

AN INVESTIGATION OF EXECUTIVE FUNCTIONING'S ASSOCIATION WITH
SOCIAL APTITUDE

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by
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Abstract

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Executive functioning (EF) is a construct that lacks clear definition in the psychological literature, but it is generally considered central to cognitive development and maturity. Recent comprehensive theories of EF suggest that the self-regulatory abilities associated with the EF system are associated with social competence and ability in humans; however, little empirical data stands to support this connection. Online surveys were collected from undergraduate participants at Appalachian State University to gather information on EF ability and social aptitude. The purpose was to determine if there was a relationship between self-reported EF ability and social skills and characteristics. Significant relationships between EF variables and social skills variables were found in five of six regression models and overall variance explained ranged from 4% to 23%. While these results lend support to an EF and social functioning connection, the relationship appears to be more complex than initially thought

Keywords: Executive functioning, social skills, ADHD, social functioning

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Foreword

This thesis is written in accordance with the style of the *Publication Manual of the American Psychological Association (6th Edition)* as required by the Department of Psychology at Appalachian State University.

An Investigation of Executive Functioning's Association with Social Aptitude

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Abstract

Executive functioning (EF) is a construct that lacks clear definition in the psychological literature, but it is generally considered central to cognitive development and maturity. Recent comprehensive theories of EF suggest that the self-regulatory abilities associated with the EF system are associated with social competence and ability in humans; however, little empirical data stands to support this connection. Online surveys were collected from undergraduate participants at Appalachian State University to gather information on EF ability and social aptitude. The purpose was to determine if there was a relationship between self-reported EF ability and social skills and characteristics. Significant relationships between EF variables and social skills variables were found in five of six regression models and overall variance explained ranged from 4% to 23%. While these results lend support to an EF and social functioning connection, the relationship appears to be more complex than initially thought

Keywords: Executive functioning, social skills, ADHD, social functioning

An Investigation of Executive Functioning's Association with Social Aptitude

Executive functioning (EF) is a construct that lacks clear definition in the psychological literature, but it is generally considered central to cognitive development and maturity. Specifically, EF skills are said to include the cognitive abilities related to mental control such as inhibition, working memory, planning and organizing. The concept of EF was first defined simply as the cognitive functions of the prefrontal cortical lobes (i.e., “the executive brain;” Pribram, 1973). Not surprisingly, neuropsychological data has associated deficits in EF to damage in the frontal lobes (Shallice, 1982). Other broad definitions have been proposed, such as casting executive functioning broadly as self-regulation (Barkley, 2012) or breaking it down more operationally as inhibition, strategic planning, and mental representation of relevant information for a task and future goal-state (Welsh and Pennington, 1988).

While there is currently no universally agreed upon definition, one framework with relatively wide support suggests that EF consists of the interrelated abilities of inhibition (i.e., inhibiting automatic responses), updating of working memory (i.e., taking in and utilizing new information relevant to the task at hand), and set shifting (i.e., the ability to switch attention back and forth between tasks; Baddeley, 1996; Best, Miller, & Naglieri, 2011; Friedman, Miyake, Young, Defries, Corley, & Hewitt, 2008; Huizinga & van der Molen, 2007; Lehto, Juujarvi, Kooistra, & Pulkkinen, 2003; van der Sluis, de Jong, & van der Leij, 2006). This conceptualization further posits that the coordination of these components is required for more complex EF tasks (Best et al., 2011; Huizinga & van der Molen, 2007).

EF Impairment and social adjustment related to psychological disorders

Deficits in EF have been implicated in a number of common disorders such as Attention-Deficit/Hyperactivity Disorder (ADHD; Seidman, 2006), learning disabilities (LD; Seidman, Biederman, Monuteaux, Doyle, & Faraone, 2001), and autism (Ozonoff, Strayer, McMahon &

Filloux, 1994). Each of these disorders is characterized by varying levels of self-regulatory dysfunction as well as impaired peer relations and social adjustment (Bagwell, Molina, Pelham, & Hoza, 2001; Friedman et al., 2003; Ozonoff, Pennington, & Rogers, 1991). ADHD is characterized by deficits in attention, working memory, and inhibition (Seidman, 2006), as well as deficits in arousal, motivation, and emotional regulation (Nigg & Casey, 2005). In addition, Seidman et al. (2001) found that a comorbid diagnosis of ADHD and LD (specifically, arithmetic and reading disability) related to increased severity of EF impairments when compared to a group of children with only ADHD, suggesting that LDs have an additive effect in terms of executive dysfunction. In autism, executive skills are hypothesized to be implicated in the major deficits underlying the disorder, such as cognitive and behavioral rigidity, perseveration, and inability to inhibit certain overlearned or familiar responses (Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002; Ozonoff et al., 1994). In addition, studies have shown an EF-autism connection through the behavioral similarities of patients with prefrontal cortical dysfunction and individuals with autism (Damasio & Maurer, 1978; Ozonoff et al., 1991).

Executive dysfunction also plays an important role in other psychological disorders, and may specifically pose risks for social impairment. Depression is associated with deficits in both EF and social adjustment, and these difficulties are key factors to impaired overall functioning (Furukawa, Azuma, Takeuchi, Kitamura, & Takahashi, 2010). Specifically, EF dysfunctions are associated with a reduction in patients' coping abilities, treatment compliance, and ability to regulate emotions, as well as an increase in probability of relapse (Castaneda, Tuulio-Henriksson, Marttunen, Suvisaari, & Lonnqvist, 2008; Furukawa et al., 2010; Wagner, Doering, Helmreich, Lieb, & Tadic, 2012). Deficits in social adjustment have been found consistently in acutely depressed patients, and this dysfunction has shown varying levels of persistence even after primary depressive symptoms have subsided (Bothwell & Weissman, 1977; Furukawa et al., 2010; Ornel, Von Korff, Van den Brink, Katon,

Brilman, & Oldehinkel, 1993; Paykel & Weissman, 1973; Weissman, Paykel, Siegel & Klerman, 1971). In a review of EF in depressed individuals, Fossati and colleagues noted that depressed patients mainly exhibit deficits in inhibition, problem-solving, planning, and cognitive flexibility (Fossati, Ergis, & Allilaire, 2002). Additionally, researchers have found that some of the cognitive deficits associated with depression persist into clinical remission, with remitted depression patients performing poorer across measures of attention, processing speed, and cognitive flexibility when compared to healthy controls (Hasselbalch, Knorr, Hasselbalch, Gade, & Kessing, 2012).

