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Composition Instruction and Cognitive Performance: Results of a Pilot Study

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Abstract
The purpose of this study was to evaluate the effects of a composition program, Composers in Public Schools (CiPS), on cognitive skills essential for academic success. The underlying hypothesis is that composition instruction will promote creative expression and increase performance on music-specific skills such as music reading, as well as foster general analytical/aural skill development associated with vocabulary, arithmetic, and processing speed abilities. Two sixth-grade classes assigned to the experimental (n = 15) and control (n = 13) groups completed a series of standardized neuropsychological and cognitive assessments pre and post-instruction. Results of a Repeated Measures ANOVA (Group X Time) indicate significant ($p < .05$) enhancements in arithmetic performance by the CiPS group compared to controls. These results suggest that creative experiences with musical notational symbols, sequence creation, and analytical compositional concepts may broadly impact student performance in subject areas depending upon analysis and symbolic manipulation such as arithmetic.

Introduction

Music education programs prepare the mind for learning in many cognitive domains. Previous research suggests that musical training enhances general cognitive abilities such as spatial temporal reasoning (Hetland, 2000; Rauscher, Levine, Shaw, Wright, Dennis, & Newcomb, 1997; Rauscher & Zupan, 2000), verbal memory performance (Ho, Cheung, & Chan, 2003; Rickard, Vasquez, Murphy, Gill, & Toukhsati, 2010) and executive processes (Bugos, Perlstein, McCrae, Brophy, & Bedenbaugh, 2007). In addition, cognitive abilities enhanced through music education programs impact learning and achievement in other academic subject areas. Musicians score higher on standardized math and reading achievement assessments compared to non-musicians (Fitzpatrick, 2006; Johnson & Memmott, 2006). Research supports a relationship between musical training and enhanced understanding of numerical concepts (Gardiner, 2008). Evidence from neuroimaging data show cortical links between areas of activation associated with musical training and mathematical computation, suggesting potential overlap between learning and memory systems (Schmithorst & Holland, 2004). The purpose of the present study was to examine the effects of music training in composition instruction on music reading, processing speed, vocabulary performance, verbal fluency, and arithmetic computation.

While this body of research suggests connections both anatomically and behaviorally between musical training and cognitive abilities, results of other studies reveal contradictory findings. Bahar and Christiansen (2000) found enhanced mathematical performance by music students in conditions where mathematical tasks contained similar structure as those in music. If the task was not structured similarly, no significant difference in performance was found. Results of a longitudinal study examining the effects of piano instruction on arithmetic performance in fourth-grade students found no significant enhancements (Costa-Giomi, 2004). It is also unclear as to whether those enrolling in music programs innately demonstrate higher academic achievement or if music has the capacity to enhance other learning domains. For instance, a comparison of academic achievement and mathematical achievement among high school students with musical credits compared to students without music credits reveal no significant differences in academic achievement (Cox & Stephens, 2006).

Despite this research, little is known as to what specific musical activities have the potential to prepare the mind for learning. It is widely acknowledged that instrumental training produces many general benefits. Instrumental music instruction is commonly treated as a foreign language in the school curriculum of some countries such as Australia where all elementary students are provided two years of instruction on an ensemble instrument (McPherson, 2005). While instrumental training is valuable, musical activities such as composition may also foster general cognitive development. Composition instruction requires complex integration of a spiral curriculum of musical knowledge, aural skills, and instrumental skills. Few articles detail transfer effects of composition instruction to other cognitive domains; however, research in clinical populations suggests that composition instruction has the capacity to enhance self-concept (Colwell, Davis, & Schroeder, 2005). The present study investigated the effects of a composition program on areas associated with academic performance in middle school students. The underlying rationale is that any project-based composition program that incorporates creative collaborative composition and compositional teaching practices with technology and comprehensive musicianship has the capacity to engage multiple learning domains. We hypothesize that a novel composition program that incorporates critical thinking, music theory and musical performance could enhance areas associated with general education such as vocabulary, arithmetic performance, and processing speed.

