A multiple pathways perspective of ADHD: An examination of “top-down” and “bottom-up” processes in a community sample of early adolescents

Hector I. Lopez-Vergara, M.A., Craig R. Colder, Ph.D., and Larry W. Hawk, Jr. Ph.D. University at Buffalo, The State University of New York

Abstract

Theoretical models emphasize heterogeneity in the mechanisms responsible for ADHD and posit one pathway that emphasizes deficits in “top-down” controlled processes and another pathway that emphasizes “bottom-up” reactive processes driven by strong inputs from the environment. We tested this hypothesis in a community sample of adolescents with ADHD relative to a comparison group of youth without ADHD, with “top-down” processes being related to symptoms of inattention and “bottom-up” processes being related to symptoms of impulsivity/hyperactivity. The current study tested a multiple pathways model in a community sample of 373 adolescents (mean age = 13.13, SD = .60). “Top-down” processes were measured using two different laboratory measures of executive functioning (the Wisconsin Card Sort and Stop Signal Tasks) and “bottom-up” processes were measured using self-report measures of BIS (Behavioral Inhibition System) and BAS (Behavioral Activation System) sensitivity (the Point Scoring Reaction Time Task). Consistent with multiple pathways models of ADHD, our findings showed specificity in the association between “top-down” and inattention, and between “bottom-up” processes and symptoms of impulsivity/hyperactivity. These results support for multiple pathways models of ADHD and extend the literature by providing a theoretically based conceptualization of “bottom-up” processes based on reinforcement sensitivity theory.

Introduction

Several researchers have articulated the possibility that there may be several developmental pathways to ADHD (Berger & Pioner, 2000; Castellanos & Tannock, 2000; Nigg, Goldsmith, & Sachek, 2004; Sergeant, Giurini, Hurlburt, & Oosterlaan, 2003; Sonuga-Barke, 2002), which have useful features that have been referred to as “top-down” and “bottom-up” processes. “Top-down,” or controlled processes, reflect effortful self-regulation of goal-directed behavior, whereas “bottom-up” processes reflect automatic responses to stimuli (e.g., latency, intensity, and duration of response to stimuli such as reward or punishment) (Eisenberg, Fabs, Gunthor, & Paisek, 2000; Nigg, 2010). According to Nigg (2010), “top-down” and “bottom-up” processes play a prominent role in the etiology of ADHD, with “top-down” processes being specifically related to symptoms of inattention and “bottom-up” processes being specifically related to symptoms of impulsivity/hyperactivity. There is empirical support for the specificity of the relationships between “top-down” processes and inattention and between “bottom-up” processes and impulsivity/ hyperactivity (Weinberger, 2007). However, these studies did not include control for a symptom cluster when examining associations between measures of both “top-down” and “bottom-up” processes and ADHD symptoms. In the present study we sought to address this research gap by examining associations between both “top-down” and “bottom-up” processes in a community sample of adolescents with ADHD, using rigorous statistical controls and conceptualizing “bottom-up” processes as individual differences in individual reinforcement sensitivity theory. Applications of RST to ADHD suggest that a strong BAS should be related to ADHD (Hunt et al., 2008), as should a weak BAS (Quay, 1997).

Top-Down Processes: Theoretical models of ADHD have long emphasized cognitive dysfunction as a central component of ADHD, and there is substantial evidence that poor executive functioning is a robust correlate of ADHD (Barkley, 1997; Douglas, 1988; Newman & Wallace, 1993; Pelham et al., 2006). RST postulates that the most two of the most studied are the Behavioral Approach System (BAS) and the Behavioral Inhibition System (BIS). The BAS is a motivational system that drives reward seeking and goal directed behavior (Gray, 1992), whereas the BIS is a control system that monitors the environments for threat cues (Gray, 1975, 1978). The behavioral inhibition system/behavioral activation system (BIS/BAS) model has been applied to the ADHD literature (Dawson, 1987; Martin, 1990), which suggests that the two conditions may share etiological factors. Future research should conceptually examine the functional and neural substrates of the BIS/BAS and ADHD using newer imaging techniques (Cukrowicz, Taylor, Schatschneider, & Iacono, 2006).

Objective

The present study examined the association between individual differences in “top-down” and “bottom-up” processes and ADHD symptoms in a community sample of adolescents.

Hypotheses:

(1) “Top-down” processes (poor set shifting and poor behavioral inhibition) will predict high levels of inattention symptoms of ADHD.

(2) “Bottom-up” processes (high BAS and low BIS) will predict high levels of impulsivity/hyperactivity symptoms of ADHD.

Participants & Procedures

The Disruptive Behavior Disorders Rating Scale (DBD; Pillow et al. 1998). The DBD is a 36 item scale measuring ADHD, ODD, and CD. Symptoms were rated on a 4-point scale (1 = not at all; 2 = just a little; 3 = pretty much; 4 = every much). The DBD provides two ADHD subscales: 9 items measuring inattention symptoms (e.g., concentration difficulties) and 10 items measuring impulsive/hyperactive symptoms (e.g., poor peer relationships).