Executive dysfunction and social maladjustment are also central features of many anxiety disorders. Researchers have found significant associations between chronic PTSD, acute PTSD, acute stress disorder, and deficits in multiple areas of EF (LaGarde, Doyon, & Brunet, 2010). Individuals with generalized social phobia exhibit executive dysfunction in the form of biased cognitive processing, performing worse than non-anxious controls on working memory tasks involving neutral words, but outperforming controls in working memory tasks involving socially threatening words (Amir & Bomyea, 2001). Further research suggests that individuals high in trait anxiety experience deficits in attentional control as a result of increased stimulus-driven processing (e.g., bottom-up processing), which happens at the expense of goal-directed processing (e.g., top-down processing) (Eysenck, Derakshan, Santos, & Calvo, 2007). Overall, patients with anxiety disorders report lower quality of life and impairment in multiple domains, including social and work, when compared to non-anxious controls, and these impairments are significant even in the absence of comorbid depression (Sudhir, Sharma, Mariamma, & Subbakrishna, 2012).

Finally, individuals with schizophrenia show significant deficits in executive processing, which is often thought to be a core component of the disorder (Wylie, Clark, Butler, & Javitt, 2010). Individuals with schizophrenia exhibit deficits in response inhibition (Barch, Carter & Cohen, 2004), working memory (Twamley, Palmer, Jeste, Taylor, & Heaton, 2006), and cognitive flexibility (Wylie

et al., 2010); however, their performance on tasks measuring switching has been shown to be similar to control subjects (Barton, Cherkasova, Lindgren, Goff, Intriligator, & Manoach, 2002; Cools, Brouwer, de Jong, & Sloof, 2000). Additionally, deficits in humor recognition in schizophrenia patients positively correlate with EF, social reasoning, and social adjustment ratings and are suggested to be a specific deficit of the condition not attributable to other factors such as depression or anxiety (Polimeni, Campbell, Gill, Sawatzky, & Reiss, 2010).

The EF/ Social Functioning Connection

Theoretically, EF has been implicated in both the development of and daily implications of social competence and functioning. Barkley (2012) suggests that considering EF's potential genetic and evolutionary roots allows us to better appreciate why EF may exist in humans: to facilitate complex social interactions. His theory states that EF exists as a phenotype extension (i.e., the physical expression of genes). The concept of extended phenotype specifically suggests that many behavioral traits or predispositions impact genetic "survival" (Dawkins, 1982). With organisms that are genetically similar or identical, an action that benefits the individual will also benefit its social group, as is the case in bees building a hive or prairie dogs making mounds and tunnels. In these cases, both the behavior of building the dwellings *and* the dwellings themselves can be tied back to the organism's genes since they both directly affect the survival of the genes that led to these behaviors and physical manifestations. They both become examples of an extended phenotype.

Humans, however, are highly variable in their genetic makeup. Because of this variability, there must exist a different explanation as to why humans are such socially advanced beings. Executive functioning as an extended phenotype offers one such explanation. If an early genetic mutation led to the behavior of two genetically different humans hunting together as opposed to by themselves, their hunting efforts were likely more successful. Successful hunting would lead to longer life, better suitability as a mate, ability to have more offspring, and more food to keep the offspring

alive. Thus, the genes that led to the behavior of social cooperation survived. This scenario can be extrapolated over time and would result in different gene expressions to explain the existence of an extended phenotype for social cooperation in modern humans. This theory further posits that complex groupings of extended phenotypes (e.g., skills, behaviors, and physical artifacts) developed into what we know of as our EF system.

Although there is still a relative dearth of empirical evidence *directly* connecting EF to social functioning, the research suggests preliminary support for this relationship. For instance, in addition to deficits in EF, the disorders discussed above are marked by varying levels of social impairment. Additionally, studies in children have shown connections between parent and teacher reports of social impairment and deficits in task-based EF measures (Clark, Prior, & Kinsella, 2002; Dennis, Brotman, Huang, & Gouley, 2007; Koffler, Rapport, Bolden, Sarver, Raiker, & Anderson, 2011; Nigg, Quamma, Greenburg, & Kusche, 1999). While it is unlikely that the social impairment seen in these disorders is completely explained by deficits in EF, one can begin to see how the relationship between EF and social aptitude may exist. Deficits in EF, therefore, seem to be related to many different psychological disorders, which emphasizes the importance of continued EF research. Specifically, the concrete establishment of an EF-social functioning connection could be important for a better understanding of a variety of disorders, and could inform the development of more comprehensive theories as well as treatments for the same.

The problem with current conceptualization and study of EF

Among all the difficulties in studying and defining EF, one problem raised in recent years seems most salient. Most current conceptualizations and definitions of EF fail to place importance in, or even acknowledge, the social and emotional aspects of self-regulation, yet it was established long ago that frontal lobe injuries strongly relate to deficits in these areas (Damasio, 1994, 1995; Dimond, 1980; Fuster, 1997; Luria, 1966; Rossano, 2011; Stuss & Benson, 1986). As Eslinger (1996) points

out, social disability is often the most distinctive feature of patients with impaired EF. Additionally, current definitions of EF adequately explain *how* humans engage in goal-directed behavior; however, without an understanding of EF in the specific context of socialization, it is difficult to understand *why* humans choose to pursue the goals they do or why humans are motivated to realize those goals.

