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ATTENTION-DEFICIT DISORDER (A ROSTAIN, SECTION EDITOR)

Risk-Taking Behavior in Attention Deficit/Hyperactivity Disorder (ADHD): a Review of Potential Underlying Mechanisms and of Interventions

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Abstract

Purpose of Review Attention deficit/hyperactivity disorder (ADHD) is associated with several forms of risk-taking behavior (RTB). This paper aims to examine the scope of ADHD-related RTB, to highlight potential underlying mechanisms of this association, and to review initial evidence for interventions aimed to treat ADHD-related RTB.

Recent Findings Multiple lines of evidence indicate that ADHD is associated with real-life RTB across several domains (e.g., reckless driving, substance use, and unprotected sex), which is corroborated by evidence on laboratory risk–taking tasks. Several individual differences, some of them informed by decision theory, e.g., comorbid disorders, parental monitoring, and perceived enlarged benefits of RTB, may explain the link between ADHD and RTB. A number of studies showed that interventions designed for ADHD may reduce RTB.

Summary ADHD is linked to RTB across several domains. Decision theory may serve as a conceptual framework for understanding the underlying mechanisms, and thus may inform future research.

Keywords Attention deficit/hyperactivity disorder (ADHD) · Risk-taking behavior · Decision theory · Expected utility · Risk return · Heuristics

This article is part of the Topical Collection on *Attention-Deficit Disorder*

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Introduction

Attention deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder, characterized by inattention, hyperactivity, and impulsivity, with a prevalence around 5.3–7.2% in children and adolescents and 2.5–5.0% in adults [1–3]. ADHD is associated with several forms of real-life risk-taking behavior (RTB), which is defined as "engagement in behavior that is associated with some probability of undesirable results" [4]. Here, we review (i) evidence for the association between ADHD and RTB across several domains, (ii) underlying mechanisms explaining this association and (iii) treatment of RTB in individuals with ADHD, and we (iv) provide future directions for studies on the link between ADHD and RTB.

ADHD and Risk-Taking Behavior

Real-Life RTB

Studies on the link between ADHD and *general* RTB reported higher RTB engagement by adolescents with ADHD [5•], as

well as a positive correlation between ADHD symptoms and general RTB in adolescents [6] and adults [7•]. Most studies, however, examined the link between ADHD and specific RTBs [8].

Driving A comprehensive review on driving risks associated with ADHD consistently found that (a) childhood ADHD predicted driving-related RTB such as traffic violations, driving under the influence of alcohol, and driving without a license in adulthood and (b) adults with ADHD were more frequently characterized by adverse driving outcomes [9]. Meta-analyses revealed that drivers with ADHD are 1.23 to 1.88 times more likely to have driving-related RTB and adverse outcomes [10–12].

Substance (ab)Use A meta-analysis on prospective cohort studies showed that childhood ADHD was associated with nicotine use in adolescence and with alcohol use disorder in adulthood [13]. A similar meta-analysis found an increased likelihood for children with ADHD to develop dependence/abuse of nicotine, alcohol, marijuana, and cocaine in adolescence or adulthood, with odd ratios in the small-to-medium effect size range of 1.58 to 2.82 [14]. Recent longitudinal findings from the MTA study confirmed these meta-analytical findings [15•].

Aggression/Delinquency Aggressive and criminal behavior most often meets the criteria of RTB as it may lead to damage to the self or others. In children and adolescents with ADHD, comorbidity with conduct disorder (CD) is high [16], and more aggressive behavior is observed in adolescents with ADHD [17]. A meta-analysis showed a significant relationship between ADHD and criminal/delinquent behavior [18]. Another meta-analysis revealed a five-fold increase in prevalence of ADHD in youth prison populations, and a 10-fold increase in adult prison populations, compared with published general population prevalence [19].

Sexual RTB Prospective studies showed that childhood ADHD/hyperactivity was associated with earlier sexual activity, a higher number of sexual partners, more sex outside of a relationship, more sexually transmitted diseases, and more partner pregnancies and teenage parenthood [20–24].

Gambling A recent meta-analysis on ADHD and gambling problems showed a small but significant correlation between ADHD symptoms and gambling severity, an ADHD prevalence of 18% in problematic gamblers, and a prevalence of problematic gambling in ADHD of 12% [25].

