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Journal of Neurology and Psychology

Special Issue

Clinical Neuropsychology

Editors:
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Assistant Professor of Psychology
Saint Louis University, USA

Avens Publishing Group
J Neurol Psychol
Special Issue 2015

Open Access Research Article

Journal of
Neurology and Psychology

Relationships between Executive Function and Emotional Regulation in Healthy Children

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Submission: 07 October 2015
Accepted: 27 November 2015
Published: 03 December 2015

Abstract

As an aspect of cognitive control, emotion regulation has been thought to be closely associated with executive functioning. Previously proposed models have indicated that they are bidirectionally linked, suggesting that deficits in one area of functioning may generate deficits in the other. The current study sought to investigate the relationships between executive functioning and emotion regulation in healthy children ages 8-12 by examining associations between standardized measures of executive functioning and emotion regulation. Children were administered neuropsychological and self-report measures of emotion regulation and executive functioning while parents completed behavioral ratings of these abilities. Associations between behavioral ratings and neuropsychological measures indicated that greater proficiency in executive functioning skills was associated with greater emotion regulation capabilities. These findings extend prior work showing that executive functioning and emotion regulation are linked, and may have important implications for treatment planning in clinical populations with weaknesses in these areas.

Introduction

Emotions are multifaceted psychological responses, arising from goal-oriented attention [1] and action predispositions [2]. Emotion regulation has been defined by Saarni as the regulation of the experience of emotion by monitoring one's expressive behavior [3]. This refers to the ability of the individual to modify the intensity, level of arousal, and time course of an emotion in order to meet the goals that the external situation requires [4]. One of the key facets of emotion regulation is the ability to modulate the development of mood disruptions by reducing negative emotional responses [5], which can be automatic or controlled, conscious or unconscious [1].

Research on emotion regulation has suggested that as an aspect of cognitive control [6], it is closely associated with executive functioning. Executive functioning can be defined as the deliberate control of thought and action for future thoughts and behaviors [7,8], involving cognitive processes such as planning, working memory, error detection and inhibitory control [9-11]. Moreover, many researchers conceptualize executive functioning as a collection of top-down control processes that are required for all goal-directed behaviors, especially when these behaviors call for inhibiting automatic or established thoughts and responses and when acting on impulse is inadvisable [9,12,13].

In the early years of development, children begin to understand emotion through contextual factors such as language development, cultural values, and influence of caregivers. As they mature their understanding of emotion becomes more complex, with the development of cognitive reappraisal to aid them in understanding the complexities of emotion in those around them. Throughout the lifespan, emotion regulation continues to develop, often necessitated by changes in life context, requiring the individual to alter one's coping style as situations change. Research has indicated that experience plays a primary role in allowing an adult to modulate emotion regulation processes [1].

The prefrontal cortex (PFC) undergoes substantial development throughout childhood and into adulthood. Since attentional control is generally associated with the PFC throughout the lifespan [14], this cognitive ability varies considerably by age. Some evidence has suggested that attentional control is associated with more posterior cortical involvement in younger children [15], and neuroimaging research has indicated less PFC activation in adults than in children [16] or adolescents [17] in tasks requiring inhibition or directed attention. Moreover, neuroimaging findings have revealed that children showed a greater volume of PFC activation than adults in a task of working memory [18]. Such changes in activation patterns over time may be due to increasing neural efficacy or developmental changes in synaptic pruning and myelination, which increase cognitive integration and development [17,18].

Associations between better self-regulation and higher social functioning in situations of conflict are found as early the preschool stage [19]. Neuroimaging studies suggest that increased attention-related neural activity in emotional contexts reflects allocation of cognitive resources for regulatory control [14,20,21]. Such results indicate that children's difficulties in regulating behaviors in emotional contexts may be the result of competition between well-developed emotional processes and poorly developed cognitive control systems [22,23].

Deficits in attention and emotion regulation tend to co-occur in many at-risk populations such as those presenting with Attention Deficit/Hyperactivity Disorder (ADHD) [24], and increased attention to distracting negative or ambiguous emotional information has been associated with mood or anxiety disorders [25,26]. These deficits reflect the importance of an appropriately developing frontal lobe to inhibit the depletion of available resources for voluntary emotion regulation [27].