Although this overall body of literature suggests an association between social and executive functioning, only a few comprehensive theories of EF explicitly incorporate social functioning as an essential component (Barkley, 1997; Damasio, 1994; Fuster, 1997; Stuss & Benson, 1986). Barkley's hierarchical model (2012) presents an in depth discussion of the EF-social functioning association. He postulates that current EF measures (e.g., Digit Span, the Stroop Task, the Simon game, the Trail Making Test, etc.) fail to assess and identify higher level EFs. These higher level EFs are theorized to be central to and occur within social contexts, so failure to measure these more complex EFs may account for the disconnect between cognitively measured EF and functional impairment resulting from executive dysfunction. The Barkley model consists of a pre-executive level (basic attention, memory, spatial and motor functions, automatic activity, etc.) and four EF levels: the instrumental-self-directed level, the methodical-self-reliant level, the tactical-reciprocal level, and the strategic-cooperative level. The first two levels exist as short-term, internal, and self-directed functions that occur within individuals. The second two levels exist within the social realm between individuals and groups of individuals. Additionally, the hierarchical model suggests the previous levels build upon one another, as the simple, short-term functions are needed to engage in more complex, longer-term functions. With this model, Barkley suggests that in order to fully understand the scope and implications of the EF system, we must expand our understanding of what EFs are, how we define them, and how we measure them.

The present study

If EF deficits indeed add risk for social dysfunction, and especially if this is true across disorders, it stands to reason that interventions that enhance EF-related skills (e.g., working memory) might improve social adjustment of affected individuals. However, it is desirable for the EF-social functioning association to be firmly established prior to investment in the development and testing of such interventions (e.g., via randomized controlled trials). The purpose of the present study is to examine the relationship between EFs and social functioning in a college sample. Given a rational analysis of the theories and findings summarized above, it is hypothesized that self-reported EF abilities will be negatively associated with perceived social dysfunction in college students.

Method

Participants and procedure

Young adults ($n = 169$; 125 male, 144 female) were recruited through the Appalachian State University (ASU) Psychology Department's research participant pool. Participants ranged from 17 to 41 years ($M = 19.75$; $SD = 2.63$) of age, and most identified as Caucasian (88.9%; Black, 2.6%; Hispanic, 2.2%; Native American, 1.1%; Asian, 1.5%; other, 3.7%). Demographic information on the sample is provided in Table 1 in the Appendix. Upon signing up for the study online, each participant completed the online battery, which included an informed consent document, demographic questionnaire, and the main study measures (see below). All participants received course credit for participating in the study in accordance with instructor policies. Procedures were approved by the ASU Institutional Review Board on September 16, 2013.

Measures

Barkley Deficits in Executive Functioning Scale for Adults (BDEFS; Barkley, 2011). The BDEFS is a self-report form for adults measuring an individual's EF capacities through the scales Time Management, Organization and Problem Solving, Self-restraint, Self-motivation, and Self-

regulation of Emotions. The measure is comprised of 89 items, which are rated on a scale from one (never or rarely) to four (very often). Scores are a sum of item responses for each of the five scales. Raw scores are converted to percentile scores, with higher scores indicative of poorer executive functioning. Percentile scores equal to or exceeding 76% indicate clinically significant difficulties in that area (Barkley, 2011). Summary scores for total EF and an ADHD-EF Index are also available. In the normative sample of 1,249 participants used in the development of the measure, the BDEFS exhibited excellent internal consistency, ranging from .91 to .95, and good test-retest reliability over a 2-3 week interval, ranging from .62 to .90 (Barkley, 2011). These results are comparable to other measures of EF. Given Barkley's assertion that traditional EF tests show little relationship to functional outcomes or EF rating scales, there is little construct validity between the BDEFS and typically used measures of EF via laboratory tasks; however, Barkley notes that rating scales like the BDEFS are a much better predictor of life functioning such as occupational and educational functioning, driving, marriage, and financial management compared to traditional EF tasks (Barkley, 2011). Within the current study, Cronbach's alpha for subscales ranged from .90 to .94, indicating excellent internal reliability.

Social Skills Inventory (SSI; Riggio, 2002). The SSI is a 90-item self-report measure of basic social abilities, which is broken down into six basic social skills subscales: Emotional Expressivity (EE), Emotional Sensitivity (ES), Emotional Control (EC), Social Expressivity (SE), Social Sensitivity (SS), and Social Control (SC). EE and ES assess an individual's ability to send and receive or interpret nonverbal information, respectively. Conversely, SE and SS assess ability to send and receive or interpret verbal information. EC and SC assess ability to regulate emotional expressions and verbal behavior and skill in social situations. Responses are scored on a 5-point Likert scale ranging from "not at all like me" (one) to "exactly like me" (five). Scores are a sum of item responses and are reported for each of the six scales, as well as the overall measure (i.e., the

overall SSI score). Scores for each of the six scales range from 15 to 75, with higher scores indicating higher skill development in that area. Internal consistency ranged from .75 to .88 and test-retest reliability ranged from .81 to .96. Internal reliability calculations with the current sample subscales ranged from adequate ($\alpha = .68$) to excellent ($\alpha = .90$).

Balanced Inventory of Desirable Responding (BIDR; Paulhus, 1988). The BIDR is a 40-item questionnaire that measures the constructs of self-deceptive positivity and impression management. Individuals rate their agreement with each item on a seven-point scale. Scores are obtained by adding one point for each extreme response (6 or 7), with scores for each scale ranging from 0 to 20. The scoring system allows for only exaggerated desirable responding to obtain high scores. Internal consistency for the BIDR overall is .83, while test-retest correlations are .69 and .65 for Self-Deception and Impression Management respectively. Using information from a study of 433 college students (Paulhus, 1988), scores of over 13 on the Impression Management scale and over 14 on the Self-Deception scale were found to be two standard deviations above the mean and suggest exaggerated desirable responding. This measure will be used to exclude outliers in the dataset based on scores two standard deviations from the mean. Internal reliability for the current study was $\alpha = .66$ and .52 for Self-Deception (SD) and Impression Management (IM), respectively. While the SD scale value falls into a range of reliability that has been described as acceptable (e.g., Bland & Altman, 1997), that of IM does not. However, given that the IM construct is only a response screening variable (see above) and that this poor α value diverges from prior research, IM was retained for use.