Composition instruction is an important part of the music education curriculum that offers opportunities to foster creativity and nurture musicianship skills. Even though composition is a natural part of music education and included in the National Standards for Music Education in the United States, many music educators in the U.S. report using composition infrequently in the classroom (Strand, 2006). One reason for reported infrequent usage of composition by music educators stems from a lack of familiarity and knowledge of compositional teaching practices. Many additional challenges such as competing course goals, teaching loads, class size, and technology limitations are cited as limiting opportunities for composition activities. Research in other countries reports similar findings. For instance, results of another study conducted in Slovenian elementary schools found that educators may not be aware of strategies to teach composition and improvisation (Rozman, 2009). Due to the 2002 counter-reform in Spain, music education in this country was restricted to instruction that included declarative knowledge and lacked instruction in authentic music skills such as performing or composing (Rusinek, 2007). Many secondary educators in Spain are reluctant to include student-centered pedagogies such as composition (Rusinek, 2007). A key challenge is to develop new composition programs that include learning opportunities related to compositional teaching practices, minimal technology requirements, and comprehensive musicianship skills. The purpose of the present study was to examine the effects of a novel composition program, Composers in Public Schools, on skills necessary for academic success.

Frequently, the focus of activities in a music classroom is on replication of expert performance rather than generation (Csikszentmihalyi & Custodero, 2002). While musical performance is essential in developing and refining musicianship skills, composition does not take away from this goal. Rather, composition instruction further contributes to the aural and intellectual development of a musician. Research suggests that participation in generative musical activities fosters creativity, critical thinking, and aesthetic experiences (Barrett, 2006). While much is known about the intrinsic benefits (i.e. overall aesthetic, creative thinking, and problem solving) of engaging in compositional activities, little is known about the cognitive benefits related to engagement in compositional activities and the best approaches for teaching composition in classroom.

Composition Pedagogy

Many music educators understand that composition instruction during the elementary and middle school years encompasses social and cultural contexts (Barrett, 2006). This concept of "creative collaboration" is especially important in a learning environment. Group-based composition instruction incorporates revision and spontaneous sharing of ideas as part of the creative process (Webster, 2003). According to Webster three main variables are necessary to facilitate group composition, those variables include: work environment, project experience, and peer scaffolding (2003). These variables can also be related to Csikszentmihalyi's concept of flow and optimal experience (1975). According to recent research examining the impact of flow on creativity, a learning environment with a reduced sense of worry of failure, clear project goals, and instant feedback combined with challenge and skill provide a sense of flow (Bryne, 2006). A sense of flow involves attention and concentration important for teaching and learning. Focused concentration on a domain-specific subject matter in which instruction offers some challenges and information on how to gain skills necessary to complete challenging tasks may have the capacity to transfer to other learning domains (Bugos et al., 2007).

In addition to the context for creative musical activities, research provides recommendations for structuring compositional activities. Prior research in composition shows that children illustrate unique characteristics in their approach to compositional tasks based upon choices such as range (Kratus, 1989; Kratus, 1994; Kratus, 2001). Many other pedagogical recommendations from the literature suggest providing structurally meaningful prompts such as phrases or motives, access to materials such as a set of pitches or rhythmic values, and opportunities that involve action-based projects (Barrett, 2006; Webster, 2003).

The Composers in Public Schools (CiPS) program, a novel composition program, encourages a collaborative creative environment through a focused progressively difficult curriculum with project-based goals that emphasize skill development and promote comprehensive musicianship. The CiPS program incorporates all of these pedagogical practices in a curriculum that has the capacity to be implemented in a variety of educational settings and grade levels. The goal of the present study was to examine the effects of Composers in Public Schools on cognitive and academic performance in sixth-grade students. We hypothesized that participation in the Composers in Public Schools (CiPS) program enhances performance in music reading, processing speed, vocabulary performance, verbal fluency, and arithmetic computation for the experimental group compared to controls who do not receive CiPS instruction.

Methodology

Participants

Participants consisted of one sixth-grade general music class and one sixth-grade physical education class assigned to experimental (n = 15; mean age 11.20 years) and control groups (n = 13; mean age 11.23 years) respectively. All participants were assigned and enrolled in music and physical education coursework for one semester in a rotational system or "wheel" system. Students not enrolled in music or physical education courses the first semester were assigned music or physical education courses the second semester. All testing for this project occurred during the first semester. Classes were taught at the same school with 38% free and reduced lunch status in the Southeastern United States. Criteria for research participation in either group consisted of no prior history of formal music instruction (private or studio instruction), not currently enrolled in band or orchestra, and not currently engaged in music reading. Informed written consent from parents and assent from participants was obtained in compliance with the guidelines established by the University Institutional Review Board (IRB) and the County School Board.