Additionally, many investigators link aggressive behavioral difficulties with inadequate or inappropriate emotional regulation

ISSN: 2332-3469

[28-30]. Young children who are less able to voluntarily shift attention and inhibit their emotional impulses have been shown to display higher levels of aggression [31]. Furthermore, externalizing and internalizing disorders can be understood as disorders of emotion regulation [32] through difficulty utilizing control, indicating their inability to disengage from the negative emotional content [33,34].

The current study investigated the relationship between emotion regulation and executive functioning in healthy children by examining associations between standardized measures of executive functioning and emotion regulation skills. Behavioral indicators of executive and emotional control were assessed using self- and parent-report rating scales and objective evaluation of executive function skills. We predicted that behavioral ratings of executive control and emotion regulation would correlate with one another and with objective measures of executive control, particularly inhibition.

Method

Participants

Participants consisted of 15 healthy, typically developing children ages 8-12 years old (11 males, 4 females) and their parents. Child participant age was distributed across the age range, with a mean age of 10 years (SD = 1.5). Chi-square analysis on participant gender and age suggested that gender did not significantly vary as a function of age, χ^2 (5.4), $p > 0.24$. Five sibling pairs were included in the sample. Children with a history of seizures, epilepsy, diagnosed neurological disease, or a family history of epilepsy or seizures were excluded from participation in the study. Additionally, no children were reported to have a history of neurodevelopmental disorders (e.g., Autism Spectrum Disorder or ADHD) or psychiatric diagnoses (e.g., depression or anxiety). IRB approval was acquired prior to the initiation of the study and individual assent and consent was obtained from all participants. Families were compensated for their participation.

Materials and procedure

Select neuropsychological tests from the Delis-Kaplan Executive Functions Scale (D-KEFS) [35] were administered to youth participants in order to assess executive function skills. The D-KEFS is an individually administered neuropsychological battery of tests designed to detect even mild forms of executive dysfunction among clinical populations ages 8-89 years. It was derived from existing experimental and clinical measures and normed on a standardization sample consisting of 1,750 individuals. For the purposes of the current study, select subtests including D-KEFS Trails, Color-Word Interference, Verbal Fluency, and Tower Task (internal consistency = .60-.89) [35] were administered in a pseudo-randomized order. The outcome variables of interest for Trails (Number-Letter Switching) and Color-Word Interference (Inhibition, Inhibition-Switching) were times to completion, the variables of interest for Verbal Fluency (Category Switching) were number of correct responses and switching accuracy, and the variable of interest for the Tower Test was the total achievement score. Given that the sample consisted of healthy, typically developing children, we chose to focus our analyses on raw scores generated for each measure. One child had incomplete data on the Verbal Fluency subtest.

In order to assess emotion regulation skills, children also completed two self-report questionnaires evaluating emotional arousal and control. The Emotion Regulation Index for Children and Adolescents (ERICA) [36] is a 16-item self-report inventory that examines ability to regulate emotions. It is comprised of Emotional Control, Emotional Awareness, and Situational Responsiveness subscales and yields an overall Emotion Regulation Index score. Psychometric evaluation of the ERICA conducted on a sample of 1,389 children ages 9-16 revealed a high Cronbach's alpha for the overall scale (r = 0.75) and reliability coefficients ranging from 0.64 to 0.73 for the three determined factors (Emotional Control, Emotional Awareness, and Situational Responsiveness) [36]. The How I Feel questionnaire (HIF) [37] is a 30-item self-report inventory that examines aspects of emotional arousal and control that can be brought to consciousness in children. The HIF measures three aspects of emotionality including Positive Emotion, Negative Emotion, and Emotion Control. A psychometric evaluation of the HIF conducted on 1,850 children ages 8-12 revealed high internal consistency estimates ranging from 0.80-0.90 and good convergent and discriminant validity [37].