Results

The final analyses included data from 124 male and 140 female college students. Data from one male and four females were incomplete and, therefore, excluded. A MANOVA of all predictor and outcome variables across sex indicated significant group differences for two variables, SSI Emotional Control, $F(1, 264) = 12.02, p = .001$, and Social Sensitivity, $F(1, 264) = 11.47, p = .001$,

and therefore sex was included as a control predictor variable in analyses examining these two constructs (see below). Examination of data from the Balanced Inventory of Desirable Responding indicated that no exaggerated desirable responding occurred. Specifically, no respondent met the threshold for exaggerated responding as indicated by a score of two standard deviations above the population mean from the original sample on either IM or SD scales. Examination of response distributions across variables indicated a positive skew for BDEFS subscales. Other descriptive statistics and zero-order correlations can be viewed in Tables 2 and 3 respectively.

Six multiple regression analyses were conducted to evaluate how well aspects of EF predict adaptation across the social behavior domains. Each analysis included five executive functioning variables (i.e., BDEFS Time Management, Organization and Problem Solving, Self-restraint, Self-motivation, and Self-regulation of Emotions) entered simultaneously as predictors of each of the six criterion variables (i.e., SSI Emotional Expressivity, Emotional Sensitivity, Emotional Control, Social Expressivity, Social Sensitivity, and Social Control). For two analyses (regressions for Emotional Control and Social Sensitivity) sex was entered hierarchically in the first block of the regression to control for its effects, with the five BDEFS subscales entered in the second block. A summary of regression analyses can be viewed in Table 4.

Emotional Expressivity

In the first regression model, the linear combination of the five executive functioning variables explained a significant proportion of variance in Emotional Expressivity, $R^2 = .16$, $F(5, 259) = 10.26$, $p < .001$. However, only three of the five variables were significant predictors of Emotional Expressivity: Self-Organization and Problem Solving, $\beta = -.32$, $t(258) = -4.07$, $p < .001$, 95% CI [- .323, -.112], Self-Restraint, $\beta = .47$, $t(258) = 5.35$, $p < .001$, 95% CI [.252, .544], and Self-Motivation, $\beta = -.259$, $t(258) = -2.67$, $p = .008$, 95% CI [-.51, -.08]. Given that higher scores on the BDEFS are indicative of *more difficulty with EF abilities*, these results suggest a positive relationship

between Self-Organization, Problem Solving, and Self-Motivation and ability to communicate with others nonverbally, through sending emotional messages and expressing emotional states. As such, the more difficulty participants report with these EF skills, the less they endorse being able to express themselves appropriately and accurately. The results also indicate a negative relationship between the EF construct of Self-Restraint and Emotional Expressivity, such that those who are less inhibited may be more adept at expressing their emotions via nonverbal communication. A table of these results and the following results can be viewed in Table 5.

Emotional Sensitivity

In the second regression model, a significant proportion of variance in Emotional Sensitivity, $R^2 = .04$, $F(5, 259) = 2.57$, $p = .02$, was accounted for. However, none of the five predictors were individually associated with Emotional Sensitivity, suggesting very little relationship, if any at all, between any distinct facet of EF and an individual's skill in noticing and interpreting the nonverbal, emotional messages of others.

Emotional Control

In the third regression model, the linear combination of sex and the five EF variables explained a significant proportion of variance in Emotional Control, $R^2 = .13$, $F(5, 259) = 6.47$, $p < .001$. In the first step of the model, sex significantly predicted Emotional Control, explaining 4.4% of the variance, $F(1, 259) = 12.02$, $p = .001$, and in the second step of the model, the five BDEFS variables explained an additional 8.7% of the variance, $F(5, 259) = 6.47$, $p < .001$. In this regression model, only Self-regulation of Emotion significantly predicted Emotional Control, $\beta = -.23$, $t(258) = -2.92$, $p = .004$, above the effect of sex, $\beta = -.20$, $t(263) = -3.46$, $p = .001$, with "maleness" predicting higher scores on emotional control. This finding suggests that the more problematic participants' self-regulation of emotion, the more difficulty they report with emotional control.

Social Expressivity

In the fourth regression model, the linear combination of the five EF variables explained a significant proportion of variance in Social Expressivity, $R^2 = .07$, $F(5, 259) = 4.40$, $p = .001$. Two of the five EF variables, Self-Organization and Problem Solving, $\beta = -.26$, $t(258) = -3.13$, $p = .002$ and Self-Restraint, $\beta = .36$, $t(258) = 3.93$, $p < .001$, were significant predictors of Social Expressivity. These results suggest that a participant with difficulty in Self-Organization and Problem Solving reported less developed skills in verbal expression and ability to engage with others in social milieus. Conversely, one with higher scores in Self-Restraint (i.e., indicating less inhibition) tended to endorse more developed abilities in verbal expression and engaging with others socially.

Social Sensitivity

In the fifth regression analysis, the linear combination of sex and the five EF variables explained a significant proportion of variance in Social Sensitivity, $R^2 = .23$, $F(5, 259) = 13.42$, $p < .001$. In the first step of the model, sex predicted a significant amount of the variance in Social Sensitivity, $R^2 = .04$, $F(1, 259) = 11.47$, $p = .001$, and in the second step of the model, the five BDEFS variables explained an additional 19.7% of the variance, $F(5, 259) = 13.42$, $p < .001$. Three of the executive functioning variables, Self-Organization and Problem Solving, $\beta = .19$, $t(258) = 2.52$, $p = .012$, Self-Restraint, $\beta = -.299$, $t(258) = -3.49$, $p = .001$, and Self-Regulation of Emotion, $\beta = .43$, $t(258) = 5.70$, $p < .001$, as well as sex, $\beta = .15$, $t(263) = 2.82$, $p = .005$, were significant predictors of Social Sensitivity. Again, given that higher scores on the BDEFS are indicative of *more difficulty with EF abilities*, the results of this analysis indicate a negative relationship between participants' Self-Organization, Problem Solving, and Self-Regulation of Emotion skills and their abilities to interpret others' verbal communication and to understand appropriate behavior in social situations. Conversely, results indicate a positive relationship between Self-Restraint and Social Sensitivity, such

that an individual reporting less inhibition (Self-Restraint) tends to nominate poorer abilities in these social domains.