Procedure

Participants completed a short questionnaire regarding demographic information and previous musical experience. All students participated in two group-administered pre-testing and post-testing sessions. Cognitive assessments were administered during the school day in two class periods (40 minutes each). Only members of the experimental group received the CiPS program. Members of the control group did not participate in any music courses. All post-testing was administered upon the completion of the four-month CiPS program. Only students who returned completed parent consent and completed child assent forms participated in testing in accordance with Institutional Review Board policies. All testing was held in a quiet classroom, testing environment.

Description of Assessments

Intermediate Measures of Music Audiation (IMMA; Gordon, 1986): measures music aptitude by responses to determine if melodic phrases are the same or different. This measure of music aptitude provides tonal and rhythmic composite scores based upon aural stimuli that consist of 30 paired melodic phrases. The IMMA was chosen for its reliability (r =.81) and content validity. *Music Reading Assessment* (MRA; Bugos & Groner, 2009): measures music reading of treble and bass clef as well as knowledge of basic musical symbols. The MRA provided information regarding domain-specific learning in music reading.

Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001) *Group Modified Verbal Fluency* subtest: Each 60-second trial consists of including as many words that begin with specific letters of the alphabet. Words selected could not be names of people, places, or numbers. Form 1 was used for pre-testing, and Form 2 was used for post-testing to remove potential practice effects.

Group Modified Wechsler Intelligence Scale for Children IV (WISC-IV; Wechsler, 2003) a modified version for group assessment included the *Vocabulary, Arithmetic, Symbol Search*, and *Coding* subtests. Group modification of each subtest consisted of paper/pencil administration and aural script of vocabulary words. The *Vocabulary* subtest indicated providing a definition of specific words. The *Arithmetic* subtest required formulating mental calculations including basic addition, subtraction and multiplication. The *Symbol Search* subtest comprised of a visual scanning task for symbols matched to a target in a specified time limit of two minutes. The *Digit Coding* subtest evaluated planning, visual scanning and processing speed in a paper pencil completion task. Symbols given in a code for specific numeric stimuli were to be placed in the box below corresponding numbers. Sattler and Dumont (2004) examined the reliability of the WISC-IV and report reliability coefficients of .94 (Verbal Comprehension), .92 (Perceptual Reasoning), .92 (Working Memory), .88 (Processing Speed) and .97 (Full Scale Intelligence Quotient). Internal consistency on the WISC-IV ranges from .79 – .90, and internal consistency is lowest for 6 year olds (.83) and highest for 12-, 15-, and 16-year-olds (Sattler & Dumont, 2004).

Composers in Public Schools (CiPS) Program

The Composers in Public Schools program provides opportunities for students to create music while learning specific compositional and stylistic concepts. Each unit of instruction consists of various compositional experiences integrated with technology. Individual lessons focus upon clear project goals. Lessons include composing for a "virtual orchestra," percussion pieces, vocal and instrumental blues pieces, recorder and ensemble pieces as well as vocal compositions. Students participate in discussions regarding compositional techniques such as sequence and retrograde, followed by group creation of music using such tools and techniques (Figure 1). Demonstrations of concepts and active participation in learning compositional concepts serve to promote a sense of ownership. Opportunities for performances and discussion about performances are fostered through instruction.

Figure 1. An example of a completed piece titled, "Mysterious Harmony," for winds and percussion


Mysterious Harmony
Flute
Alto Saxophone
Cymbals
Snare Drum
Bass Drum
ppp


4
Fl.
A. Sax.
Cym.
S. D.
B. D.
2
poco rit.
♩ = 90
7
Fl.
A. Sax.
Cym.
S. D.
B. D.
mf


10
accel.
Fl.
A. Sax.
pp
Cym.
S. D.
B. D.
14
♩ = 110
Fl.
A. Sax.
Cym.
S. D.
B. D.

Implementation of the CiPS program included four-months of weekly composition instruction administered by a university professor of composition and highly trained graduate composition students. Graduate composition students were trained in the curricular content of the program, required to observe instruction, and meet regularly with the professor to discuss program performance. The middle school music educator at the school provided basic rhythmic notational instruction to students and background information about composers prior to the integration of the CiPS program and focused daily music classes on compositional skills addressed by the composer. Each composition lesson correlated to previous learning established by the music educator. The music educator systematically incorporated compositional skills taught by composers in conjunction with prior-developed lessons to ensure compliance with state and national standards.

