

INTRODUCTION

Fluent reading is a critical skill in our society and is based on children's acquisition of several essential subskills, including phonological awareness ("PA"). Musical activity has been used experimentally as a means of bolstering reading skills, including those of children with dyslexia, with preliminary indications that music and reading are related. Yet little is known about the exact relationships and the specific links between these two domains.

Study 1 included basic research into relationships between musical rhythm and PA subskills in kindergartners. In a pre-post design, the study also compared post-year PA subskills of kindergartners in two schools with different amounts of musical training.

Study 2 investigated relationships between the children's rhythm skills in kindergarten and their PA and reading in the middle of second grade.

STUDY 1 – KINDERGARTNERS – RESEARCH QUESTIONS

- 1) What relationships exist between phonological awareness (PA) and rhythm pattern (perception and production) and tempo production subskills in kindergarten children?
- 2) Will the post-year PA subskill performance of children who participate in more musical activity be different from the performance of children who participate in less musical activity during their kindergarten year?

PARTICIPANTS & MUSIC CURRICULA

	EXPERIMENTAL SCHOOL	CONTROL SCHOOL
Number of Kindergartners	15	15
Mean Age [Range at Study Start]	5.6 [5.0 – 5.11]	5.6 [5.2 – 5.11]
Gender	9M, 6F	8M, 7F
Mean KBIT [Range]	97 [89 – 112]	99 [80 – 114]
Mean PPVT (Receptive Vocabulary) [Range]	102 [74 – 123]	102 [76 – 119]
Music Curriculum	Kodaly	Silver-Burdett
Music Lesson Frequency	45 mins/day	35 mins/week

PARTIAL CORRELATION RESULTS: FALL SCORES

Study groups combined into one sample, n = 30

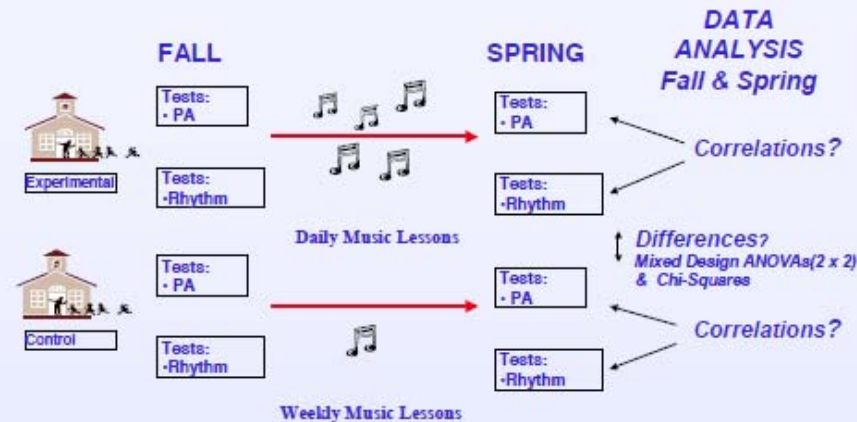
Control for KBIT-Composite "Abbreviate IQ"

		RHYTHM				
		Tempo Copying Computer Score	Tempo Copying Human Rater Score	Rhythm Pattern Copying Computer Score	Rhythm Pattern Copying Human Rater Score	Rhythm Pattern Discrimination Raw Score
PHONOLOGICAL AWARENESS	Segmentation Of Sentences	.37*	.22	.37*	.44*	.13
	Segmentation Of Syllables	.06	-.14	.44*	.38*	-.15
	Composite of 4 PA Tests ^a	.30	.13	.45*	.50**	.01



^aComposite of 4 PA Tests = Latent Variable comprised of average of Segmentation of Sentences, Segmentation of Syllables, Isolation of Initial Phoneme, and Deletion of Compounds/Syllables standard scores (Cronbach's Alpha = 0.77)

RESEARCH DESIGN



MEASURES, SCORING & CONTROL VARIABLE

Phonological Awareness Tests ("PA" tests)

- **Phonological Awareness Test (PAT)** (Robinson & Salter, 1997): Subtests: Rhyming Discrimination and Production; Segmentation of Sentences, Syllables, and Phonemes; Isolation of Initial, Final, and Medial Phonemes; Deletion of Sounds (Compounds and Syllables) and Phonemes. Scoring = standard scores.