Social Control

In the sixth and final multiple regression, the model explained a significant proportion of variance in Social Control, $R^2 = .23$, $F(5, 259) = 15.92$, $p < .001$. Three of the executive functioning predictors, Self-Organization and Problem Solving, $\beta = -.51$, $t(258) = -6.70$, $p < .001$, Self-Restraint, $\beta = .27$, $t(258) = 3.22$, $p = .001$, and Self-Regulation of Emotion, $\beta = -.16$, $t(258) = -2.11$, $p = .03$, were independently associated with Social Control. These results indicate that participants reporting lower self-organization, problem solving, and emotional regulation skills tended to also have lower scores on Social Control, suggesting less confidence and poorer abilities in social situations. Similar to results on the Social Expressivity regression, those reporting lower inhibition tended to express higher confidence and abilities in social situations.

Discussion

The primary purpose of this study was to examine the relationship between self-reported EF skills and social aptitude in a college student sample. Many theories suggest that social ability and social outcomes are an important aspect of the human EF system (Barkley, 1997, 2012; Damasio, 1994; Fuster, 1997; Stuss & Benson, 1986); despite this, there is little direct empirical support for this hypothesized connection in the current literature. Overall, these results provide qualified support for the connection between these constructs. In all regression analyses save that for Emotional Sensitivity, the EF model accounted for a significant proportion of the variance in the respective social skill outcome variables and at least one EF facet emerged as an independent predictor. The regression model for Emotional Sensitivity seemed, in effect, to be an anomaly, accounting for only a small proportion (4%) of the variance, as compared to 7-23% in the other models. This may be at least partially explained by differences in EF and a similar self-regulatory mechanism known as

effortful control (Blair & Ursache, 2011). Although EF and emotional regulation (through effortful control) have been shown to be highly overlapping constructs (Bridgett, Oddi, Laake, Murdock, & Bachmann, 2013), these results may lend evidence to differences between the two. It is possible that the EF abilities as measured by the BDEFS are not also tapping effortful control, which may be more related to the SSI variable of Emotional Sensitivity. Indeed, the authors of the SSI suggest that individuals high in Emotional Sensitivity may be susceptible to becoming emotionally aroused by others, indicating lower levels of effortful control.

The hypothesis that executive dysfunction would negatively relate to self-reported social ability in college students received mixed support in that the *inverse* relationship was sometimes suggested by the data. More specifically, in the case of the BDEFS Self-Restraint variable, which is similar to the widely discussed construct of inhibition, higher scores were actually predictive of *better* social outcomes. Less inhibition predicted better ability to accurately express emotional states, engage with others conversationally (both initiating and guiding conversation), and appear self-confident, skilled, and comfortable in social situations. These results suggest that having fewer inhibitions may actually be adaptive in the context of social situations. These findings are consistent with literature showing that individuals with lower inhibition also report higher levels of the Big Five characteristics of Openness and Extraversion (Peterson, Smith, & Carson, 2002). Another study of individuals with ADHD showed that less restraint was associated with fewer problems in a professional setting, suggesting that quick decision making and risk taking may be advantageous in the social setting of work (Kamradt, Ullsperger, & Nikolas, 2014). Furthermore, research indicates that individuals with ADHD-combined type exhibit somewhat better relational adjustment when compared to those with ADHD-inattentive type, suggesting the possibility of disinhibition as a positive factor in adult relationships (Canu & Carlson, 2007).

Two other EF variables also followed this same pattern. Higher scores (i.e., worse self-reported functioning) in Self-Organization/ Problem Solving and Self-Regulation of Emotion were predictive of *higher* sensitivity to other's verbal communication, as well as the norms that govern social behavior. These results suggest that individuals with more difficulty in these areas of EF may be sensitive to what people say to them or how they are *supposed* to act; however, this finding does not address how well individuals are able to incorporate this sensitivity into appropriate action or reaction. While results discussed below and in the next paragraph do address this possibility, this may be an important area of investigation for future studies. A recent study of EF and functional life outcomes indicated that difficulties with emotion regulation are associated with relationship problems, lending support to the thought that knowledge of and sensitivity to social norms and verbal communication is not predictive of the ability to act accordingly (Kamradt et al., 2014). Friedman and colleagues (2003) also found that adults with ADHD are more sensitive toward violations of social norms but report being less socially competent than non-ADHD individuals.

Despite the findings summarized above, EF variables were shown to be predictive of less favorable social ability, as well. Individuals with higher scores on Self-Organization/ Problem Solving were likely to report less developed ability to accurately express emotions, initiate and guide conversations, and understand appropriate comportment in various social situations. Self-reported difficulty in Self-Organization and Problem Solving was also associated with problems related to the ability to recognize social feedback from the environment and effectively use it to shape one's own behavior. This finding relates to the results discussed above regarding Self-Organization and Problem solving, in that while individuals with difficulty in this area may be more sensitive to how they are *supposed* to act in social situation they may lack the ability to integrate environmental social feedback and use that to act appropriately (Friedman et al., 2003; Kamradt et al., 2014). Further, those reporting low Self-Restraint (i.e., high scores) were likely to endorse inattentiveness to social

behavior and may also be less aware of the social appropriateness of their actions, which is also consistent with extant literature (Friedman et al., 2003). Although the present results suggest that individuals with less inhibition may be good at communicating their emotions and fitting comfortably into a variety of social situations, it would seem from these latter findings that their inability to pick up on the *appropriateness* of their behavior may be likely to cause them problems.

Self-motivation was also negatively associated with social skill, specifically nonverbal communication of emotional messages and states. This finding may reflect that effective communication of one's feelings requires effort, which an individual with a lack of ability to self-motivate would have difficulty with, which may become especially problematic over time in close relationships. Finally, Self-Regulation of Emotion was negatively associated with ability to mask and convey emotions when desired (i.e., conveying the "appropriate" emotion) as well as the skills associated with self-confidence and tact in social situations.