Data Analysis

Independent samples *t*-tests were used to examine potential group differences on demographic variables. All other data were analyzed using separate 2-Group (Experimental, Control) X Time (Pre-test, Post-test) analyses of variance (ANOVAs) with group as a between-subjects factor and time as within subjects factor over each independent cognitive domain of verbal fluency, vocabulary, arithmetic, and processing speed. A group by time interaction indicates a differential response to training. Cohen's effect size coefficients (*d*) are reported upon for significant group X time interactions (1992). Interpretation of effect size of .2 to .3 is considered a small effect, .5 to .8 a medium effect, and .8+ is considered a large effect (Cohen, 1992).

Results

Results of a *t*-test on age and music aptitude show no significant differences between groups (Table 1). Results of a Group (Experiment, Control) X Time (Pre-test, Post-test) ANOVA on the

Music Reading Assessment (MRA) indicate no significant ($p < .05$) differences between groups, $F(1,26) = .002$, $p = .96$. No main effects were found.

Table 1.
Demographic Table with Means (SD)

	Experimental Group (*n* = 15)	Control Group (*n* = 13)	*t*	*p*
Male/Female	7/8	7/6		
Age	11.20 (.41)	11.23 (.73)	-0.14	0.89
MRA Pre-Test	18.13 (24.54)	19.85 (19.55)	-0.20	0.84
MRA Post-Test	19.33 (21.42)	21.23 (19.76)	-0.24	0.81
IMMA Tonal All	34.4 (2.0)	33.2 (2.1)	1.50	0.14
IMMA Rhythmic All	33.5 (2.3)	34.0 (2.8)	-0.56	0.58

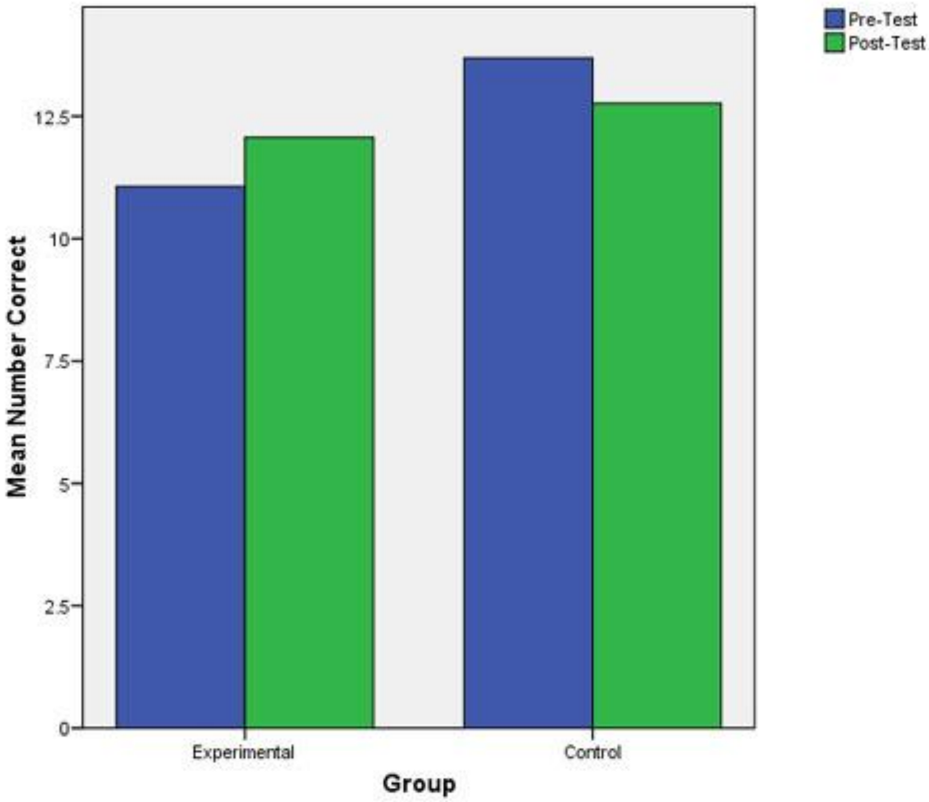
*Note: MRA, Music Reading Test; IMMA, Intermediate Measures of Music Audiation
Results of a Group (Experimental, Control) X Time (Pre-test, Post-test) ANOVA on WISC-IV *Arithmetic* subtest scores revealed significantly enhanced performance for the experimental group compared to controls, $F(1, 26) = 6.64$, $p = .02$ (Table 2).