Finally, to assess practical executive control and emotion regulation skills, parents completed two standardized informant-report inventories evaluating various aspects of their child's behavioral and executive functioning. The Behavior Assessment System for Children Parent Rating Scale (BASC-2 PRS) [38] evaluates broad behavioral functioning in children and adolescents and yields eight clinical subscales, three clinical composite scores, and four adaptive scales. BASC-2 scales and composites have high internal consistency and test-retest reliability with alpha coefficients for subscales exceeding 0.80 [38]. The BASC-2 PRS has been shown to possess reliabilities for the subscales ranging from 0.80-0.87, as well as good validity established using four separate types of evidence with an additional four indices to measure the validity of parents' responses [38]. The Behavior Rating Inventory of Executive Function (BRIEF) [39] assesses executive functioning in children and adolescents and yields eight subscales reflecting various facets of executive function, two composite scores, and a global executive composite. The BRIEF was normed on a sample of 1,419 healthy children and an additional clinical sample of 852 children, and was found to demonstrate high internal consistency (r = 0.80- 0.90) and good content validity [39,40].

All neuropsychological testing and completion of questionnaires took place at the Cognitive and Affective Psychophysiology (CAP) laboratory at Saint Louis University in St. Louis, Missouri. A qualified research team member administered neuropsychological tests and youth self-report questionnaires in a quiet testing room. The research team member was available to answer questions for youth participants during completion of the self-report questionnaires. Parents of participants completed informant-report inventories in a nearby, adjacent room.

Statistical analyses

Assessment measure raw scores for each participant were calculated and scored according to the directives of the assessment literature, testing manuals and associated scoring software. Means and standard deviations were calculated for the raw scores of each subscale score. A series of Pearson correlations were conducted among parent (BASC-2 and BRIEF) and child report measures (ERICA and HIF), and objective measures of executive function

ISSN: 2332-3469

(D-KEFS: Color-Word Interference *Inhibition* and *Switching* scores, Verbal Fluency *Correct Category Switching* and *Category Switching Accuracy* scores, Trails *Number-Letter Switching* score, and Tower total score). For the analyses, square root transformations were performed on the following variables, due to violations in normality: BASC-2 *Emotional Self-Control*, BRIEF *Emotional Control*, and Color-Word Interference *Switching*.

Results

Initial mean raw scores for all behavioral and performance indicators of executive and emotional control are presented in Tables 1 and 2. Decreased scores on inventories with negatively-phrased questions, such as the BASC-2, BRIEF, and HIF (*Negative Emotion*), indicate greater competency in the designated skill area. Alternatively, increased scores on questionnaires with positively-phrased questions, such as the ERICA (*Emotion Control, Emotional Self-Awareness, Situational Responsiveness*) and HIF (*Emotion Control, Positive Emotion*), indicate greater skill proficiency. Evaluation of proficiency in executive functioning, as measured by the D-KEFS, varies by subtest. For the Tower and Verbal Fluency tasks, higher scores indicate greater executive control, whereas for the Trails and Color-Word Interference tasks, lower scores indicate greater proficiency.

Parent report of executive functioning and emotion regulation

Pearson's correlations between subscales on parent-report measures of executive control indicated that decreased scores on the BASC-2 *Emotional Self-Control* subscale corresponded as expected with decreased scores on the BRIEF *Emotional Control* subscale. However, correlations among BASC-2 subscales and the BRIEF *Inhibit* subscale were non-significant. Additionally, strong positive relationships were found between the BRIEF *Emotional Control* and BASC-2 *Anger Control* and *Negative Emotionality subscales*, further supporting similarities in the constructs as assessed by both measures.

Table 1: Raw and standardized behavioral indicators of executive functioning and emotion regulation.

	N	Mean Raw Score	Std. Deviation Raw Score	Minimum Raw Score	Maximum Raw Score	Mean T-Score	Std. Deviation T-Score
BASC-2							
Emotional Self-Control	15	2.20	2.57	0.00	7.00	45.87	9.55
Anger Control	15	5.07	2.58	1.00	10.00	47.33	6.60
Executive Function	15	6.53	3.62	1.00	14.00	43.67	7.63
Negative Emotionality	15	3.08	2.78	0.00	10.00	46.27	10.19
BRIEF							
Emotional Control	15	13.73	3.88	10.00	21.00	45.67	10.27
Inhibit	15	13.00	2.51	9.00	18.00	46.33	5.37
How I Feel (HIF)							
Emotion Control	15	32.33	8.07	17.00	47.00	--	--
Positive Emotion	15	27.60	7.61	11.00	39.00	--	--
Negative Emotion	15	24.40	8.42	12.00	39.00	--	--
Emotion Regulation Index (ERICA)							
Emotional Control	15	22.73	4.93	13.00	31.00	--	--
Emotional Self-Awareness	15	17.20	2.93	13.00	23.00	--	--
Situational Responsiveness	15	16.40	2.10	13.00	20.00	--	--