Financial RTB Financial RTB is understudied in relationship to ADHD. However, among college students, an effect was found of ADHD symptoms on compulsive buying and credit-card misuse (although this was included in a factor that also contained risky driving) [26•]. A prospective study showed that, although hyperactive children as young adults did not differ from controls regarding debts and loans, they did report more problems saving money [21]. In adults, especially hyperactive-impulsive symptoms of ADHD were associated with financial RTB like delayed credit-card payments, carrying credit-card balances, and having more debts [27].

Food-Related RTB As the risks of unhealthy eating are well known to most people, this might also be considered as a RTB. A meta-analysis and a systematic review found a positive relationship between ADHD and overweight/obesity, with odd ratios in the small effect size range of 1.20 to 1.55 [28, 29]. Relatedly, associations between childhood ADHD and the number of overeating episodes and amounts of unhealthy food consumption (e.g., soft drinks and fast food) were observed [30] and students with ADHD reported lower healthy/unhealthy food consumption ratios [31].

Laboratory Risk–Taking Tasks

To study the nature of ADHD-related RTB, laboratory tasks with a gambling component have been used. Here, participants choose between several alternatives that differ in amount and probability of gain or loss. Typically, participants choose between a certain (or less risky) alternative with a small gain and a probabilistic alternative delivering a greater gain. Two meta-analyses revealed an overall small-to-medium effect size, indicating that groups with ADHD made more risky decisions [32••, 33].

Summary ADHD was associated with several forms of RTB, such as risky driving, substance (ab)use, aggression and delinquency, sexual RTB, gambling, financial RTB, and unhealthy eating. These findings were corroborated by laboratory risk–taking tasks. In the next section, we will outline several mechanisms that potentially explain the link between ADHD and RTB.

Understanding the Link Between ADHD and RTB

Most studies aimed at explaining the link between ADHD and RTB examined individual–related variables associated with both RTB and the absence or presence of ADHD. These individual differences thus have the potential to act as mediators in the ADHD–RTB relationship. Other studies, inspired by decision-making theories, examined several other individual or task-related variables having the potential to respectively mediate or moderate the relationship between ADHD and RTB. This paper focuses on cognitive and clinical

mechanisms of the link between ADHD and RTB. For a review of neurobiological mechanisms, potentially underlying the link between ADHD and RTB, see [34••].

Individual Differences

ADHD Presentation

Most of the studies reviewed in the previous section also examined specific associations between RTB and ADHD presentations (predominantly inattentive, predominantly hyperactive/impulsive, combined) or symptoms clusters. This yielded mixed results: RTB was sometimes associated with inattention, sometimes with hyperactivity/impulsivity, and sometimes with both (e.g. [14, 35],). For example, De Alwis et al. [36] found that the associations between substance use and either inattentive or hyperactive/impulsive symptoms were similar, except for alcohol and nicotine use that were more strongly associated with hyperactive/impulsive symptoms. On the other hand, teacher-rated inattention, but not hyperactivity/impulsivity symptoms, predicted sexual RTB in a sample of adolescents [37]. A recent study found a correlation between overall RTB and both inattention and hyperactivity/impulsivity symptoms [7•]. Therefore, RTB seems to relate to both symptoms of inattention and hyperactivity/impulsivity.

Presence of Comorbid Psychiatric Disorders

Generally, comorbidity in ADHD is high and more than half of the individuals with ADHD have at least one comorbid disorder [1, 16]. Some of these comorbid disorders are also associated with RTB.

Conduct Disorder The criteria of CD, which is highly prevalent in individuals with ADHD, in itself describe several RTBs (e.g., running away from home), and increase the risk for RTBs in other domains. That is, various studies have demonstrated that having both ADHD and CD increased the likelihood of RTBs like substance use, risky driving, and risky sexual behavior [23, 38–40].

Substance Use Disorders Substance use disorders, which describe RTBs in itself, are highly prevalent among individuals with ADHD [16]. These high rates of comorbidity can be explained by the "self-medication" hypothesis, which sees substance use as a way of alleviating ADHD symptoms [41]. The relationship between ADHD and the risk of developing substance use disorders can be explained by many factors, such as comorbid CD, executive functioning, negative affect, and parenting (see [42] for an extensive review).