Musical Rhythm Tests - Adapted from Overy et al., 2003, Musical Aptitude Tests (MAT):

- **Rhythm Pattern Discrimination** - A computer produced two rhythm stimuli with varied intervals (3-7 bongo drum taps per stimuli at overall presentation speed of 100 bpm); Ss determined whether same or different. Both halves of paired stimuli had equal number of taps and varied in rhythm only. (Scoring = raw score of correct answers)
- **Rhythm Pattern Production (Copying)** - A computer produced rhythm stimuli with varied intervals between taps (3-7 taps at 100 bpm); Ss copied stimuli by listening then tapping on computer space bar. (Scoring*)
- **Tempo Production (Copying)** - Computer produced isochronous rhythm sequences (4 drum taps per sequence at 60, 80, 100, 136 bpm); Ss copied stimuli by listening then tapping on computer space bar. (Scoring*)
- *Rhythm and tempo copying tests scored both by measuring and assessing difference in milliseconds between stimulus taps and response taps ("computer score"), and by two musicians independently judging audio files of Ss' responses using Likert scale (average of two musicians' scores = "human rater score").

Correlational Analyses Control Variable:

- **Kaufman Brief Intelligence Test (KBIT)** (Kaufman & Kaufman, 1990) Composite Score of Vocabulary and Matrices tests.



PARTIAL CORRELATION RESULTS: SPRING SCORES

Results by group

Control for KBIT-Composite "Abbreviate IQ"

		RHYTHM				
		Tempo Copying Computer Score	Tempo Copying Human Rater Score	Rhythm Pattern Copying Computer Score	Rhythm Pattern Copying Human Rater Score	Rhythm Pattern Discrimination Raw Score
		EXPERIMENTAL GROUP (n = 14)				
PHONOLOGICAL AWARENESS	Rhyming Discrimination	.20	.18	.26	.60*	.26
	Rhyming Production ^b	-.59*	-.32	-.15	-.23	-.34
	Isolation of Medial Phoneme	.13	.21	.33	.58*	-.02
		CONTROL GROUP (n = 13)				
	Rhyming Discrimination	.27	.04	-.06	.13	.67*

^bNegative correlation between Tempo Copying and PA subtest in Experimental Group was not hypothesized and is unexplained.

MIXED DESIGN ANOVAs (2 X 2) RESULTS: FALL TO SPRING

		F_{Group} <i>p</i>	F_{Time} <i>p</i>	$F_{\text{Group} \times \text{Time}}$ <i>p</i>
PHONOLOGICAL AWARENESS	Rhyming Discrimination ^c	ns	0.026*	0.005**
	Segmentation Of Syllables	ns	0.004**	ns
	Isolation of Initial Phoneme	ns	0.018*	ns
RHYTHM	Tempo Copying Computer Score	0.022*	ns	ns
	Human Rater Score	0.000**	ns	ns
	Rhythm Pattern Copying Human Rater Score ^c	0.037*	0.006**	0.031*
	Rhythm Pattern Discrimination Raw Score	0.011*	0.028*	ns

^c Interaction (Group xTime): Experimental Group improved more than Control Group.

STUDY 2 – KINDERGARTEN TO SECOND GRADE RESEARCH QUESTION

What relationships exist between rhythm and tempo subskills in kindergarten children and their phonological awareness (PA) and reading skills in second grade?

PARTICIPANTS AND RESEARCH DESIGN

Participants: 12 of original 30 kindergartners participated, 8 from experimental group and 4 from control group. All 12 combined into one sample, mean age 8.1, range 7.9 to 8.5, 6M/6F. Kindergarten Mean KBIT-Composite [range] for second grade sample 97 [89-112]. Kindergarten Mean PPVT (Receptive Vocabulary) [range] 100 [74-113].

Research Design: Participants tested in the middle of their second grade year, at same schools attended as kindergartners. Partial correlations obtained between kindergarten rhythm and tempo scores and second grade phonological awareness and reading scores.

MEASURES, SCORING & CONTROL VARIABLE

Musical Rhythm Tests – Kindergarten test scores.

Second Grade Phonological Awareness and Reading Tests (all standard scores):

• **Comprehensive Test of Phonological Processing (CTOPP)** (Wagner, Torgeson, & Rashotte, 1999): Subtests: Elision, Blending Words, Nonword Repetition.

