The Patterns of Music

Young Children Learning Mathematics through Beat, Rhythm, and Melody

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Research on music and music therapy suggests that math and music are related in the brain from very early in life (Burack 2005). Musical elements such as steady beat, rhythm, melody, and tempo possess inherent mathematical principles such as spatial properties, sequencing, counting, patterning, and one-to-one correspondence. Music also seems to be related to very primal parts of the brain (Hudson 2011). Our bodies cannot help but react physiologically to musical input (Thaut & Kenyon 2003; Hasan & Thaut 2004). This implies that even the youngest children have the potential to inherently respond to music and the mathematical constructs it contains.

Recent music neuroscience research indicates that steady beat does affect attention behaviors in humans. We typically process steady beat in the premotor cortex of the brain, an area also related to attention (Bengtsson et al. 2008). Zentner and Eerola (2010) found that 120 infants, ages 5–24 months, were more engaged with rhythm-only stimuli (for example, a steady drum beat) than with speech-only stimuli. The results of this study indicate that children have the potential to be more engaged when listening to steady beats than when listening to verbal-only instructions. Therefore, it is conceivable that listening to a steady beat pattern during mathematics teaching activities in the early childhood classroom could promote better attention and increased engagement in young children.

Everyday learning experiences, such as listening to music, are especially important in supporting developing mathematics concepts in children from infancy to 5 years old (Linder, Powers-Costello, & Stegelin 2011). Music is made up of rhythmic patterns and can be structured to make the patterning simple or complex, depending on the activity. Zentner and Eerola (2010) suggest that infants and toddlers have an innate capability to not only see patterns but also hear them in music. Reinforcing these capabilities by teaching patterns through music at an early age may benefit children's cognitive abilities (Bell et al. 2009; Meltzoff et al. 2009).

Teaching patterns to very young children is also a key to the concept of *emergent mathematics*, which parallels the idea of emergent literacy. As with literacy, emergent mathematics suggests the following:

- Mathematical learning begins very early in life.
- Mathematics is related to many other developmental milestones.
- Mathematics develops from real-life situations in which the child is an active participant.
- Children learn mathematics through actively engaging their minds in as many different ways as possible.
- Thinking about relationships, such as bigger, smaller and faster, slower, and especially about pattern relationships, plays a special role in young children's mathematical development.
- Learning mathematics is a developmental process influenced by the child's physical, social-emotional, and cognitive learning and development, and nurtured by a stimulating mathematical environment (Geist 2009).

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A study guide for this article is available through **www.naeyc.org/memberlogin**.

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Everyday patterns for infants

Many good hands-on patterning materials are available for teachers of young children. Walk down an exhibit hall at any education conference to see the various choices. These materials tend to be mostly visual/spatial in nature, such as colored blocks or tiles. They are meant to be perceived by the eyes. However, one of the first patterning experiences that children encounter as early as infancy is through their sense of hearing or touch (Meltzoff et al. 2009).

Steady beats and rhythms that parents use to soothe their infants or rock them to sleep and the songs they sing to their children contain many complex patterns. For example, when an infant is distressed, a caregiver instinctively rocks or pats the baby in a rhythmic way, using a musical pattern. The caregiver may even sing an improvised lullaby that has a repeated musical pattern (for example, *abab*) in the lyrics:

(Sung to "Hush, Little Baby")

Verse 1: Little baby, don't you cry, little baby, don't you cry,
Pattern: *a* *b* *a* *b*

Verse 2: Mama loves you, don't you cry, mama loves you, don't you cry.
Pattern: *c* *b* *c* *b*

In this song, the words themselves present a pattern. While rocking and singing this lullaby, the caregiver can gently pat a repeated steady beat, or even a 1, 2, 3, rest pattern, on the child's back. Patterns inherent in the music are heard and felt simultaneously. If the child looks up at the singing caregiver, the child will see the movement of the singer's mouth. The child may then stop crying and begin a steady pattern of breathing, possibly sucking a finger, thumb, or pacifier (Standley 2003).