BASC-2, BRIEF, HIF Negative Emotion subscale: lower scores indicate greater proficiency; HIF Emotion Control, HIF Positive Emotion, ERICA: Higher scores indicate greater proficiency.

Table 2: Raw and standardized scores for neuropsychological measures of executive functioning.

	N	Mean Raw Score	Std. Deviation Raw Score	Minimum Raw Score	Maximum Raw Score	Mean T- Score	Std. Deviation T-Score
D-KEFS							
Trails, Number-Letter Switching	15	89.20	28.31	48.00	160.00	56.13	8.21
Verbal Fluency, Correct Switching	14	10.14	2.60	6.00	14.00	52.35	11.44
Verbal Fluency, Correct Switching Accuracy	14	7.93	2.76	4.00	13.00	50.71	11.10
Color-Word Interference, Inhibition	15	75.53	17.29	48.00	103.00	54.73	5.78
Color-Word Interference, Switching	15	76.47	16.98	59.00	111.00	56.87	4.73
Tower, Total Achievement	15	16.27	3.28	11.00	22.00	52.80	7.51

D-KEFS: Higher Verbal Fluency and Tower scores indicate greater proficiency while lower Trails and Color-Word Interference scores indicate greater proficiency.

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Intra-measure subscale correlations indicated moderate to strong positive relationships between the BASC-2 *Executive Functioning, Emotional Self-Control, Negative Emotionality, and Anger Control* subscales (Table 3).

Child report of emotion regulation

Pearson's correlations between child-report measures of emotion regulation indicated moderate to strong inter-subscale relationships and strong intra-subscale relationships. Specifically, higher scores on HIF *Emotion Control* corresponded with higher scores on ERICA *Situational Responsiveness*, and increased ratings of positive emotion, assessed by the HIF *Positive Emotion* subscale corresponded with higher ratings of ERICA *Situational Responsiveness*. Intra-measure correlations indicated moderate to strong positive relationships between all ERICA subscales, suggesting adequate construct validity (Table 4).

Parent report and objective measures of executive functioning

Correlational analyses between parent-report measures and D-KEFS performance indicators revealed moderate to strong inverse relationships. In contrast to our predictions, Pearson's correlations between BASC-2 and BRIEF executive control subscales (*Emotional Self-Control*, *Emotional Control*, and *Inhibit*) and performance on the Color-Word Interference task (*Inhibition* and *Inhibition/Switching*) were found to be non-significant (Table 5). However, correlations investigating associations between BASC-2 and BRIEF executive and emotional control subscales and performance on the Verbal Fluency task revealed several significant relationships. Higher scores (number of correct responses) on the Verbal Fluency task were related to lower scores on the BASC-2 *Negative Emotionality*, *Emotional Self-Control*, and *Anger Control* subscales. Similarly, better switching accuracy on the Verbal Fluency task corresponded with lower scores on the BASC-2 *Negative Emotionality, Emotional Self-Control*, and *Executive Functioning* subscales. Finally, decreased scores on the BRIEF *Emotional Control* subscale were related to better performance (number of correct responses and switching accuracy) on the Verbal Fluency task. These relationships can be seen in Table 5 and Figure 1.

Table 3: Intercorrelations between BASC-2 and BRIEF raw scores.

Measure	1	2	3	4	5	6
1. BASC-2 *Emotional Self-Control*	--					
2. BASC-2 *Executive Functioning*	0.66**	--				
3. BASC-2 *Negative Emotionality*	0.74**	0.64*	--			
4. BASC-2 *Anger Control*	0.43	0.54*	0.77**	--		
5. BRIEF *Emotional Control*	0.67**	0.32	0.81**	0.69**	--	
6. BRIEF *Inhibit*	-0.30	-0.03	-0.09	0.17	-0.20	--

***p* <0.01 **p* <0.05, df = 13

Table 4: Intercorrelations between ERICA and HIF raw scores.