Table 2.
Means (SD) of Repeated Measures

Measures	Experimental Group (*n* = 15)	Control Group (*n* = 13)
Total Correct Verbal Fluency Pre-Test	23.47 (6.26)	26.08 (7.81)
Total Correct Verbal Fluency Post-Test	27.53 (8.18)	27.69 (8.31)
Digit Coding Pre-Test	42.60 (12.41)	54.46 (17.19)
Digit Coding Post-Test	53.40 (11.33)	55.08 (9.09)
Symbol Search Pre-Test	28.93 (8.49)	28.77 (6.61)
Symbol Search Post-Test	32.73 (7.38)	31.08 (11.01)
Vocabulary Pre-Test	19.07 (8.89)	22.54 (6.58)
Vocabulary Post-Test	20.33 (8.99)	24.85 (7.01)
Arithmetic Pre-Test	11.07 (1.53)	13.69 (3.09)
Arithmetic Post-Test	12.07 (2.12)	12.77 (2.71)

No main effect for time was found, $F(1, 26) = .01$; $p = .92$. We further examined the effect size associated with the performance on the *Arithmetic* subtest. Cohen's (d) effect size was calculated based upon means and standard deviations between the performance of the experimental and control group (1992). According to Cohen's coefficient, our data shows a small effect ($d = .33$) for group differences on the *Arithmetic* subtest (Figure 2).

Figure 2. Arithmetic Subtest Results for Experimental and Control Groups



A series of Group (Experimental, Control) X Time (Pre-test, Post-test) ANOVAs were conducted for the *Verbal Fluency, Vocabulary, Digit Coding,* and *Symbol Search* subtests (Table 2). No significant group interactions were found for *Verbal Fluency*, $F(1,26) = 1.01$, $p = .32$; *Vocabulary*, $F(1,26) = .37$, $p = .55$; *Digit Coding*, $F(1,26) = 2.80$, $p = .11$; and *Symbol Search*, $F(1, 26) = .29$, $p = .59$ subtests. Main effects for time were found for the *Verbal Fluency*, $F(1,26) = 5.42$, $p = .03$; *Vocabulary*, $F(1,26) = 4.34$, $p = .05$; and *Symbol Search*, $F(1,26) = 4.89$, $p = .04$ subtests only.

Discussion

Our original hypothesis was that participation in the Composers in Public Schools (CiPS) program would enhance performance in music reading, processing speed, vocabulary performance, verbal fluency, and arithmetic computation. Results show improvements in arithmetic scores, but not in other cognitive measures. While scores on measures that place demands on processing speed such as the *Digit Coding* and *Symbol Search* subtests reveal enhancements, due to a relatively large variance in scores, these enhancements were not significant.

Our data indicate enhancements in arithmetic performance resulting from participation in the Composers in Public Schools (CiPS) program. As shown in Figure 2, the experimental group demonstrated a 23.7% increase in arithmetic performance on a 34-item *Arithmetic* subtest, while the control group did not show such a pattern as a function of time. Since the *Arithmetic* subtest contains high reliability of .94 (Ryan, Glass, & Bartels, 2009) upon repeat administration and the time between pre/post-testing was just over four months, the increase in scores by the experimental group can not adequately be explained by practice effects. These data are consistent with previous findings investigating the effects of music instruction on standardized English and math assessments (Johnson & Memmott, 2006). We hypothesize that some concepts/skills reinforced in the CiPS program such as music reading (decoding), sequencing and pattern recognition may have contributed to the experimental group's success on the *Arithmetic* subtest.

Our overall results are consistent with previous data regarding the relationship between music and mathematics. Results of a metanalysis indicate modest support for the relationship between music and mathematical abilities (Vaughn, 2000). Further research on the relationship between music and mathematics is necessary. Since the field of mathematics includes examining quantity, structure, space, and change, this research investigated the effects of a novel composition program on arithmetic performance, a small part of the field of mathematics. Further research is necessary to examine potential relationships between skills learned in music instruction related to abstraction and logical reasoning and those skills employed in algebra, geometry, or analysis.

We found no significant differences between groups with regard to music reading performance. Students performed similarly on music reading skills as measured by the *Music Reading Assessment* (MRA; Bugos & Groner, 2009) at both time points. This result was surprising, since the middle school general music instructor and the Composers in Public Schools program included instruction on music notation and reading skills. The CiPS program engaged students in a variety of musical experiences including performing, creating, notating, and evaluating music. While the program was comprehensive, daily drill and practice with notational skills was not required. It may be necessary to provide more opportunities for practice with music notation (i.e. assignments and drills) in order to demonstrate enhancements in this area.