The pattern is processed in various parts of the brain as the child listens to, feels, watches, and then finally internalizes the pattern. The child moves from relying on the caregiver to provide the musical structure to calm her, to in-ternalizing the pattern and calming herself by sucking to the rhythm and closing her eyes. This early exposure to patterns is not intended to teach mathematics, although the caregiver is introducing the building blocks of mathematical understanding (Clements et al. 2011; VanDerHeyden et al. 2011).

Music brings order to disorder. Teachers can demonstrate patterns without using any materials. All that is necessary is the presence of the caregiver offering an instinctive gift of rhythm and music to comfort the child.

These and other patterning and mathematical experiences that are easily and naturally part of an infant's everyday routine can support the future learning of mathematics and literacy, and of other more formal learning. However, especially in the early years, an emphasis on learning through play and other everyday experiences is the most developmentally appropriate way to promote important mathematical concepts such as patterning (Phillips-Silver, & Trainor 2005).

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Patterning in the preschool and kindergarten classrooms

As children develop and learn, their understanding of patterns becomes more complex. Patterning is a key benchmark for the National Council of Teachers of Mathematics (NCTM) and part of many states' preschool learning standards (NCTM 2000, 2006;

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NAEYC & NCTM 2002/2010; Papic, Mulligan, & Mitchelmore 2011).

Patterning activities in the preschool classroom help children create and repeat relationships and even use rudimentary number concepts. To create patterns with blocks or beads, a child must understand and then create specific relationships between the objects. For example, a child might alternate colors (red, blue, red, blue), sizes (large, small, small, large), or numerical patterns (1 block, 2 blocks, 1 block, 2 blocks).

As children move into the preschool and even kindergarten years, they can recognize, describe, extend, and create patterns (VanDerHeyden et al. 2011). They make patterns that are more complex and more numerical, and they develop the ability to create and use three types of patterns:

Repeating patterns are virtually the same patterns the children created as infants and toddlers: repeating sequences such as red, blue, red, blue. However, in preschool, the children are more intentional about patterning, and their repeating patterns become more complex. They may use three or more colors in their sequence and they may add mathematical elements to the repeating pattern (Seo & Ginsburg 2004).

Growing patterns, such as 1, 2, 3, 4 or 2, 4, 6, 8, comprise numbers as the central element. Growing patterns can be demonstrated with numerals or with groups of objects. With these patterns, there are numerical or mathematical rules that govern the growing relationship of the groups. It can be "add one more" for 1, 2, 3, 4 or "count by twos" for 2, 4, 6, 8 (Geist 2009).

Relationship patterns link two numbers by using some sort of function. For example, one box of crayons contains 8 crayons, 2 boxes of crayons have 16, so the pattern could be 1, 8, 2, 16, 3, 24. Generally, this type of patterning is not seen until second or third grade, due to the multiplicative properties of the patterning sequence (Geist 2009).

To create patterns with blocks or beads, a child must understand and then create specific relationships between the objects.

Children's reactions to music and mathematics

Music plays an important role in patterning experiences at home and at school. Music activities and materials are excellent for promoting patterning and emergent mathematics (Geist & Geist 2008; Southgate & Roscigno 2009). Music keeps children engaged in a mathematical activity for long periods of time. Such experiences promote positive attitudes toward mathematics and support the construction of mathematical concepts in a developmentally appropriate way for infants and toddlers. Edelson and Johnson (2003) found that music enriches the mathematical learning environment for children because such activities are infused with a degree of pleasurable intensity, promote the fun of learning, and allow the child to be an active participant.

Keeping mathematics learning natural and comfortable should be the goal of all teachers, whether they are teaching infants or college students. In our study of 3- and 4-year-old children, conducted at the Ohio University Child Development Center in Athens, Ohio, we interviewed the children about the math activities in their classrooms (some with and some without music). All but one of the children commented on the activities that included music, and these children used music in some way to explain the math concept to the interviewer. Many times the children did not recognize the activity as mathematics. The children who did not have the musical experiences along with the mathematics had trouble recalling any of the concepts that were discussed in the lessons.