Measure	1	2	3	4	5	6
1. HIF *Emotion Control*	--					
2. HIF *Positive Emotion*	0.25	--				
3. HIF *Negative Emotion*	-0.11	-0.27	--			
4. ERICA *Emotional Control*	0.33	0.28	-0.49	--		
5. ERICA *Emotional Self-Awareness*	0.47	0.44	-0.56*	0.72**	--	
6. ERICA *Situational Responsiveness*	0.52*	0.62*	0.11	0.40	0.53*	--

***p* <0.01 **p* <0.05, df = 13

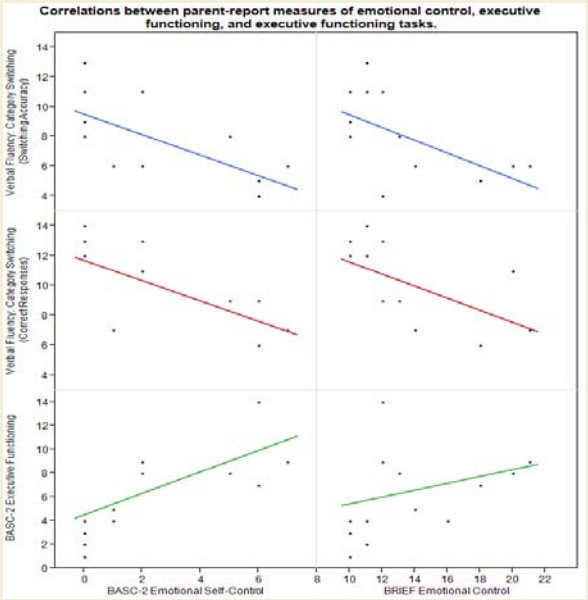

Figure 1: Correlations between parent-report measures of emotional control, executive functioning, and executive functioning tasks.

Child report and objective measures of executive functioning

Pearson's correlations between self-report measures of emotion regulation and D-KEFS performance indicators revealed several significant relationships. In line with our hypotheses, correlations among the HIF, ERICA, and Color-Word Interference task indicated that higher scores on the ERICA *Situational Responsiveness* subscale were related to better performance on Color-Word Interference (*Switching*). Similarly, higher scores on the ERICA *Emotional Self-Awareness* subscale were also related to better performance on the Color-Word Interference task (*Inhibition*). Additional exploratory correlations conducted among other D-KEFS performance indicators showed that higher scores on the ERICA *Emotional Self-Awareness* subscale correlated with better performance on Verbal Fluency (number of correct responses and switching accuracy). Additionally, decreased scores on the HIF *Negative Emotion* subscale corresponded with greater proficiency in switching accuracy on the Verbal Fluency task (Table 6).

In summary, our prediction that behavioral ratings of executive control and emotion regulation would correlate with one another and with objective measures of executive control, particularly inhibition, was partially supported. Correlations between behavioral ratings and performance indicators of executive functioning revealed significant associations among parent ratings of executive functioning and emotion regulation, among child ratings of emotion regulation, and among parent and child behavioral ratings and performance

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Table 5: Intercorrelations among BASC-2, BRIEF, and D-KEFS raw scores.

Measure	1	2	3	4	5	6	7	8	9	10	11	12
1. BASC-2 *Emotional Self-Control*	--											
2. BASC-2 *Executive Functioning*	0.66**	--										
3. BASC-2 *Negative Emotionality*	0.74**	0.64*	--									
4. BASC-2 *Anger Control*	0.43	0.54*	0.77**	--								
5. BRIEF *Emotional Control*	0.67**	0.32	0.81**	0.68**	--							
6. BRIEF *Inhibit*	-0.30	-0.03	-0.09	0.17	-0.20	--						
7. Trails: *Number-Letter Switching*	-0.18	0.11	0.12	0.36	-0.05	0.37	--					
8. Verbal Fluency: *Correct Category Switching*	-0.69**	-0.49	-0.67**	-0.54*	-0.62*	0.30	-0.15	--				
9. Verbal Fluency: *Correct Category Switching Accuracy*	-0.66**	-0.55*	-0.66**	-0.43	-0.62*	0.30	-0.15	0.82**	--			
10. Color-Word Interference: *Inhibition*	0.31	0.49	0.35	0.24	0.08	0.29	0.36	-0.46	-0.21	--		
11. Color-Word Interference: *Switching*	0.07	0.33	0.18	0.24	-0.10	0.42	0.40	-0.13	0.18	0.70**	--	
12. Tower *TotalAchievement*	-0.32	-0.51	-0.27	0.07	-0.08	0.12	-0.23	0.29	0.34	-0.42	-0.35	--

