Executive Functions: Academic Skills and Gender Differences

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Abstract

This study investigated the relations between executive functions and three levels of academic skills, as well as the extent of gender differences in executive skills. The subjects were 1,000 children aged 5-18. The measure was the teacher rating form of the recently released McCloskey Executive Functions Scale (MEFS). The level of skill development on all nine executive functions clusters was significantly different between students with below average, average, and above average academic skill rankings. There were also significant differences between males and females on most executive functions clusters, with the most significant differences occurring during the preschool, middle, and high school years.

Introduction

Executive functions are responsible for the self-regulation of such cognitive processes as planning, working memory, initiating work, and self-monitoring. In academic settings, executive functions have been found to be important predictors of academic achievement (Brice, Whitebread, & Szucs, 2015). Jacob and Parkinson (2015) found a moderate, unconditional association between executive functions and achievement that did not differ by executive function construct, age, or measurement type. Executive functions also play an essential role in academic performance, such as completing homework (Wood, Murdock, & Cronin, 2002). In daily life, executive functions influence behaviors such as attention, inhibition, and social perceptions. Thus, deficits in executive functions can account for poor academic performance and poor social functioning. Learning disabilities, ADHD (Barkley, 2005), and autism are among the disorders that are often characterized by poor executive functions.

It is known that there are differences in executive functions between boys and girls who have behavior disorders, such as conduct disorders (Urazán-Torres et al., 2013). However, very little research has investigated gender differences in executive functions among children without behavior disorders, and the results so far have been equivocal. For example, Feifer and Rattan (2007) reported that males and females typically display different profiles of executive functions; for example, some studies have found girls to have better inhibitory control. However, Brocki and Bohlen (2004) did not find any consistent data on sex differences.

This study hypothesized that there would be significant differences between males and females across the majority of the MEFS executive functions clusters. It was also hypothesized that academic performance would be significantly related with the developmental and skill levels of executive functions.

Method

Participants

During standardization of a norm-referenced test, 254 teachers from 167 communities in 29 U.S. states completed ratings on 1,000 children and adolescents who were their students. The subjects ranged in age from 5 through 18 years of age, with 500 males and 500 females. The sample's demographic characteristics closely approximated the 2010 U.S. Census percentages. Also, 17 percent of the subjects were students with disabilities.

Materials and Procedures

Data was collected with the McCloskey Executive Functions Scale (MEFS; McCloskey, 2016), a standardized, web-based, teacher rating scale designed to assess teacher perceptions of students' use of executive functions. The main purpose of the MEFS is to facilitate the identification of executive function strengths, executive function deficits, and executive skill deficits in children referred for a psychological evaluation. The MEFS consists of 110 items that assess multiple aspects of self-regulation, self-realization and self-determination. The scale is organized into nine clusters and composites: Attention, Engagement, Optimization, Efficiency, Memory, Inquiry, Solution, Self-Realization, and Self-Determination. Approximately half of the items address executive skills needed for academic success, such as "Moves from one school task to another without difficulty." The other items address "self" and social skills, such as "Maintains emotional control in frustrating situations."

Classroom and special education teachers who agreed to participate were asked to rate up to five of their current students. Teachers completed the ratings online, selecting one of six ratings, ranging from "Unable to do it even with assistance" to "Almost always does it on own without prompting." The teacher raters also were asked to select the subject's overall level of academic skills, with the options being "Below Average," "Average," and "Above Average."

Results

Teacher rankings of students' overall academic skills approximated a normal distribution, with 16.7 percent ranked as "below average", 63.9 percent as "average", and 19.4 percent as "above average." For each of the nine executive function clusters, students rated as below average had the lowest t-scores, those rated as average had the next highest, and those rated as above average had the highest. Students with higher scores had more executive strengths and fewer executive deficits than students with lower scores. The results of the ANOVA revealed very significant between-groups differences for all of the executive clusters (see Table 1).

Gender differences varied somewhat by age (see Table 2). For the most part, females were rated as having better executive functions abilities and skills than males. For the middle school years (ages 11-13), females had significantly higher raw scores on each of the nine clusters. For the high school years (ages 14-18), females had significantly higher scores on the seven Self-Regulation clusters, but there were no differences for the Self-Realization and Self-Determination clusters. Also, females were mostly superior at ages 5-6, but differences between the sexes were minimal during the elementary school years (ages 7-8 and 9-10), except for the Engagement and Optimization clusters.

Discussion

Based on teacher ratings of students' executive functions, there appears to be exceptionally strong relations between academic skills acquisition and the development and application of executive functions. Clearly, executive functions have a strong influence on the development and performance of academic skills. The implication is that assessment of executive functions should be an integral component of psychoeducational evaluations when students are referred for academic deficiencies.