Internalizing Disorders One study indicated that comorbidity with internalizing disorders did not predict later substance abuse in ADHD [43]. Similar conclusions were supported by a recent meta-analysis [32••], showing that comorbid disruptive behavioral disorders, but not internalizing disorders, increased laboratory risk taking in ADHD.

These results thus indicate that underlying mechanisms might be related to comorbid disruptive behavioral disorders or substance use disorders, but not to internalizing disorders.

Anger

A large body of literature confirms the role of emotions in decision making under risk [44]. For example, trait driving anger and aggression were consistently associated with risky driving [45]. As anger and problems with anger control are over-represented in individuals with ADHD [46], the link between ADHD and RTB may be accounted for by this emotional state. One study provided direct evidence for this hypothesis: anger and hostility partially mediated the link between ADHD and risky driving [47]. Other studies provided indirect evidence by showing higher levels of both driving anger and risky driving in adults with ADHD [48–50].

Deficits in Executive Functioning

Decision making under risk requires goal-directed behavior, which in its turn relies on attention and executive functioning (e.g., response inhibition and working memory) [51•]). As ADHD has been consistently associated with attention and executive functioning deficits [52–55], this may explain why individuals with ADHD excessively engage in RTB.

This hypothesis was partially supported by several studies incorporating measures of both real-life RTB and executive functions. For example, response inhibition significantly predicted substance use in adolescents with ADHD [56]. Moreover, a link between ADHD and lane management in a simulated driving environment was documented, and this link was partially mediated by sustained attention and working memory [57, 58]. Furthermore, ADHD vs. controls differences in gambling task performance correlated with response inhibition, but not with working memory performance [59, 60]. On the other hand, abnormal performance on executive functioning tests failed to predict earlier onset, or rate, of substance use in late adolescence in participants with and without ADHD [61]. Finally, on experimental gambling tasks, it has been consistently shown that participants with ADHD demonstrated similar, or even longer, deliberation times [5•, 62–66], which does not support the inhibition account, as this would suggest faster responding.

Reluctance to Invest Effort

ADHD is linked to unwillingness to invest effort, as reflected by the incorporation of the symptom "reluctance to engage in activities that require mental effort" into the criteria of ADHD in the DSM-5 [1]. Unwillingness to invest effort may result in RTB, if, which is true for most RTBs, the less risky choice requires more effort (e.g., complex calculation of outcomes, overcoming temptation or frustration) [67]. Consistent with the hypothesis above, a higher degree of ADHD symptoms was associated with health-related RTB, but only when self-reported effortful control was low [26].

Sensation Seeking

Sensation seeking refers to the tendency to seek out experiences that are novel, varied, complex, and intense [68], and high sensation seeking predicts greater engagement in RTB [69]. Correlations between ADHD and sensation seeking were repeatedly documented [70, 71] and in a recent study, sensation seeking levels of adults with ADHD significantly mediated the association between ADHD symptoms and health-related RTB (but not risky driving/financial behavior) [26].

Social Influences

In adolescents, the effect of two social variables on ADHD-related RTB has been studied: peers and parents.

Peers Adolescent RTB often takes place in social contexts and is enhanced by affiliation with peers who approve RTB [72, 73]. Adolescents with ADHD encounter a lower peer acceptance and higher rates of peer rejection, which may result in socializing in a deviant peer group [74]. For example, adolescents with ADHD were more likely to report friendships with substance-using/tolerant peers [75]. Moreover, the association between peer substance use/tolerance and self-reported substance use was stronger in the ADHD group, which may suggest greater vulnerability to peer pressure in adolescents with ADHD. This is corroborated by a study showing that peer rejection in children with childhood ADHD predicted cigarette smoking and delinquency in a 6-year follow-up [76].

Parents ADHD was associated with lower parental monitoring (i.e., knowledge about their child's friendships, activities, and whereabouts) [77], which was associated with elevated RTB [78]. Similarly, in adolescents with childhood ADHD, parental monitoring was associated with less delinquency and substance/alcohol use [79]. Moreover, childhood ADHD only predicted alcohol use frequency at age 17 when parental monitoring was low [80]. Two recent studies suggested that while ADHD symptoms account for significant variability in adolescents' RTB, this relationship is partially mediated by reduced parental monitoring [6, 81].