Kamile: I've been asking everyone this question. What is math?

Janey: *(She says nothing, shrugs her shoulders, and shakes her head.)*

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Kamile: Okay, here are pictures of some activities that you've been doing in class. Here are some ducks, and here are some shirts.

Janey: *(interrupts)* Oh, I know. *(She begins tapping her knees to a steady beat and singing one of the patterning songs developed for her classroom.)* Here comes the color train, here it comes. / Here comes the color train, here it comes. / The color train is here to stay, we line up, line up on the way. / Here comes the color train, here it comes.

Kamile: Wow, what is that song about?

Janey: Patterens.

Kamile: Patterns?

Janey: Yeah!

Kamile: What are patterns?

Janey: Patterns are where you have a red shirt, then a blue, then a red and a blue shirt all in a row. *(Janey starts tapping her knees to a steady beat and again begins to sing.)* Looking for a red shirt, red shirt, red shirt, / Looking for a red shirt, come line up. / Looking for a blue shirt, blue shirt, blue shirt, / Looking for a blue shirt, come line up. / Red . . . Blue . . . What's next? *(She stops singing.)* See? Red, blue, red, blue. See, it's a pattern.

Kamile: Oh, a pattern.

The second song in the interview with Janey is "The Color Train" (Geist 2009). It is a musical teaching activity created to support development of early patterning by using repeated rhythmic beats within the song and creating a structured activity in which the children repeat color patterns. When singing this song, teachers can use drums or other instruments to emphasize patterns in the song to encourage children to imitate different beats on drums or replicate an action. The words teach repeated color patterning, but the music itself is filled with simple and complex repeated patterns.

There are math opportunities and interactions all around young children, which often are not recognized as mathematics by the children or their parents or teachers. In fact, some children even added math to the Color Train activity where none was intended. Here is part of Michael's interview about another musical activity created to promote mathematical understanding.

Kamile: Tell me about the ducks.

Michael: Well, did you know the mother duck lost her babies?

Kamile: Really?

Michael: And do you know how she called them back into line?

Kamile: No, tell me.

Michael: Well, she would quack so that all the baby ducks could hear and then the little ducks heard and then they went back into line. And you know what?

Kamile: What?

Michael: Well, the mother duck would quack as many times as there were baby ducks.

Kamile: Really?

Michael: Yeah. So, if there were five ducks, she would quack five times, like "Quack, quack—quack, quack, quack." *(Michael represented this quacking example in a rhythmic pattern, like 1, 2, 1, 2, 3, and used his fingers to count up to 5 as he was quacking.)*

Kamile: So you counted the quacks.

Michael: Yes, the momma quacked five times, five baby ducks!

The quacking part of the activity that Michael referred to was only in the musical activity. In fact, Michael only talked about activities that involved music and did not specifically

"The Color Train"

The teacher begins by keeping a steady beat and encourages the children to keep a beat as well.

Chorus *(To the tune of "This Train is Bound for Glory." Can be sung or chanted.)*

Here comes the color train, here it comes. (Choo choo)
Here comes the color train, here it comes. (Choo choo)
The color train is here to stay; we line up, line up on the way.
Here comes the color train, here it comes. (Choo choo)

Chant

Looking for a PINK shirt, PINK shirt, PINK shirt.
Looking for a PINK shirt, come line up, come line up.
Looking for a RED shirt, RED shirt, RED shirt.
Looking for a RED shirt, come line up, come line up.
PINK . . . RED . . . (What's next?) PINK!
Looking for a PINK shirt, PINK shirt, PINK shirt.
Looking for a PINK shirt, come line up, come line up.
PINK . . . RED . . . PINK . . . (What's next?) RED!
Looking for a RED shirt, RED shirt, RED shirt.
Looking for a RED shirt, come line up, come line up.
PINK, RED, PINK, RED.

Repeat chorus

The line of children can then follow the leader, pretending to be a train. The other children sitting in the group keep the beat, sing the chorus, and observe the pattern.

refer to the math-only activities. Other children chose different methods, such as singing, humming, tapping a beat, or talking about what happened in the musical activity and naming the song to explain the mathematical concept to the researcher. All of the children's explanations included more mathematics explanations and understanding than were directly taught in the lessons.

