The Relationship Between Cognition and Action in At-risk Preschool Children

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INTRODUCTION

An important relationship exists between cognitive and motor abilities (e.g., Becker et al., 2014; Diamond, 2000; Livesey et al., 2006; Rigoli et al., 2012), such that one's ability to plan, monitor, and control these abilities may be regulated by the same underlying brain mechanisms. Though previous research has demonstrated this cognitive and motor abilities relationship in older children, little has focused on the critical period for executive function (EF) development during the preschool years, especially among children from disadvantaged backgrounds.

For the preschool age group, early fine motor skills in particular are an important predictor of academic success (Cameron et al., 2012). However, an understanding of the role of other types of motor abilities (such as balance and gross motor skills) is lacking.

Discovering a relationship between EF and these other motor abilities among at-risk children may especially benefit this disadvantaged population, who have lower EF abilities than their non-disadvantaged peers (Noble et al., 2007).

PURPOSE

The current project explored the relation between EF and motor abilities in at-risk preschool-aged children from a disadvantaged population.

METHODS

Participants: 19 3- and 4-years from a preschool attended by low-SES children (3-year-olds: N=7, 2 girls, M_{age}=42.5-months; 4-year-olds: N=12, 5 girls, M_{age}=55.5-months)

Procedure: Participants completed

- an expressive IQ test: (Expressive One Word Picture Vocabulary Test; EOWPT)
- 4 age-appropriate EF tasks: Gift Delay, Peg Tapping, Head-Toes-Knees-Shoulders (HKTS), dimensional conflict card sort task (DCCS)
- Measures of manual dexterity, aiming, and balance: Movement Assessment Battery for Children v. 2 (MABC-2)

RESULTS

Four-year-olds outperformed 3-year-olds across the EF measures (Table 1), MANOVA $F(4, 13)=3.809$, $p=0.029$. Univariate ANOVA tests demonstrated that this was true for Peg Tapping ($p=0.001$) and DCCS ($p=0.002$), but not for Gift Delay ($p=0.163$) or HTKS ($p=0.321$). Because the four measures cohered well (Cronbach α=0.832), an EF composite score was created by averaging the four Z-scores from each child. Each of the motor skills assessment scores were normalized for age as specified by the MABC-2 manual, and an overall motor score and three subscores were calculated (Table 1). Given the age-normalization, as expected, no age differences existed, MANOVA $F(3, 15)=1.850$, $p=0.181$.

Table 1: Means and (SD) on EOWPT, EF, and motor skills tasks.

Task	3-year-olds	4-year-olds
EOWPT	101.86 (18.33)	108.73 (14.35)
DCCS (level achieved)	0.86 (0.69)	1.83 (0.39)
Peg Tapping (# correct trials)	5.00 (3.79)	10.5 (3.85)
HTKS (# correct inhibits)	6.90 (16.41)	13.25 (14.60)
Gift Delay (sec)	40.86 (23.11)	53.82 (14.72)
Aiming Score	26 (5)	22 (4)
Manual Dexterity Score	25 (8)	22 (6)
Balance Score	36 (5)	30 (5)
Combined Motor Score	87 (12)	74 (12)

EF positively correlated with overall motor ability, even when controlling for age and expressive IQ (Table 2). For the motor subscales, there was a positive correlation between EF, manual dexterity, and balance, but not aiming. However, EF positively correlated with all three motor subscales, when controlling for age and expressive IQ.

Table 2: Raw and (partial correlations) for age and verbal ability between EF and motor skills.

	EOWPT	EF Comp	Motor Total	Manual Dexterity	Aiming	Balance
Age (mos)	0.115	0.124	-0.302	-0.109	-0.202	-0.366
EOWPT		0.359	-0.406^{+}	-0.008	-0.583*	-0.369
EF Comp			0.529* (0.854)**	0.475* (0.527)*	0.272 (0.662)**	0.390^{+} (0.679)**
Motor Total				0.708** (0.777)**	0.731** (0.653)**	0.779** (0.714)**
Manual Dexerity					0.231 (0.266)	0.225 (0.216)
Aiming						0.525* (0.380)

Note: ** $p<0.01$, *$p \leq 0.05$, $^{+}$ $p<0.10$

DISCUSSION

These preliminary findings demonstrate that preschoolers from low-SES environments who demonstrated more advanced EF skills also exhibited more advanced motor skills, further highlighting the importance of the relationship between motor and cognitive abilities.

As evidenced by our preliminary findings, we believe that a successful EF intervention program would need to emphasize all aspects of motor skills training, not just fine motor skills, to provide optimal benefits.

Given the importance of preparing preschoolers for kindergarten and beyond an early focus on fine motor, gross motor, and balance abilities may positively impact later academic performance.

REFERENCES

Becker et al. (2014). *Early Education & Development, 25*(1), 56-70.

Cameron et al. (2012). *Child Development, 83*(4), 1229-1244.

Diamond (2000). *Child Development, 71*(1), 44-56.

Livesey et al. (2006). *Human Movement Science, 25,* 50-64.

Noble et al. (2007). *Developmental Science, 10*(4), 464-480.

Rigoli et al., (2012). *Developmental Medicine & Child Neurology, 54*(11), 1025-1031.