Summary and Implications

Studies on individual differences have two important implications. First and scientifically, they suggest processes that may explain the link between ADHD and RTB, such as comorbid disorders, sensation seeking, executive functioning deficits, and low parental monitoring. Second and clinically, they may help in recognizing specific at-risk individuals within the ADHD population (e.g., those with comorbid conduct disorder), and may lead clinicians to reduce risk factors (e.g., peer rejection) and to boost protective factors (e.g., parental monitoring).

Decision Theory–Based Studies

A decision-theory framework may help in understanding the link between ADHD and RTB. Some studies aimed at explaining the link were inspired by decision theory, more specifically by expected utility, risk return, and heuristic theories. We therefore first describe these theories briefly, and then review the ADHD-RTB studies that were inspired by these theories.

Decision Theory

Expected Utility A basic tenet of expected utility models is that people try to maximize expected utility [82]. Individuals are assumed to assign expected utility to each alternative, by summing over subjective gain and loss amounts, multiplied by their corresponding subjective probabilities. Decision makers then choose the alternative with the highest expected utility [83]. According to expected utility models, including prospect theory [84], individual differences in RTB may thus originate in differences in how amounts and/or probabilities are subjectively evaluated. For example, if loss amounts and/or loss probabilities are subjectively underweighted, this will result in RTB [51•].

Risk Return Models The risk return model from finance states that decisions are based on comparing, for each alternative, the weighted sum of return (objective expected value) and its risk (objective standard deviation of expected value). In the general population, the weight associated with risk is negative and therefore people are risk averse [85]. If this weight is less negative or even positive in ADHD, it may explain enhanced RTB accordingly.

According to the behavioral decision theory (BDT) [86], a psychological risk return model, risk and return are subjectively evaluated. According to this model, RTB in ADHD may again be explained not only by a less negative, or positive,

weight given to risk, but also by differences in subjective evaluation of risk or return, i.e., risk and benefit perception.

Heuristic Models Heuristic models assume that decision makers will not always take into account all information about gain and loss amounts and probabilities. That is, they use decision heuristics that simplify the decision process by comparing options based on a limited set of attributes [87]. Reliance on heuristics, rather than on integration of amounts and probabilities, may lead to suboptimal decision making and RTB [88•]. An application of heuristic models to the link between ADHD and RTB would suggest that individuals with ADHD rely on heuristics that might be bias towards RTB, for example by only considering information on gains and not on losses.

These decision theory models may serve as conceptual frameworks for understanding individual differences that were reviewed earlier (also see Fig. 1). In the following, we speculate on how each of these individual difference variables may link to each of the theories. For example, according to the expected utility model, *comorbid conduct disorder* may lead to a diminished sensitivity to losses [89, 90], which may lead to enhanced RTB. Alternatively, according to the financial risk return model, comorbid conduct disorder may result in a positive weight associated to risk, i.e., thrill seeking [91], which will also result in enhanced risk taking. Moreover, according to psychological risk return theory, comorbid conduct disorder may change the way individuals perceive the potential benefit and risk of alternatives, which may in turn relate to enhanced RTB. Finally, according to theory on heuristics, comorbid conduct disorder may lead to disregarding losses altogether and thus to an exclusive focus on gains, again leading to enhanced RTB.

Deficient executive functioning may lead to difficulty in calculating expected utility, resulting in suboptimal choices, as would be predicted by the expected utility and the financial and psychological risk return models. Furthermore, in order to simplify decision making, people with deficient executive functioning may prefer heuristics to save effort. Similarly, *unwillingness to invest effort* will lead to the same results: difficulty in maximization of utility and the use of heuristics to save effort.

Sensation seeking may increase the sensitivity to gains, which may lead to RTB according to the expected utility model. Alternatively, it may increase benefit perception of RTB, changing the balance between psychological risk and return. Finally, sensation seeking is characterized by susceptibility to boredom [92], and therefore may lead to the use of heuristics to speed the decision process, which can ultimately lead to RTB.

