Phonological Awareness and Musical Rhythm Subskills in Kindergartners

C. Moritz[1], S. Yampolsky[1], G. Papadelis[2], K. Overy[3], M. Wolf[1]

[1]Center for Reading & Language Research,Tufts University [2]Aristotle University of Thessaloniki, Greece [3]Institute for Music in Human and Social Development, University of Edinburgh, UK

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 reading and music are related. Yet little is known about the exact relationships and the specific links between these two domains.

This study included basic research into relationships between musical rhythm and phonological awareness subskills in five-year-olds. In a longitudinal design, the study also compared post-year phonological awareness subskills of kindergartners in two schools with different amounts of musical training.
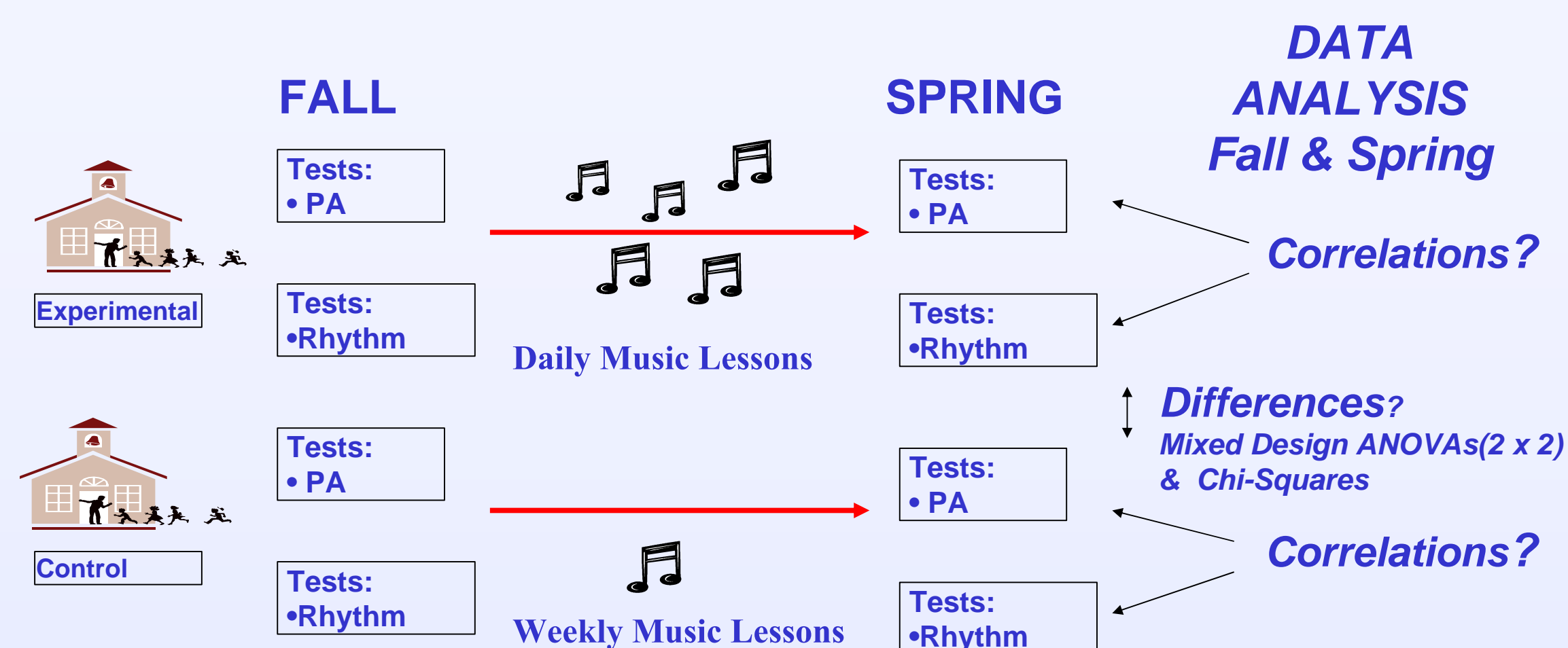
RESEARCH QUESTIONS

1) What specific relationships exist between phonological awareness and rhythm pattern (perception and production) and tempo production subskills in five-year-old children?

2) Will the post-year phonological awareness subskill performance of kindergarten 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

RESEARCH DESIGN

FALL   SPRING

Experimental
Tests:
• PA
Tests:
•Rhythm
Daily Music Lessons
Tests:
• PA
Tests:
•Rhythm

Control
Tests:
• PA
Tests:
•Rhythm
Weekly Music Lessons
Tests:
• PA
Tests:
•Rhythm

DATA ANALYSIS Fall & Spring

Correlations?