Taken as a whole, these findings suggest that EF abilities relate to a variety of social skills, and the data provide some empirical support for the theoretical connection between EF and social functioning. Social difficulties are a well-documented and often impairing characteristic of ADHD that are present across age ranges (Bicket & Milich, 1990; Boo & Prins, 2007; Gaub & Carlson, 1997; Hoza et al., 2005). The present study lends evidence to contemporary models suggesting that these impairments may be a result of underlying neurocognitive impairments such as EF deficits (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005), but also suggests that the relationship is complex, given some of the unexpected negative associations that arose.

Limitations and Future Directions

The first and likely most salient limitation to this study is its reliance on self-report regarding EF and social aptitude. Self-reports are easy to use and cost effective, and their relative reliability and validity make them effective tools for hypothesis testing and early investigation of new constructs or

theories. Although there are advantages to using rating self-report scales, there are also important disadvantages. Self-reports assume that respondents and examiners share an understanding of the item being rated, as well as how to use the rating system in relation to each item (Barkley, 2011). Additionally, the rating systems themselves have been criticized for being relatively vague by using frequency references such as “sometimes,” “often,” or “very often” (Barkley, 2011). Given these shortcomings, researchers have emphasized the importance of “other-informant” reports to heighten data reliability and validity. For instance, Sibley et al. (2012) note that informant (i.e., parent and teacher) report of ADHD symptoms and impairment tends to be more diagnostically sensitive in identifying ADHD in adolescents and young adults than self-report measures. While ADHD is related to but distinct from EF, such research suggests that future studies investigating EF and social functioning might benefit from the inclusion of other-informant reports.

In addition to relying on self-report measures of EF and social functioning, the current study did not utilize any task-based measures of EF or investigate *actual* social impairment (i.e., number of friends, quality of friendships, length of friendships). Although it has been suggested that laboratory-based EF tasks often fail to capture higher level EFs or impairment resulting from executive dysfunction (Barkley, 2012), studies have shown significant relationships between parent and teacher ratings of social difficulties and EF deficits assessed through task-based measures (Clark, Prior, & Kinsella, 2002; Dennis, Brotman, Huang, & Gouley, 2007; Koffler, Rapport, Bolden, Sarver, Raiker, & Anderson, 2011; Nigg, Quamma, Greenburg, & Kusche, 1999). The inclusion of laboratory EF tasks in future studies may more precisely illustrate the relationship between EF and social functioning, and in addition provide better evidence for or against a hierarchical model of EF. Furthermore, an important factor in future research may be the collection of objective data regarding social functioning. Children with ADHD often fail to report experiencing social problems even when teacher, parent, and peer reports indicate peer social difficulties (van der Oord, van der Meulen, Prins,

Oosterlaan, Buitelaar, & Emmelkamp, 2005). This underlines the need for more objective measures and collaborating reports of social functioning.

Although this study attempted to use a screening measure to avoid exaggerated or desirable responding, the reliability coefficients discussed in the measures section indicate very low alpha levels for the validity scale, the BIDR. This measure had been shown to exhibit more acceptable reliability in other studies; however, in this sample, reliability estimates were in the borderline to unacceptable range. Despite the fact that this measure is only used as a validity check for the overall study questionnaire and is not one of the main study measures, it is worth noting that these reliability coefficients indicate that this measure may not have served its intended purpose.

Another limitation of this study is the exclusive use of a college student sample, along with its limited age range and relative lack of cultural diversity. Distributions of the BDEFS subscales showed our sample to have a positive skew, with only a small percentage of the sample falling into a disordered or clinical range. This leads to difficulties in interpretation of our results, with potentially lower statistical power in the more dysfunctional ranges of EF. Future studies may benefit from comparisons between normal populations and more disordered populations such as individuals with ADHD or ADHD with a comorbid diagnosis. Additionally, future research in this area should examine these constructs across age ranges (i.e., children, adolescents, and older adults) and more diverse populations, which would increase external validity and generalizability of the findings.

Finally, as this study is one of the first to directly examine the relationship between EF and social ability, it is somewhat exploratory in nature. Although results from this study suggest there is a connection between EF and social ability, it is still too early to interpret how strong that connection is or whether it is truly “direct” in nature, as opposed to involving mediators or moderators. For example, Kamdradt and colleagues (2014) found that EF ratings were significant predictors of specific symptoms of ADHD such as inattention and hyperactivity/impulsivity. It is feasible then that

these specific symptoms or skill areas may mediate the relationship between EF difficulties and broad social impairments. Future research in this area would benefit from the inclusion of multiple reports of predictors and criterion variables, the use of informant report, inclusion of multiple comparison groups to examine to additive effect of various forms of psychopathology on EF and social ability, and potential examination of theoretical mediators and moderators of the EF/ social functioning connection.

While there are a number of limitations present in this study, there are also considerable strengths related to the current sample. First is the utility and importance of a college student population when studying social functioning. College is a time marked by increased demands in the self-regulation abilities needed to succeed in the academic environment and the new social environment, yet also a time of decreased presence of an individual's typical support system. EF and social functioning are both important aspects of successful engagement in post-secondary settings, and this fact makes studying the connection between these constructs in a college sample both logical and important. If EF is indeed related to social functioning, it would likely be salient in this environment. A second potential strength of this sample is that these effects were apparent in a non-clinical sample. Although this could also be conceived as a limitation (see above), the fact that strong associations were found with a relatively "normal" population may actually point to the robust nature of the connection between EF and social functioning; however, additional research is still warranted in line with the future directions, stated above, to solidify the pattern of findings.

Summary

Executive functioning is a construct that is poorly understood, yet purported to be central to the development of and daily interactions among humans. Most of the existent research on EF overlooks possible associations with social functioning, and the few comprehensive theories of EF that recognize this possible connection have in effect spurred very little empirical research that

directly examines the theoretical connection between the EF system and social functioning outcomes. The present study provides some initial support for theories implicating underlying EF deficits as being central to social development and interaction, although it also suggests that the relationship may be more complex than initially thought.