***p* <0.01 **p* <0.05, df = 12, 13

Table 6: Intercorrelations among ERICA, HIF, and D-KEFS raw scores.

Measure	1	2	3	4	5	6	7	8	9	10	11	12
1. HIF *Emotion Control*	--											
2. HIF *Positive Emotion*	0.25	--										
3. HIF *Negative Emotion*	-0.11	-0.27	--									
4. ERICA *Emotional Control*	0.33	0.28	-0.49	--								
5. ERICA *Emotional Self-Awareness*	0.47	0.44	-0.56*	0.72**	--							
6. ERICA *Situational Responsiveness*	0.52*	0.62*	0.11	0.40	0.53*	--						
7. Trails: *Number-Letter Sequencing*	-0.26	0.09	-0.17	-0.15	-0.38	-0.17	--					
8. Verbal Fluency: *Correct Category Switching*	-0.20	0.39	-0.46	0.50	0.78**	0.18	-0.36	--				
9. Verbal Fluency: *Correct Category Switching Accuracy*	-0.13	0.25	-0.73**	0.36	0.64*	-0.19	-0.15	0.82**	--			
10. Color-Word Interference: *Inhibition*	-0.50	-0.42	0.06	-0.60	-0.56*	-0.41	0.36	-0.46	-0.21	--		
11. Color-Word Interference: *Switching*	-0.15	-0.25	-0.20	-0.01	-0.31	-0.60*	0.39	-0.13	0.18	0.70**	--	
12. Tower *Total Achievement*	0.11	0.09	0.06	-0.03	0.34	0.10	-0.23	0.29	0.34	-0.42	-0.35	--

***p* <0.01 **p* <0.05, df = 12, 13

indicators of executive functioning (D-KEFS Verbal Fluency and Color-Word Interference). No significant relationships were found between parent- and child-report measures.

Discussion

This study investigated relationships between executive functioning and emotion regulation in a sample of healthy, typically developing children. The main objective was to determine the nature of the relationship between emotion regulation and executive control through self- and parent-report behavioral ratings and objective neuropsychological measures of these abilities. Associations between behavioral ratings and neuropsychological measures observed in the current study suggest broadly that enhanced executive function skills may be associated with greater emotion regulation capabilities. Taken together, these results help to clarify bidirectional associations underlying the relationship between executive and emotional control.

Neuropsychological evidence of relationships between executive functioning and emotion regulation

Consistent with our hypothesis that behavioral ratings of executive control and emotion regulation would correlate with one another and with objective measures of executive control, significant associations between behavioral ratings of executive functioning and emotion regulation and objective measures of executive functioning were observed. Broadly speaking, BASC-2 indicators of executive control and emotion regulation correlated with one another, indicating that report of better executive function skills is associated with better reported emotion regulation abilities. Additionally, although our hypothesis that behavioral ratings of executive control and emotion regulation would correlate with objective measures of inhibition

ISSN: 2332-3469

was not supported, additional analyses examining other facets of executive functioning illuminated several important relationships. First, parent endorsement of greater executive control and emotion regulation skills was generally associated with better performance on tasks measuring executive functioning. Second, child endorsement of better emotion regulation skills was found to be indicative of better executive control. Of note, parent- and child-report measures did not correlate with one another. Given that they both demonstrated similar trends in their relationships with D-KEFS measures, this lack of convergence may be attributable to wording differences between the questionnaires.

