An Investigation of the Role of Executive Functioning in Adolescent Depression

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Background

Adult depression is largely viewed as a disorder of adolescent onset (Burke, et al., 1990), suggesting that adolescence is a crucial developmental period in which to study the etiology of depression. In this study, we investigated the association between adolescent depressive symptoms and three facets of executive functioning (EF) including set shifting (Wisconsin Card Sorting Task), planning (Tower of London), and inhibition (Stop Signal Task) in a community sample of 12-14 year olds. Further, we examined individual differences in motivation and tested the moderating effect of motivation on the relationship between EF and depressive symptoms.

Hypotheses

- A main effect of motivation predicting depressive symptoms
  - Specifically, we expect an underactive BAS, and an overactive FFFS to be associated with high levels of depressive symptoms

- A motivation by EF interaction such that poor EF will predict depressive symptoms for those with an underactive BAS, and an overactive FFFS
  - Due to the inconsistencies and methodological limitations of prior studies it is difficult to form empirically driven hypothesis on which EF components may have a unique relationship with depressive symptoms
  - Anxiety is included as a statistical control variable to examine the unique association between EF and depressive symptoms

Executive Function

Executive functions represent high-level cognitive processes, which include the ability to sustain and shift attention, inhibit dominant responses, hold information in working memory, and plan responses (Pennington & Ozonoff, 2006). EF is conceptualized as a multi-component construct and implicated as an important etiological factor in depression. However, in adolescent samples the relationship between depression and EF is equivocal (Brooks, et al., 2010; Favre et al., 2009; Gunther, et al., 2004; Micco et al., 2009). Inconsistent findings may be due to unmeasured moderators, such as motivation, as well as, only considering a single EF component.

Moderation

According to the triadic neural systems model, the role of EFs are to modulate behavioral impulses that are governed by motivational systems (Ernst & Fudge, 2009). In other words, dysregulated behavior (such as the manifestation of depression) is the result of the interactive effects of poor executive functioning and motivational reactivity. According to this model forwarded by Ernst & Fudge (2009), and others (e.g., Carver, Johnson, & Joormann, 2003; Spear, 2010, Luciana, 2008), the impact of EF on depression may only be evident in the presence of individual differences in motivational systems that predispose an adolescent to experience high levels of depressive symptoms. Strong motivational risk for depression is particularly difficult to regulate and likely to overwhelm deficient EF resources, resulting in an association between poor EF and high levels of depressive symptoms. The current study aims to provide a test of the triadic neural systems model by examining if motivation moderates the relationship between EF and adolescent depressive symptoms.

Motivation

In this study, motivation is conceptualized via the revised Reinforcement Sensitivity Theory (r-RST; Gray & McNaughton, 2000). According to a r-RST framework depression may be the result of dysregulation in two motivational systems: the behavioral approach system (BAS) and the fight, flight, and freeze system (FFFS). The BAS is sensitive to appetitive stimuli, while the FFFS is activated by aversive events and is associated with responses such as freezing (i.e., behavioral shutdown), withdrawal, helplessness, loss of energy, and emotional reactions. Adaptive responding to aversive events likely involves problem solving, planning, and goal implementation. A strong emotional reaction to aversive events (i.e., strong FFFS) may tax problem solving resources, creating less flexible and adaptive responses. Depression may be the outcome of maladaptive responses to aversive events (Hammen, 2000), and individual differences in executive and motivational variables may jointly predispose some people to develop depression.

This finding is consistent with neuroscience models of regulatory behavior that suggest that non-executive variables, such as motivational individual difference, can influence the relationship between executive functioning psychopathology (e.g., Ernst & Fudge, 2009; Luciana, 2006; Spear, 2010). Our findings underscore the need to integrate motivational and executive dysfunction models in the study of depression. Neither set shifting (Wisconsin Card Sorting Task) nor inhibition (Stop Signal Task) was associated with depression, highlighting the importance of considering multiple aspects of EF in studies of depression.

Limitations

We acknowledge several limitations. First, we used a dimensional view of depression instead of DSM-IV diagnostic criteria. While there is evidence that adolescent depression lies on a continuum rather than a category (Hankin et al., 2005), the results might not generalize to clinical diagnoses. Secondly, this was a cross-sectional design which provides a limited snap-shot view of EF development in young adolescents and leaves open the question of direction of effects.

Contact Information & Acknowledgment

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Results

Table: Regression Results of Moderational Model predicting Depression symptoms

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>β (SE)</th>
<th>t-value</th>
</tr>
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<tbody>
<tr>
<td>Intercept</td>
<td>-0.01 (0.04)</td>
<td>-0.37</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.08 (0.04)</td>
<td>1.95</td>
</tr>
<tr>
<td>Age</td>
<td>-0.00 (0.04)</td>
<td>0.00</td>
</tr>
<tr>
<td>Anxiety Symptoms</td>
<td>0.63 (0.04)</td>
<td>16.14**</td>
</tr>
<tr>
<td>BAS – Drive</td>
<td>0.03 (0.05)</td>
<td>0.60</td>
</tr>
<tr>
<td>BAS – Social Approval</td>
<td>-0.00 (0.04)</td>
<td>0.02</td>
</tr>
<tr>
<td>BAS – Impulsivity / Fun Seeking</td>
<td>-0.08 (0.05)</td>
<td>1.54</td>
</tr>
<tr>
<td>BAS – Anxiety</td>
<td>0.03 (0.05)</td>
<td>0.67</td>
</tr>
<tr>
<td>FFFS – Fear / Shyness</td>
<td>0.02 (0.05)</td>
<td>0.36</td>
</tr>
<tr>
<td>Tower of London Task</td>
<td>-0.04 (0.04)</td>
<td>2.63***</td>
</tr>
<tr>
<td>Wisconsin Card Sorting Task</td>
<td>0.02 (0.04)</td>
<td>0.25</td>
</tr>
<tr>
<td>Stop Signal Task</td>
<td>0.05 (0.05)</td>
<td>1.41</td>
</tr>
</tbody>
</table>

Step 1: R² = .48

Step 2: Change in R² = .02

BAS – Drive X Tower of London Task | -0.01 (0.05) | 0.27 |
BAS – Social Approval X Tower of London Task | -0.06 (0.04) | 1.07 |
BAS – Impulsivity / Fun Seeking X Tower of London Task | -0.01 (0.05) | 0.22 |
BAS – Anxiety X Tower of London Task | -0.07 (0.05) | 1.44 |
FFFS – Fear / Shyness X Tower of London Task | 0.01 (0.05) | 1.97* |
Wisconsin Card Sorting Task | -0.04 (0.05) | 0.92 |
Social Approval X Wisconsin Card Sorting Task | 0.01 (0.05) | 0.23 |
BAS – Impulsivity / Fun Seeking X Wisconsin Card Sorting Task | -0.07 (0.05) | 1.33 |
BAS – Anxiety X Wisconsin Card Sorting Task | 0.06 (0.06) | 0.88 |
FFFS – Fear / Fun Seeking X Wisconsin Card Sorting Task | 0.01 (0.06) | 0.14 |
BAS – Drive X Stop Signal Task | 0.03 (0.05) | 0.58 |
BAS – Social Approval X Stop Signal Task | -0.07 (0.05) | 1.53 |
BAS – Impulsivity / Fun Seeking X Stop Signal Task | -0.00 (0.05) | 0.01 |
BAS – Anxiety X Stop Signal Task | -0.02 (0.06) | 0.32 |
FFFS – Fear / Fun Seeking X Stop Signal Task | 0.03 (0.06) | 0.55 |

Note: All standardized beta and error terms reported; * p<.05, ** p<.01