process through practical examples, the administrators distributed the necessary materials (paper, pencils) to each subject. The tape player was located in the center of the room to ensure that everyone clearly heard the music excerpts. The administrator then asked everyone to be quiet and to raise a hand if they had questions. Subjects who could not provide an answer for a sequence were encouraged by the administrator to continue the test, thus ensuring a constant presence during the experiment. After the tonal test, subgroups one and two returned to their classroom to resume the various activities of that day's schedule. At that time, subgroup three (administrator one) and subgroup four (administrator two) met to begin the same task. The experimental process was identical to the one described for subgroups one and two.

Control Task (rhythm test). The control task was performed using the same principle as the performance of pitch processing task. In the course of the same morning, the administrators met with the same four subgroups to evaluate their rhythmic aptitudes. To prevent bias during this pilot study, it was suggested that the groups be interchanged (i.e., subgroups one and three were met by administrator two and subgroups two and four by administrator one). The entire Gordon's PMMA test (1979), including the explanations and practical examples, lasted about 20 minutes.

The Phonological Awareness Test. The administration of the Armand and Montésinos-Gelet's (2001) phonological awareness test was scheduled for exactly one week after the processing of pitch awareness, and control tasks were given. The students met individually with the researchers during class. The order of subjects was determined randomly by the administrator of the test. Each child met in a room near the classroom. Immediately after entering the room, the student was given the tools needed for the work ahead. The administrator provided assistance throughout the visual and sound control as well as for each of the examples of the six tasks. If a subject gave a wrong answer during practical examples, the administrator provided the correct answer with the reasoning behind it. Once the explanations were given and the practical examples shown, the student had to answer, without assis-

tance, the various items of each task. In addition, unused keyboard keys were hidden to highlight those needed to indicate the answers (red/yellow/blue keys).

Data Analysis

For Gordon's (1979) PMMA test, the number of correct answers given by each subject during the tonal test and rhythm test (control task) was compiled. For the phonological awareness task (Armand and Montésinos-Gelet, 2001), the number of correct answers given for each of the six tasks was calculated. The number of correct answers given by each student for the entire test also was tallied. Then the entire data set was subjected to calculations of bivariated correlations (Pearson's Correlation).

Results

This research consists of testing the existence of a correlation between performance in the processing of pitch and phonological awareness skills in kindergarten children. The results show that subjects who scored distinctly higher than average in the processing of pitch awareness also obtained above average scores in the phonological awareness test. Moreover, the subjects that had lower than average results in pitch processing also were less successful at the phonological awareness test than the group as a whole. For their part, subjects obtaining average results in the pitch awareness task obtained equal results for phonological awareness. Results show that a significant correlation exists between the processing of pitch awareness performance and the phonological awareness skills test ($r = .975, p < .001$). However, a link could not be established between phonological awareness and the control task ($r = -.072, p = .815$).

Discussion

It is important to keep this pilot study's limits in mind. A correlation study allows for the observation of the link and relationship between assorted variables. In the case of this research, it is obvious that performance in pitch processing is significantly correlated to phonological awareness skills. However, the results do not indicate the causality of one variable on another. It would be difficult to say if performance in pitch processing influences phonological awareness performance; or conversely, if phonological awareness performance influences pitch processing performance. Even if the results are unequivocal, other variables could influence these data. Contrary to an experimental study where variables as a whole are usually controlled, a correlation study requires that the assorted variables be placed in perspective and that results be analysed with some reserve. The results need to be reinforced by additional research with a larger sample before large scale inferences can be made.

The results connect directly with the hypotheses formulated by various experts. Namely, these results support those advanced by Lamb and Gregory

(1993). The present data not only indicate that performance in musical pitch processing is correlated to phonological awareness skills, but they also support the research of British authors by showing that only pitch awareness is correlated to phonological awareness skills and that rhythm perception skills have no relationship at this level.