As previously described, the relationships between executive and emotional control have been widely discussed in the literature. Barkley suggested that inhibitory functions, comprised of many factors including self-regulation of affect, are fundamental for efficient executive functioning [24]. More specifically, the ability to self-regulate or bring about emotional states in order to support goal-directed behaviors requires the incorporation of greater executive functioning. Zelazo and Cunningham and Carlson and Wang created models that determined that executive function and emotion regulation demonstrate bi-directional relationships [41,42], implying that deficits in one area may lead to deficits in the other.

Results of the current study support this conceptualization of the relationship between executive functioning and emotion regulation, namely that better skills in one area are associated with better skills in the other. Although our results are limited to healthy children who do not display clinically significant executive or emotion control deficits, further research examining the nature of this relationship in clinical populations is warranted.

Possible Limitations

The current study has several limitations which must be considered. First, the uniform characteristics of our healthy sample yielded a lack of variability in the results. Despite being recruited from the greater St. Louis community, the majority of participants reported a moderate to high SES background, with high levels of educational achievement in both children and their parents. As a result, performance on neuropsychological measures was very high across participants and tasks, with very little variability in the raw scores. It should also be noted that there was a large number of sibling pairs in the study, which might have further skewed the data if the participants shared heritable traits. Additionally, although analyses suggested that gender did not vary by age, the large difference in the number of males and females in the study may also limit the representativeness of the sample.

For this preliminary study, in order to better control for task difficulty and response variability on the rating forms, our sample was kept relatively homogenous with regard to participant age and background. This did not include restricting gender; however, few female children indicated interest in participating in the study. In order to better understand these suggested relationships, further research is warranted to better explore these relationships in a more diverse child population with greater equality of gender distribution. Moreover, recruitment of additional participants would serve to increase the power of the study, given that the current sample size was notably small.

Second, it was observed that parent and child report measures of executive function and emotion regulation did not correlate with one another, despite having similar associations with objective measures of executive functioning. This may be accounted for by the potential confound that parent measures were negatively worded (e.g. “Loses temper too easily”), while child reports were positively worded (e.g. “I was in control of how often I felt excited”). Further investigation of the discrepancy between child and parent report is warranted and future studies may benefit from selecting questionnaires with consistent phrasing.

Third, specific parent and child characteristics may have impacted performance on measures or subject report. Parent reports might have been susceptible to the *Desirability Effect*, such that parents might have under-reported any difficulties with emotion regulation or executive functioning skills. Similarly, some children might have likewise been hesitant to answer all questions with complete honesty if the answers were viewed as less socially desirable. Furthermore, confounds such as fatigue, confusion, or boredom may also have impacted child participant results.

Future Directions

The results of this study clearly highlight relationships between executive control and emotion regulation, suggesting that better executive function skills are associated with more proficient emotion regulation skills. Relatedly, these findings also suggest that deficits in one area may lead to impaired functioning in the other. As previous studies have suggested, poor emotion regulation has been associated with lower levels of effortful control [43]. Moreover, deficits in both effortful control and emotion dysregulation represent core impairments characteristic of a variety of internalizing and externalizing disorders including ADHD, mood disorders, and anxiety disorders [24-26,32-34]. Given consistently observed relationships between executive functioning and emotion regulation, such as those described in the current study, it is likely that associations between executive control and behavioral deficits in psychiatric and neurological disorders are also linked to deficits in emotion regulation.

Summary

The current study investigated the relationships between executive functioning and emotion regulation in healthy children ages 8-12 by examining associations between standardized measures of executive functioning and emotion regulation. Associations between behavioral ratings and neuropsychological measures of executive functioning revealed that more proficient executive functioning skills were associated with enhanced emotion regulation abilities. Broadly, these findings illustrate that better executive functioning is associated with enhanced emotion regulation, which when taken together with prior literature, may suggest that impairments of both processes are also linked. Better understanding of this relationship may help elucidate mechanisms underlying clinical disorders characterized by deficits in both executive and emotional control. These findings extend prior work demonstrating that executive functioning and emotion regulation are linked, and may have important implications for treatment planning in clinical populations with converging deficits in these areas.

Citation: Sudikoff EL, Bertolin M, Lordo DN, Kaufman DAS. Relationships between Executive Function and Emotional Regulation in Healthy Children. J Neurol Psychol. 2015; S(2):8.

ISSN: 2332-3469

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