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Table 1

Demographic Information

Variable	N	%
<i>Sex</i>		
Male	125	46.5
Female	144	53.5
<i>Ethnicity</i>		
White	240	88.9
Hispanic or Latino	6	2.2
Black or African American	7	2.6
Native American or American Indian	3	1.1
Asian/ Pacific Islander	4	1.5
Other	10	3.7
<i>Have you ever been diagnosed with ADHD</i>		
Yes	34	12.6

No	236	87.4
<i>Have you ever been diagnosed</i>		
<i>with a psychological disorder</i>		
Yes	53	19.6
No	217	80.4
Learning Disability	11	4.1
Bipolar Disorder	3	1.1
Major Depressive Disorder	36	13.3
Dysthymic Disorder	2	0.7
Other Depressive Disorder	3	1.1
GAD	11	4.1
OCD	2	0.7
Panic Disorder	7	2.6
PTSD	3	1.1
Social Phobia	7	2.6
Other Anxiety Disorder	4	1.5
Anorexia	2	0.7

Bulimia	6	2.2
Other Eating Disorder	2	0.7
Substance Abuse	3	1.1
Substance Dependence	2	0.7
<i>Have you ever experienced a serious head injury or been diagnosed with a traumatic brain injury</i>		
Yes	67	24.8
No	203	75.2

Table 2

Means and Standard Deviations for all BDEFS and SSI Scales Grouped by Sex

	Male (N = 124)	Female (N = 140)
	M (SD)	M (SD)
Self-Management to Time ^a	38.91 (10.88)	40.73 (12.19)
Self-Organization/Problem Solving ^a	38.59 (10.86)	39.38 (12.33)
Self-Restraint ^a	33.25 (8.59)	32.52 (9.66)
Self-Motivation ^a	20.06 (6.34)	18.86 (6.90)
Self-Regulation of Emotion ^a	23.06 (7.89)	23.92 (8.55)
Emotional Expressivity ^b	45.13 (7.25)	45.86 (7.93)
Emotional Sensitivity ^b	46.85 (8.82)	49.07 (10.24)
Emotional Control ^b	47.74 (6.96)**	44.48 (8.14)**
Social Expressivity ^b	42.68 (11.11)	44.10 (12.46)
Social Sensitivity ^b	46.23 (9.17)**	50.35 (10.42)**
Social Control ^b	51.86 (9.45)	50.19 (9.75)

Note. SD = standard deviation, ^a denotes EF variable, ^b denotes social aptitude variable, ** = Significant group difference at p =

.001

Table 3

Zero-Order Correlations Between BDEFS Scales and SSI Scales

	1	2	3	4	5	6	7	8	9	10	11
1. EE	—										
2. ES	.24**	—									
3. EC	-.18**	.17**	—								
4. SE	.59**	.41**	.13*	—							
5. SS	.01	.43**	.16**	-.10	—						
6. SC	.46**	.21**	.30**	.67**	-.30**	—					

7. SMgmt.	.02	.15*	-.07	-.04	.25**	-.22**	—				
8. SOrg	-.08	.14*	-.19**	-.12*	.30**	-.44**	.60**	—			
9. SRest.	.23**	.19**	-.19**	.11	.14*	-.15*	.54**	.60**	—		
10. SMot.	-.02**	.16**	-.09	-.03	.20**	-.25**	.74**	.62**	.64**	—	
11. SRgEm.	.16**	.19**	-.27**	-.005	.38**	-.26*	.50*	.55**	.66**	.52**	—

** = correlation is significant at the .01 level (2-tailed)

* = correlation is significant at the .05 level (2-tailed)

Table 4

Regression Analyses

	Self- Management to Time		Self- Org./Problem Solving		Self-Restraint		Self-Motivation		Self-Regulation of Emotion		Sex		R Square
	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	
EE	.10	.1.15	-.32**	-4.07	.47**	5.35	-.25**	-2.67	.10	1.35			.16**
ES	.04	.427	-.01	-.15	.09	1.02	.02	.21	.10	1.22			.04*
EC	.16	1.79	-.12	-1.47	-.05	-.62	.001	.008	-.23*	-2.92	-.20	-3.46	.13**
SE	.01	.14	-.26*	-3.13	.36**	3.93	-.07	.44	-.07	-.83			.07**
SS	.06	.73	.19*	2.52	-.29**	-3.49	.009	.09	.43**	5.70	.15	2.82	.23**
SC	.08	1.00	-.51**	-6.70	.27**	3.22	-.08	-.95	-.16*	-2.11			.23**

Note: EE = Emotional Expressivity, ES = Emotional Sensitivity, EC = Emotional Control, SE = Social Expressivity, SS = Social Sensitivity, SC = Social Control, * = $p < .05$, ** = $p \leq .001$

Table 5

SSI Domain and Associated EF Predictor

SSI Domain	Low EF Predicts Low SSI Domain Score	Low EF Predicts High SSI Domain Score
Emotional Expressivity	Self-Organization/Problem Solving Self-Motivation	Self-Restraint
Emotional Sensitivity	---	---
Emotional Control	Self-Regulation of Emotion	---
Social Expressivity	Self-Organization/Problem Solving	Self-Restraint
Social Sensitivity	Self-Restraint	Self-Organization/ Problem Solving Self-Regulation of Emotion
Social Control	Self-Organization/Problem Solving Self-Regulation of Emotion	Self-Restraint

Note. Reminder: Low EF on Barkley Deficits in Executive Functioning Scale is indicated by *higher* scores.

Appendix A

To: Dane Hilton
Psychology
CAMPUS MAIL

From: Dr. Stan Aeschleman, Institutional Review Board Chairperson

Date: 6/16/2013

RE: Notice of IRB Approval by Expedited Review (under 45 CFR 46.110)

Study #: 14-0030

Study Title: An Investigation of Executive Functioning's Association with Social Adjustment

Submission Type: Initial

Expedited Category: (7) Research on Group Characteristics or Behavior, or Surveys, Interviews, etc.