"How Many Ducks?"

(Sung to the tune of the theme from "The Addams Family")

How many ducks? *(clap clap)*
How many ducks? (*clap clap*)
How many ducks? How many ducks? How many ducks? (*clap clap*)

Chant

What does mother duck do to get her ducks in line?
Quack, quack—quack, quack, quack.
Let's count together *(children count the five ducks while the teacher keeps a beat)*

Sing again

How many ducks? FIVE!
How many ducks? FIVE!
How many ducks? How many ducks? How many ducks? FIVE!

Conclusion

With new understanding about the nature of everyday learning experiences, the key role of patterns in the development of literacy and mathematics, and the need for a stimulating environment in the very early years, the importance of music in the home and in the classroom is becoming clear. Music is children's first patterning experience and helps engage them in mathematics even when they don't recognize the activities as mathematics. Music is a highly social, natural, and developmentally appropriate way to engage even the youngest child in math learning.

By Michael J. Rosen /© NAEYC

Music is a highly social, natural, and developmentally appropriate way to engage even the youngest child in math learning.

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Tips for Using Music to Engage Children in Mathematics

Based on our research findings, here are four practical suggestions that use music in the classroom to promote children's active engagement in math.

1. **Maintain a steady beat throughout the mathematics lesson.** For example, have children pat their knees, march in place, nod their heads, or listen to or play a drum during a math lesson. You will know if you are creating the appropriate tempo (speed) and dynamic (volume) based on the children's responses. If the children get overstimulated and start to exhibit very active behavior, such as shouting or running around the room, it may be too fast and possibly too loud. If you see fidgeting, inattention, or talking to a friend about an unrelated topic, it's possible that children are bored because the music is too slow or too soft.
2. **Change the beat's tempo and dynamics regularly.** Keeping the same tempo and dynamic throughout an entire lesson may also lead to children becoming bored. You may want to vary the tempo and dynamic levels during an experience to achieve a certain level of active engagement. For example, during "The Color Train" song, one teacher would whisper the chanted parts of the song to change the dynamic texture of the singing activity. Also, when chanting, she would speed up the tempo of the steady pulse to move the activity along. When she sang "Looking for a red shirt, red shirt, red shirt, Looking for a red shirt, come line up, come line up," she would whisper at a faster tempo and then sing the rest of the song at the original volume and tempo. Flexibility in the music's tempo and volume increases children's attention to the activity. With practice and experience, you will become more effective at knowing when to change tempo during an activity.
3. **Observe, listen, and respond to the children's musical behaviors.** Teachers need to be aware of children's musical interactions. Children reveal what tempo (speed) is most comfortable for them through the speed of their movements or the speed of their singing or talking. If you aren't sure about the appropriate tempo to begin an activity, you might respond to the children's tempo by matching it. Children also reveal what volume they need to hear by singing. They may also seek out an object that makes sound to create the volume they need.

   For example, one teacher conducted the activity just after the children had come in from the playground. They were very active and had high energy levels. Because she recognized the needs of the children, she started the math/music lesson with a very fast beat and loud dynamic. Once she had everyone's attention and the children started to "cool down," she gradually lowered her volume and decreased the tempo of the activity. She noticed that all the children were sitting in the group looking at her.
4. **Try to keep the music and math activities concept based and open-ended.** The goal of using music and math together is to harness the power of music to engage children and foster emergent mathematics by stimulating children to make mathematical relationships. While there is no harm in having songs that focus solely on specific skills such as counting or naming shapes, these activities do not take advantage of what the research tells us about how music affects the brain. Begin by developing an activity that facilitates the construction of mathematical knowledge by encouraging the child to think mathematically, and then add musical elements to enhance the activity. Giving children a stimulating mathematical environment as infants and toddlers is vitally important and can enhance future abilities in mathematics (Mazzocco, Feigenson, & Halberda 2011).