Results

Table 1: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>SE</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAS</td>
<td>1.0</td>
<td>1.0</td>
<td>0.1</td>
<td>3.89</td>
<td>85</td>
<td>**</td>
</tr>
<tr>
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<td>1.0</td>
<td>0.1</td>
<td>2.19</td>
<td>85</td>
<td>*</td>
</tr>
<tr>
<td>Int</td>
<td>0.1</td>
<td>1.0</td>
<td>0.1</td>
<td>1.0</td>
<td>85</td>
<td>.30</td>
</tr>
<tr>
<td>Imp</td>
<td>1.64</td>
<td>1.0</td>
<td>0.1</td>
<td>3.12</td>
<td>85</td>
<td>**</td>
</tr>
<tr>
<td>Age</td>
<td>14.8</td>
<td>1.0</td>
<td>0.1</td>
<td>11.17</td>
<td>85</td>
<td>**</td>
</tr>
</tbody>
</table>

Results generally supported specificity of associations between “top-down” and “bottom-up” processes and ADHD symptomatology. Hypothesis 1 was supported for the BIS but not the BAS. Table 1 provides a summary of the results from the analysis of symptomatology for ADHD, ODD, and CD. Table 2 provides a matrix of results from the analysis of symptomatology for ADHD, ODD, and CD. The table shows that the BIS and BAS are significantly related to each other, but the BIS is more strongly related to ADHD symptoms. The BAS is positively associated with ADHD symptoms of impulsivity/hyperactivity, which is consistent with previous research (Goméz & Conr, 2010; Hunt et al., 2008; Mitchell & Nelson-Gray, 2006). However, when we looked at the prediction of hyperactivity/impulsivity symptoms, results were remarkably similar to our model that did not include impulsivity/hyperactivity symptoms in a statistical control. One exception was the effect of the WCST was reduced to below conventional criteria for statistical significance (p = .19). Overall, these findings suggest that poor behavioral inhibition can be a risk factor for the development of ADHD symptoms, and that the evidence for deficits in behavioral inhibition is stronger than that for set-shifting.

Discussion

There was evidence that “bottom-up” processes, both the BAS and the BIS (as measured by the PSRT) were associated with impulsivity/hyperactivity symptoms, but not with inattention symptoms. The BAS was positively associated with ADHD symptoms of impulsivity/hyperactivity, which is consistent with previous research (Goméz & Conr, 2010; Hunt et al., 2008; Mitchell & Nelson-Gray, 2006). However, when we looked at the prediction of hyperactivity/impulsivity symptoms above and beyond symptomatology for ADHD, the BAS was not associated with impulsivity/hyperactivity symptoms. Thus, individual differences in the BAS did not meet our more stringent criteria for specificity with respect to hyperactivity/impulsivity.

More consistent support for specificity of “bottom-up” processes was found for the BIS. The BIS was positively associated with ADHD symptoms of impulsivity/hyperactivity, even when we included inattention symptoms as statistical control variable. This association was surprising and inconsistent with theoretical expectations that a hypofunctional BIS should be associated with ADHD (Quay, 1997). However, Quay’s rationale for expecting the BIS to be negatively associated with ADHD was based on evidence that a hyperactive BIS manifests a strong BIS. However, the present study had a notably different sample, with a sample that is older and more representative of early adolescents. Although the original version of the RST (Gray, 1982) viewed reactions to conditions of aversive stimuli as being mediated by the BIS, in the revised theory (Gray & McNaughton, 2000) response to aversive stimuli is mediated by the BAS. However, the BIS/BAS model does not postulate that the two systems are independent, but rather that they are functionally related. The BIS is thought to play a role in the development of behavioral inhibition in early childhood, whereas the BAS is thought to play a role in the development of behavioral activation in early childhood. The emotional consequence of a strong BIS is worry and anxiety (Smillie, Pickering, & Jackson, 2006), and worrying about symptoms which may be related to a hypofunctional BIS. Hypofunctioning of the BIS is often observed in conjunction with a hyperfunctioning BIS. However, it is likely that future research should consider Gray’s revised theory.

Limitations

• Cross-sectional design. Both executive functioning and reward sensitivity develop through late adolescence and into early adulthood (Luciana, 2006; Spear, 2010; Steinberg, 2005) and therefore, it is likely that future research should examine the development of “top-down” and “bottom-up” developmental changes in these processes related to ADHD.

• Our laboratory measure of RST only assessed the BAS and BIS. According to Quay (1997), ADHD is characterized by deficient reactions to contiguity of stimulus events and such reactions may be thought to be mediated by the Flight-Flight or Freeze System (FFS) in the revised RST. Future work should consider the role of the FFS.

• We did not consider all aspects of executive functioning (Miyake et al., 2000), and it will be important for future research to extend our work on multiple pathways and consider other aspects of executive functioning, including working memory (Martinussen, Hayden, Hogg-Johnson, & Tannock, 2000).

Conclusion

In conclusion, the present study supports the view that different processes are involved in the etiology of ADHD. Such heterogeneity in the etiology of ADHD suggests that it may be important to use person-specific approaches in the treatment and prevention of ADHD. Research on the evolution of social and emotional functioning and its role in heterogeneity in our theoretical models and intervention approaches, results will likely yield a complex set of contradictory findings.

References

Please see handout for references.

Acknowledgements & Contact Information

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