Approval Date: 9/16/2013

Expiration Date of Approval: 9/15/2014

The Institutional Review Board (IRB) approved this study for the period indicated above. The IRB found that the research procedures meet the expedited category cited above. IRB approval is limited to the activities described in the IRB approval materials, and extends to the performance of the described activities in the sites identified in the IRB application. In accordance with this approval, IRB findings and approval conditions for the conduct of this research are listed below.

Regulatory and other findings:

The IRB waived the requirement to obtain a signed consent form for some or all subjects because the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context.

Approval Conditions:

Appalachian State University Policies: All individuals engaged in research with human participants are responsible for compliance with the University policies and procedures, and IRB determinations.

Principal Investigator Responsibilities: The PI should review the IRB's list of PI responsibilities. The Principal Investigator (PI), or Faculty Advisor if the PI is a student, is ultimately responsible for ensuring the protection of research participants; conducting sound ethical research that complies with federal regulations, University policy and procedures; and maintaining study records.

Modification and Addendum: IRB approval must be sought and obtained for any proposed modification or addendum (e.g., a change in procedure, personnel, study location, study instruments) to the IRB approved protocol, and informed consent form before changes may be implemented, unless changes are necessary to eliminate apparent immediate hazards to participants. Changes to eliminate apparent and immediate hazards must be reported promptly to the IRB.

Approval Expiration and Continuing Review: The PI is responsible for requesting review in a timely manner and receiving continuing approval for the duration of the research with human participants. Lapses in approval should be avoided to protect the welfare of enrolled participants. If approval expires, all research activities with human participants must cease.

Prompt Reporting of Events: Unanticipated Problems involving risks to participants or others; serious or continuing noncompliance with IRB requirements and determinations; and suspension or termination of IRB approval by an external entity, must be promptly reported to the IRB.

Closing a study: When research procedures with human subjects are completed, please complete the Request for Closure of IRB review form and send it to irb@appstate.edu.

Websites:

1. PI responsibilities:

<http://researchprotections.appstate.edu/sites/researchprotections.appstate.edu/files/PI%20Responsibilities.pdf>

2. IRB forms: <http://researchprotections.appstate.edu/human-subjects/irb-forms>

CC:

Will Canu, Psychology

Appendix B Student Participant Consent Form

Purpose of Research

Recent comprehensive theories of executive functioning (EF) have suggested that there is a connection between the cognitive processes of our prefrontal cortex and our social aptitude; however, there is scant empirical evidence supporting this connection. This study seeks to extend the current research and theoretical base of EF by directly comparing reports of both EF and social adjustment in the college student population at Appalachian State University. Specifically, you will be asked to complete questions regarding personal history (e.g., ethnicity, age, education, history of psychological diagnosis) and current behaviors that have been shown to be related to EF and various aspects of social adjustment. The researchers are also examining whether any of these behaviors differ between males and females. The purpose of this study is to examine whether executive processes of the prefrontal cortex are associated with social behavior in college students

Duration of Participation: Participation will take approximately one hour, and you will complete the study online. No follow-up procedures are planned.

Risks and benefits: There are minimal foreseeable risks, either physical or psychological, associated with your participation in this study. The data collected for this study is conducted online, and no method of transmission over the Internet, or method of electronic storage, is perfectly secure. Therefore, we cannot guarantee absolute security. However, we anticipate that the information being requested will put you at no greater risk than you would typically encounter during a routine psychological examination.

Benefits to the Individual or Others: While there are no direct benefits to you for participating in this study, the information derived from this project may have important societal benefits. Specifically, the information gained may contribute to a better understanding of executive functioning, as well as its potential connection to social adjustment.

Compensation: You may earn class credit if this is required or optional for a psychology class that you are currently taking. The class instructor will assign credit according to class policy; you will receive two ELCs for completion of this online study. If you choose not to participate in this study, your professor can provide you with a non-research alternative to obtain the same extra credit.

Confidentiality: The records of this study will be kept private. In any sort of report we make public we will not include any information that will make it possible to identify you. Research records will be kept in a password protected file; only the researchers will have

access to the records. Anonymized data from this study may be used to answer future research questions.

Voluntary Nature of Participation: Taking part in this study is completely voluntary. If you find that you cannot or do not want to answer a question (e.g., due to lack of experience or personal discomfort), you may elect to skip that question. If you decide to take part, you are free to withdraw at any time.

Contact Information: The researchers conducting this study are Dane Hilton and Dr. Will Canu. If you have any questions regarding the study, you may contact Dane Hilton at hiltondc@appstate.edu or at 828-850-7256. You may contact Dr. Will Canu, Psychology Department, 107-a-Smith-Wright Hall, Appalachian State University, 828-262-2711, canuwh@appstate.edu. If you have any questions or concerns regarding your rights as a research volunteer in this study, you may contact the Appalachian State University IRB administration at 287 Rivers St., Suite 232, J. E. Thomas Building, Boone, NC 28608, 828-262-2130, irb@appstate.edu.

YOU HAVE HAD THE OPPORTUNITY TO READ THIS CONSENT FORM, AND YOU ARE PREPARED TO PARTICIPATE IN THIS PROJECT. IN ADDITION, YOU ACKNOWLEDGE THAT YOU ARE EIGHTEEN YEARS OF AGE OR OLDER (if you are under eighteen years of age, you should not continue)

Yes No

The full name (first, middle, last) you have used for course registration this term is (this will be used to facilitate course credit, as appropriate).

Vita

Dane Cortland Hilton was born in Hickory, North Carolina to Bruce and Kristine Hilton. He graduated from Appalachian State University in Boone, NC in August 2011. He earned a Bachelor of Science degree, majoring in psychology. After working as an afterschool coordinator for a Montessori school for one year, he entered Appalachian State University in the fall of 2012 to begin study toward a Master of Arts degree in Clinical Health Psychology. He earned this degree in August 2014, and will be continuing his education in the Clinical Psychology Ph.D. program at the University of Alabama in August 2014.