Differences? Mixed Design ANOVAs(2 x 2) & Chi-Squares

Correlations?

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: FALL SCORES
Study groups combined into one sample, n = 30
Control for KBIT-Composite "Abbreviate IQ"

	RHYTHM				
PHONOLOGICAL AWARENESS	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*
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

[a]Composite 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)

PARTIAL CORRELATION RESULTS: SPRING SCORES
Results by group
Control for KBIT-Composite "Abbreviate IQ"

	RHYTHM				
PHONOLOGICAL AWARENESS	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)					
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*

[b]Negative 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} *p*	F_{Time} *p*	$F_{Group \times Time}$ *p*
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
Tempo Copying *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

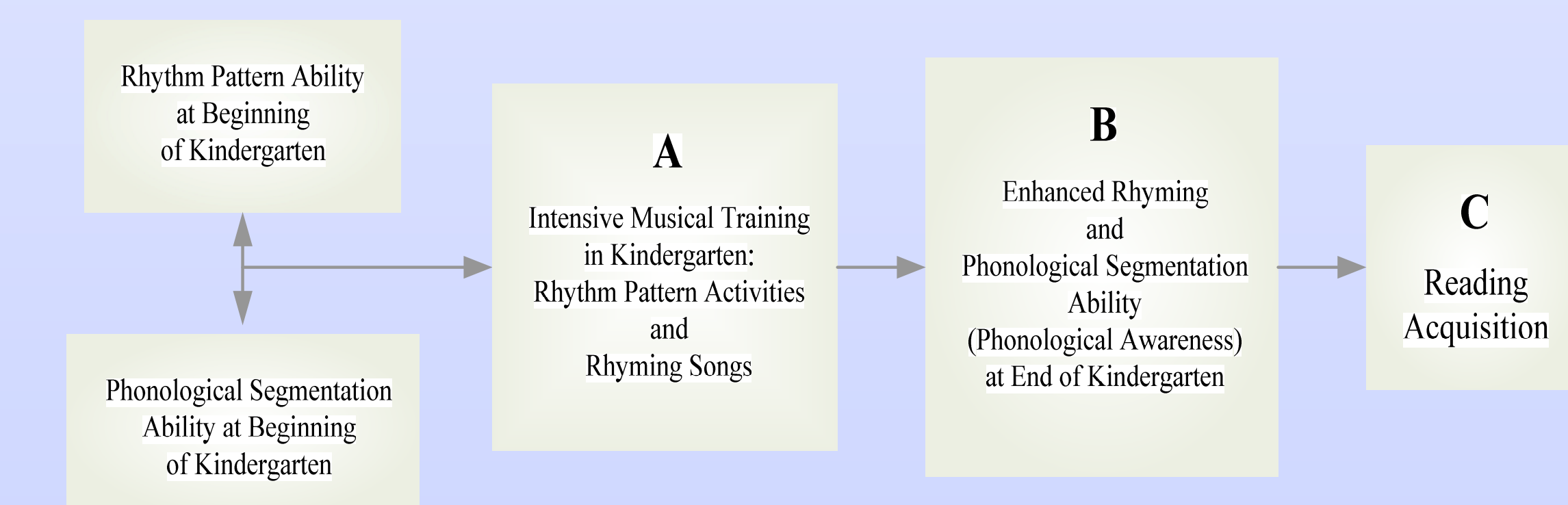[c] Interaction (GroupxTime): Experimental Group improved more than Control Group

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 %

CONCLUSIONS AND FUTURE DIRECTIONS

This study's results suggest the following pathway by which musical training in young children could affect reading acquisition: (1) rhythm pattern production is linked to phonological segmentation ability; (2) exposure to rhythmic pattern production activities and rhyming song lyrics through intensive musical instruction are connected to enhanced phonological awareness in the form of rhyming discrimination and phonological segmentation subskills; and (3) phonological awareness enhances reading acquisition. This study provided support for the underlying links between rhythm pattern abilities and phonological segmentation subskills, 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 Pattern Ability at Beginning of Kindergarten ↕ Phonological Segmentation Ability at Beginning of Kindergarten → **A** Intensive Musical Training in Kindergarten: Rhythm Pattern Activities and Rhyming Songs → **B** Enhanced Rhyming and Phonological Segmentation Ability (Phonological Awareness) at End of Kindergarten → **C** Reading Acquisition

Further Research:
School 1 children's improvement in phonological awareness subskills may be due to intensive practice with rhyming song lyrics in the Kodály music curriculum. More research is needed to tease apart effects of exposure to music and lyrics in musical training.