• **Test of Word Reading Efficiency (TOWRE)** (Torgeson, Wagner, & Rashotte, 1999): Subtests: Sight Word Efficiency, Phonemic Decoding Efficiency.

• **Woodcock Reading Mastery Tests – Revised** (Woodcock, 1998): Subtests: Word Identification, Word Attack, Passage Comprehension.

Correlational Analyses Control Variable:

• **Kaufman Brief Intelligence Test (KBIT)** (Kaufman & Kaufman, 1990) Kindergarten Composite Score of Vocabulary and Matrices tests.

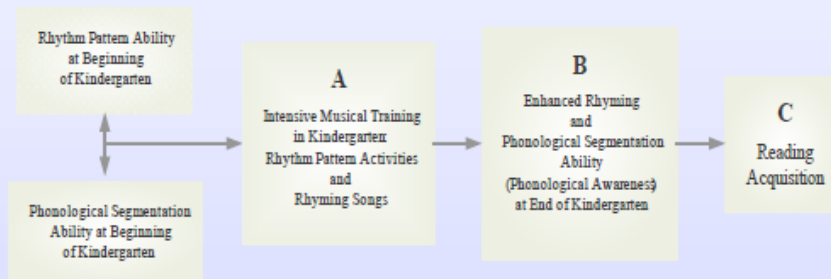
PARTIAL CORRELATION RESULTS n = 12
**Kindergarten Rhythm & Tempo to 2nd Grade PA & Reading
 Control for Kindergarten KBIT-Composite “Abbreviate IQ”**

CHI-SQUARE TEST RESULTS: SPRING % of Children Able to Perform More Difficult PA Tests

	EXPERIMENTAL GROUP	CONTROL GROUP
Segmentation of Phonemes $X^2(1,27) = 12.24, p < .01$	100 %	38 %
Isolation of Final Phoneme $X^2(1,27) = 12.24, p < .01$	100 %	42 %

STUDY 1 – CONCLUSIONS

This study's results suggest the following pathway by which musical training in young children could affect reading acquisition:



This study provided support for the underlying links between rhythm pattern abilities and phonological segmentation subskills in kindergarten, and for the link between musical training (A) and enhanced phonological awareness (B) as represented in Figure below. Decades of prior research support the link shown between phonological awareness (B) and reading acquisition (C) (Adams, 1990; National Reading Panel, 2000). Prior research with dyslexic primary grade children (Overy, *Annals. N.Y. Acad. Sci.*, 999, 2003) suggested a similar model.

		RHYTHM				
		Tempo Copying Computer Score	Tempo Copying Human Rater Score	Rhythm Pattern Copying Computer Score	Rhythm Pattern Copying Human Rater Score	Rhythm Pattern Discrimination Raw Score
		KINDERGARTEN RHYTHM – FALL SCORES				
PHONOLOGICAL AWARENESS	Blending words	.40	.35	.63*	.76**	.65*
	Nonword Repetition	.01	.27	.33	.66**	.65*
	Phonemic Decoding Efficiency	.19	.18	.64*	.41	.51
			KINDERGARTEN RHYTHM – SPRING SCORES			
	Word Attack	.47	.28	.33	.02	.67*

STUDY 2 – CONCLUSIONS & FUTURE DIRECTIONS

Study 2 results suggest that kindergarten rhythm production and perception scores are related to their second grade phonological skills (PA) both in speech (blending words and nonword repetition) and in print (phonemic decoding efficiency and word attack). Tempo production was not related to second grade PA. However, the sample size may have been too small to identify a relationship. Alternatively, tempo production may lose its initial positive relationship to PA (sentence segmentation only) in the middle of the kindergarten year as shown in Study 1. Kindergartners' PA skills typically develop from sentence-to-word segmentation to word-to-syllable/phoneme segmentation.

Future Directions:

Study 1 and Study 2 pilot results provide several new research questions:

- How early do relationships between rhythm/tempo production and perception ability and PA appear in children?
- If such relationships exist as early as preschool, might preschool rhythm/tempo tests be used to predict later PA, both in speech and in print? As diagnostic tools, rhythm/tempo tests have the advantage of being non-language-based. The same test can be administered to both English-speaking and ELL children.
- If pre-reading rhythm/tempo ability predicts later PA, an essential subskill of reading acquisition, might early music intervention bolster PA in pre-reading children predicted to become poor readers in primary grades?