In the same line of thought, McMahon (1979) has demonstrated that children who are most successful in sound discrimination tasks also obtain better results in fixed phonological tasks. In addition to these observations, we also have determined that sequential tasks, where the linguistic unit occupies a determined place, appear to be more successfully and easily accomplished by our young subjects.

On a larger scale, the results also support those of Atterbury (1985). The author established that bad readers at the elementary level had deficient tonal memory without, however, experiencing problems with rhythm perception. Thus, the present study shows that subjects scoring significantly lower than average in pitch processing and phonological performance had similar, if not higher, scores than the group average in rhythm perception. Thus rhythm perception and coding of pitch awareness would seem to come from different cognitive processes.

Toward New Research

Considering that the nationality of one of the study's participant is Chinese and that this student's scores were clearly superior, it would be justified to research the possibility that performances in pitch and phonological awareness processing are influenced by characteristics in the spoken sinological languages. Deutsch (1999) has demonstrated that people speaking in tonal languages are much more apt to develop a high level of pitch processing. Consequently we should try to find out if learning to analyse linguistic units according to pitch awareness in the mother tongue favors the development of phonological awareness skill and of learning to read in alphabetical languages.

As already mentioned, the establishment of correlations does not permit us to determine a causal relation; subsequent research therefore would be useful in determining causality. It would be interesting to explore the parallel demands of the two tasks that correlate so strongly. The ability to segment the stream of sound could be an important task component that perhaps drives the correlation. Also, it would be justifiable to develop assorted experimental design protocols to observe if the teaching of music at a young age would improve reading skills.

It also would be interesting to verify whether the introduction of an early auditory musical training program would be helpful to students experiencing difficulty at the level of language development. By the same token, we could determine if the fact of learning to logically and spontaneously process pitch awareness of musical sounds would have repercussions at the prereading skills level. Should these results prove to be well-founded, the place given to music in the classroom would have to be reconsidered to allow each child,

with or without a learning disability, to sharpen his or her hearing senses and to develop appropriate tools for musical and linguistic analysis.

In this respect, many individuals might wonder why early musical training would be chosen over directly teaching phonological awareness. In the course of their schooling, some students might experience reading and writing difficulties. Relentlessly working at a task often discourages the student and affects academic results. Developing the skill to process pitch allows the student to use his or her phonological memory and the meta positioning without, however, having to devote himself or herself exclusively to reading and writing tasks. Thanks to a musical education, the child's attention is focused on elements that are different but potentially as useful to the emergence and development of skills at the linguistic level.

In terms of the results, it is essential to rethink the space allocated to the teaching of music in the school system. Even if the emphasis is placed on basic subjects, music remains an important part of preshcool and elementary school learning programs. Given the overloaded schedules, why not integrate music into the teaching of another subject such as French as a second language? Previous studies have shown that the integration of music in New Brunswick's second language classes had shown to be helpful in learning both subjects (Lowe, 1998). Given the wealth of research aimed at proving that music and language are linked to similar mental principles, this educational commitment could only be advantageous.

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Author Note

Jonathan Bolduc is a doctoral student at the Université Laval (Faculty of Music). His research is focused on the emergence of musical aptitudes and the benefits of music education on the cognitive and social development of young children at preschool and elementary levels. Send correspondence to jonathan.bolduc@mus.ulaval.ca.

Isabelle Montésinos-Gelet is a reading specialist at the Université de Montréal (Faculty of Education, Didactic department). Her research projects explore several aspects of emerging literacy: automation, the development of reading and writing strategies, collaboration between children during writing assignments and the influence of linguistic contexts on emerging literacy.

Footnote

[1]*L'Épreuve de métaphonologie* by Armand & Montésinos-Gelet (2001) was developed within the research project *Apprentissage de la lecture et de l'écriture en milieux pluriethniques: étude des contextes langagiers et du degré d'automatisation des processus en lecture* [Learning to read and write in a multiethnic setting: study of linguistic contexts and of the degree of automation of reading processes]. Subventionary organisation: Immigration et métropoles (Immigration and Capital Cities), software creator: Michel Bastien.