The results of gender comparisons reveal that female development for the majority of executive functions is more advanced than that of males at most age levels. This finding is consistent with the fact that more males than females have developmental, learning, and behavior disorders. However, it may be that males have similar levels of executive functions awareness and ability but fail to apply their executive functions abilities and skills without prompts.

References

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Table 1 MEFS *T*-Scores by Academic Skills Level and ANOVA Results

Cluster	Academic Skills Level	*N*	Mean**	SD	*F**	Significance
Attention	Below Average	167	39.15	11.198	186.739	.000
	Average	639	50.91	8.008		
	Above Average	194	55.94	7.343		
Engagement	Below Average	167	41.44	11.962	104.898	.000
	Average	639	50.80	8.579		
	Above Average	194	54.91	7.742		
Optimization	Below Average	167	40.53	10.554	140.357	.000
	Average	639	50.73	8.519		
	Above Average	194	55.75	8.011		
Efficiency	Below Average	167	37.95	10.244	255.541	.000
	Average	639	51.15	7.900		
	Above Average	194	56.61	6.555		
Memory	Below Average	167	37.16	10.778	309.818	.000
	Average	639	51.28	7.322		
	Above Average	194	56.99	6.333		
Inquiry	Below Average	167	39.31	10.223	195.076	.000
	Average	639	50.75	8.113		
	Above Average	194	56.54	7.756		
Solution	Below Average	167	38.89	10.048	218.395	.000
	Average	639	50.82	8.108		
	Above Average	194	56.86	7.265		
Self-Realization	Below Average	167	44.86	9.382	48.505	.000
	Average	639	49.92	9.300		
	Above Average	194	54.78	10.449		
Self-Determination	Below Average	167	42.28	7.776	110.903	.000
	Average	639	50.07	9.248		
	Above Average	194	56.53	9.473		

**Between Groups ANOVA
** Higher *t*-scores equal better development executive functions.

Table 2 MEFS Raw Score Means by Gender and Age and *T*-Test for Equality of Means*

Cluster	Gender	Ages 5-6 Mean	Ages 5-6 Significance	Ages 7-8 Mean	Ages 7-8 Significance	Ages 9-10 Mean	Ages 9-10 Significance
Attention	Female	24.74	**.001**	24.99	.054	25.36	**.019**
	Male	22.03		23.43		23.67	
Engagement	Female	92.46	**.000**	93.97	**.007**	94.18	**.012**
	Male	83.15		86.49		87.99	
Optimization	Female	55.84	**.000**	56.53	**.019**	58.13	**.000**
	Male	49.24		52.19		52.01	
Efficiency	Female	52.91	**.006**	55.09	.254	55.73	.067
	Male	47.34		52.83		52.40	
Memory	Female	27.37	.069	28.45	.308	28.89	.183
	Male	25.47		27.46		27.72	
Inquiry	Female	39.92	**.003**	41.83	.091	42.72	**.018**
	Male	35.02		39.09		39.09	
Solution	Female	47.91	**.002**	49.35	.078	50.30	**.035**
	Male	41.99		45.77		46.68	
Self-Realization	Female	15.72	**.020**	17.67	.585	17.23	.881
	Male	12.65		17.00		17.44	
Self-Determination	Female	6.80	.092	8.62	.514	9.40	.245
	Male	5.66		8.16		8.56	

* Two-tailed significance testing; equal variances not assumed.

P values in bold are significant at the .05 level or less.

N = 100 males and 100 females in each age group.

Table 2 MEFS Raw Score Means by Gender and Age and *T*-Test for Equality of Means Continued*

Cluster	Gender	Ages 11-13 Mean	Ages 11-13 Significance	Ages 14-18 Mean	Ages 14-18 Significance
Attention	Female	25.23	**.000**	25.54	**.001**
	Male	22.29		23.26	
Engagement	Female	93.41	**.000**	93.95	**.001**
	Male	82.38		85.46	
Optimization	Female	57.98	**.000**	58.77	**.000**
	Male	50.16		52.56	
Efficiency	Female	55.45	**.003**	57.78	**.000**
	Male	49.66		50.92	
Memory	Female	28.29	**.016**	29.62	**.018**
	Male	26.01		27.52	
Inquiry	Female	42.08	**.000**	25.54	**.000**
	Male	36.67		23.26	
Solution	Female	49.54	**.002**	93.95	**.000**
	Male	43.92		85.46	
Self-Realization	Female	20.07	**.002**	19.26	.153
	Male	16.51		17.21	
Self-Determination	Female	10.86	**.000**	11.06	.096
	Male	8.36		9.74	

* Two-tailed significance testing; equal variances not assumed.

P values in bold are significant at the .05 level or less.

N = 100 males and 100 females in each age group.