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Neurocognitive characteristics of youth with noncomorbid and comorbid forms of conduct disorder and attention deficit hyperactivity disorder

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Abstract

Objective: Studies investigating neurocognitive deficits in youth with conduct disorder (CD) and attention deficit hyperactivity disorder (ADHD) are often confounded by the high rates of comorbidity between the two.
Method: Neurocognitive functioning was examined in three diagnostic groups (ADHD only, CD only, comorbid ADHD and CD) matched by age, sex, IQ, and medication status (n = 28–32 per group).
Results: No significant differences emerged between the diagnostic groups on measures of risk-taking or response inhibition. Children with CD performed better on a measure of spatial planning than those with comorbid ADHD and CD, and dimensional analyses in the full sample (n = 265) revealed a small association between ADHD symptoms and poorer spatial planning.
Conclusion: These results suggest that deficits in spatial planning may be more pronounced in individuals with ADHD, but that the neurocognitive functioning of youth with noncomorbid and comorbid CD and ADHD are largely similar.

1. Introduction

High rates of comorbidity between childhood conduct disorder (CD), oppositional defiant disorder (ODD), and attention deficit hyperactivity disorder (ADHD) suggest a shared etiology among these disorders [1,2]. There has been recent interest in examining underlying mechanisms that may account for the high rates of comorbidity between these disorders. A number of studies have examined neurocognitive functioning in youth with these diagnoses, but studies of ODD and CD have often been confounded by ADHD comorbidity and vice versa [3–5]. It remains unclear whether youth with noncomorbid forms of ODD/CD have the same neurocognitive deficits as those with ADHD only, and how deficits may differ in youth comorbid for these disorders.

Interestingly, although ADHD and ODD/CD were previously included in the same chapter of DSM-IV [6], which included all diagnoses usually first made in infancy, childhood, or adolescence, in the update to the DSM (DSM-5; [7]), ADHD was placed in the neurodevelopmental group of disorders, whereas ODD and CD were placed in the chapter on disruptive, impulse-control and conduct disorders. The categorization of ADHD as a neurodevelopmental disorder was made "to reflect brain developmental correlates with ADHD" [7]. Although this implies that there are neurocognitive factors specific to ADHD that are not found in ODD/CD, it is unclear from current research whether this is the case. Improving our understanding of the similarities and differences between ADHD and ODD/CD at the neurocognitive level may aid in determining whether the brain developmental correlates are significantly different

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enough to warrant classification into distinct categories in future iterations of the DSM.

It has been hypothesized that ODD/CD may be associated with greater impairments in the domains of motivational control and risk-taking, whereas ADHD may be associated with deficits in executive functions such as planning, set-shifting, and behavioral inhibition [8], but this hypothesis has not been directly tested. Furthermore, it is unclear how these deficits may manifest in youth with comorbid ODD/CD and ADHD. On one hand, having both disorders may serve as a "double hit," resulting in more severe or widespread deficits [9]. On the other hand, some studies have shown that comorbid youth perform better on some neurocognitive tasks than individuals with ADHD only [10,11].

Four prior studies have compared neurocognitive functioning in all three diagnostic groups: ADHD-only, ODD/CD-only, and ADHD+ODD/CD [10–13]. These studies each assessed different aspects of neurocognitive functioning ([12]: risk-taking; [10]: verbal fluency, working memory, and planning; [11]: inhibitory control; [13]: inhibition, working memory). However, these aspects of neurocognitive functioning have not been examined in a single study. The purpose of the present study was to examine neurocognitive functioning in these three diagnostic groups. We focused on the domains of planning, inhibition, and risk-taking in order to capture deficits that have been hypothesized to be specific to each disorder [8].

1.1. Risk taking

Increased risk-taking is commonly described as a feature of both ODD/CD and ADHD, yet findings on tasks assessing risk-taking in these groups are inconsistent. Groen et al. [14] reviewed fourteen studies that examined performance on gambling tasks, which are a common way of assessing risk-taking, in youth with ADHD. They found that only half of the studies demonstrated evidence that youth with ADHD take more risks on these tasks compared to normal controls. Two of these studies examined comorbid ODD/CD and both demonstrated that comorbidity increases risky behavior. Matthys et al. [9] found that risk taking on the Door Opening Task [15] was elevated in boys with CD only (n = 11) compared to normal controls (n = 31), and even further elevated in boys with comorbid CD and ADHD (n = 10), but the study did not examine boys with ADHD only. Humpreys and Lee [12] assessed risk taking in all three diagnostic groups using the Balloon Analog Risk Task. They found that youth with comorbid ADHD + ODD (n = 48) took the most risk, followed by the ODD group (n = 13), ADHD group (n = 55), and control group (n = 87), respectively. This study suggests that ODD may be more associated with risk-taking than ADHD.

On the Iowa Gambling Task, Hobson et al. [3] found that youth with ODD/CD-only (n = 28) and youth with ADHD ± ODD/CD (n = 31) sampled more from the risky decks than controls. However, dimensional analyses showed that ODD/CD symptoms, but not ADHD symptoms, were related to increased risky decision-making. This further suggests that risk taking may be more associated with ODD/CD. Other studies suggest that the relationship between risk-taking and ADHD may be more nuanced. Kroyzer, Gross-Tsur, & Pollak [16] found that on a modified version of the Cambridge Gambling Task (CGT), adolescents with ADHD (n = 32) chose unfavorable outcomes more frequently than typically developing controls, but also made smaller bets (i.e., risked less). Further, they did not show deficits in decision speed or risk adjustment, meaning they decreased the amount bet as they chose less likely outcomes. Overall, the ADHD group did perform more poorly on the task than the control group (n = 32), but this was not due to impulsivity or insensitivity to the concept of probability. However, it should be noted that 41% of the ADHD group also had ODD or CD, although the authors state that the presence of behavior disorders had no significant effect on any of the dependent measures of the CGT. In sum, it is unclear the degree to which risk-taking may differ in youth with noncomorbid versus comorbid forms of ODD/CD and ADHD.

1.2. Response inhibition

Deficits in inhibition have been described as features of both ADHD and CD. Inhibition has been described as a primary deficit in ADHD, and is also described as a feature of ODD and CD. One of the most widely used tasks to assess response inhibition is the Stop Signal Task (SST), which is used in the present study. The SST measures the ability to cancel an ongoing speeded motor response. An early meta-analysis found that deficits in response inhibition as measured by the SST were present in youth with ADHD and also in youth with disruptive behavior disorders without comorbid ADHD [17]. However, studies conducted since then have suggested that deficits in response inhibition may be specific to ADHD. Schachar et al. [11] directly compared youth diagnosed with ADHD only (n = 72), CD only (n = 13), or comorbid ADHD/CD (n = 47) with normal control children (n = 33) on the stop signal task. They found that the ADHD-only group had significantly impaired performance on the task compared to the other three groups, although it should be noted that the CD only group was quite small. Similarly, in a non-referred sample of school-aged boys, Avila et al. [18] found performance on the SST and other measures of inhibitory control to correlate with ADHD but not ODD symptoms. A more recent meta-analysis of studies using SST found that across over 9000 study participants, participants who had ADHD demonstrated medium deficits on stop signal reaction time, but participants who had ODD/CD without comorbid ADHD showed only small deficits in reaction time [19]. The deficits of the comorbid group were in between the two. The authors speculate that ODD/CD may phenotypically resemble ADHD, but that these individuals