Our data reveal no significant differences with regard to verbal fluency and vocabulary performance. We originally hypothesized that composition instruction would increase vocabulary due to the introduction of new vocabulary describing patterns and relationships; however, vocabulary knowledge did not transfer to items on the standardized subtest. While we observed an increase in verbal fluency performance by the experimental group, the variance among these scores was high. Further research is necessary to examine the effects of composition instruction on vocabulary and verbal fluency performance.

Composition programs such as the CiPS focus on a large array of skills. This study offers some insight into areas most sensitive to compositional programs. We found significant increases in arithmetic performance, an area similar to composition as it necessitates analytical skills and relies upon sequence. In addition to the intrinsic benefits of music education, knowledge of musical structure through composition may have the potential to enhance cognitive abilities essential to academic success.

Limitations and Potential Explanations

One limitation of the current research design was the usage of relatively intact classes. Students with formal musical training were the only group disqualified from research participation. Students with experience in band, orchestra, private lessons, and those currently reading music were disqualified. Due to exclusionary criteria, a relatively small sample size was employed in this research design. However, without exclusionary criteria, we would not be able to isolate the independent variable in composition instruction.

In addition, while demographic variables were collected on students and all students attended the same community school, no specific data were collected on individual students regarding socioeconomic status. In addition, composition lessons in the CiPS program focused primarily on western musical styles. More research is necessary to examine outcomes of the CiPS method of composition using non-western musical styles. This information would be helpful in the design of future composition-based programs.

Implications for Music Educators

The results of this research add to the preponderance of evidence suggesting that musical training has the capacity to prepare the mind for learning in certain subject areas. Music education programs should not be justified or evaluated by potential external benefits; participation in music programs provides intrinsic benefits and fosters aesthetic sensitivity. A comprehensive music education encourages creativity and critical thinking skills and most importantly, can broaden and enrich a child’s life. Composition, an important part of a comprehensive music education, promotes creativity and communication in a group environment.

Our findings show increases in arithmetic abilities as a result of a group-based novel composition program, Composers in Public Schools. Project-based compositional programs that incorporate creative collaborative composition and compositional teaching practices with technology and comprehensive musicianship have the capacity to engage multiple learning domains and provide an optimal learning experience. Students gain a sense of accomplishment by implementing concepts and skills recently acquired into their own compositions. Student compositions serve as an assessment tool and an opportunity to experiment with new ideas. For instance, Figure 2 illustrates the students’ knowledge of complementary rhythmic patterns between wind and percussion parts. Experimentation of new ideas can only occur in a learning community that values contributions by all. The structure of the Composers in Public Schools program offered a supportive environment in which ideas are discussed. Decision-making and critical thinking opportunities allow students to reflect on concepts and serve to establish a learning community (Bamberger, 2003; Collins, 2005). Research on child development stresses that intellectual development is related to a child’s learning environment (Crncec, Wilson, & Prior, 2006). Music educators should strive to foster a community of learners through a cooperative and experimental learning environment that embraces creativity.

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Jennifer Bugos, Assistant Professor of Music Education at the University of South Florida, received a BA in music education from the University of Florida, MA in music education from the University of Central Florida, and PhD in music education with a minor in gerontology from the University of Florida. Bugos's main research interests include the neurological basis for music perception and cognition with regard to human development, lifespan learning, and cognitive transfer. She currently supervises student teachers, teaches undergraduate and graduate level coursework, and pursues interdisciplinary research at the University of South Florida. Her research has been featured at national and international conferences such as the *American Orff Schulwerk Conference, MENC Conferences, Society for Neuroscience*, and the *International Conference on Music Perception and Cognition*.

Edward Jacobs is Professor of Music at the East Carolina University School of Music, with training in jazz performance, composition and conducting from University of Massachusetts, Amherst (BA), University of California, Berkeley (MA) and Columbia University (DMA). His music has been performed by groups including the JACK Quartet, earPlay, Empyrean Ensemble, Meridian Arts Ensemble, NewEar, Second Instrumental Unit, and members of Speculum Musicae, and at the Festival of New American Music, the Third Practice Festival, the Louisville New Music Festival, the World Saxophone Congress, and the NewMusic@ECU Festival. His activities have also included the founding and direction of the Annual NewMusic@ECU Festival, and work in the Pitt County Public Schools, with middle school general music teachers in his "Young Composers Project," which strives to make the creation of music a fundamental part of our children's' education.