Peer pressure and lack of parental monitoring may lead the child to underweight the dangerous outcomes of RTB, thereby

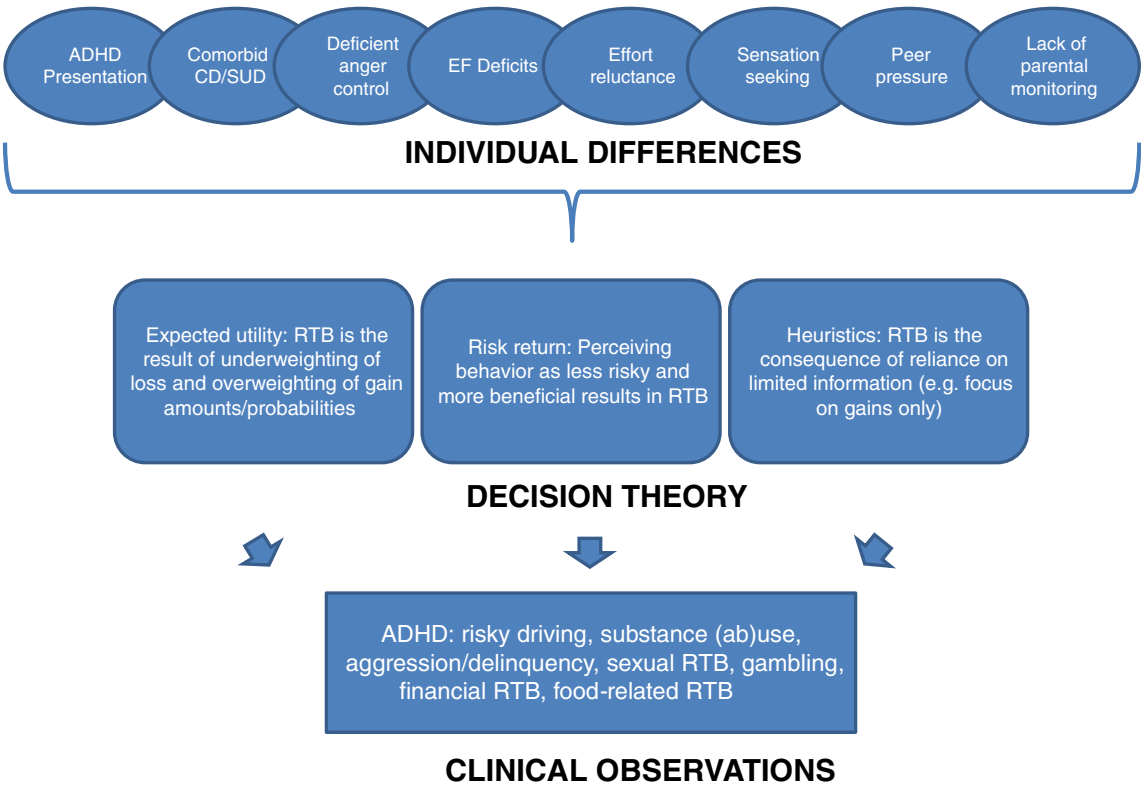

Fig. 1 Conceptual framework on individual differences and decision theory explaining the link between ADHD and RTB. Abbreviations: CD, conduct disorder; SUD, substance use disorder; EF, executive functioning; RTB, risk-taking behavior

increasing its expected utility. Alternatively, it may diminish the weight associated to risk or decrease risk perception, changing the balance between risk and return. For instance, having risky friends was correlated with young drivers' lower perceived risk of speeding, leading to greater likelihood of speeding [93]. In addition, parenting behavior was found to correlate with the child's executive functions, which may be associated with the use of heuristics [94].

These speculative conceptual links between decision theory models and individual differences potentially mediating the link between ADHD and RTB seem promising and may promote further research. However, as indicated above, each mediating effect can be explained by multiple models. Therefore, it precludes testing specific hypotheses inspired by decision-theory models. In the following, we therefore review how RTB in ADHD is affected by decision theory–related variables.

Risk Attitude/Risk Perception

According to the *financial risk return model*, risk attitude, which ranges from risk aversion to risk seeking, reflects individual differences in the weight that is given to the objective risk. The link between ADHD and RTB intuitively suggests that individuals with ADHD are more risk seeking. A recent study provided evidence *against* this hypothesis. In a multilevel meta-regression analysis of laboratory risk–taking tasks, participants with ADHD only chose the risky alternative more often if it yielded a lower return, whereas groups performed similarly if the risky alternatives yielded a similar or higher return. Moreover, an empirical study showed that when the risky alternative yielded a higher return, adults with ADHD chose the risky alternative less often than controls [95].

Psychological risk return models, by emphasizing the subjective perceptions of risk and return, inspired a study in which the self-reported likelihood of engagement in a range of RTBs, as well as the perceived benefit and perceived risk ascribed to these behaviors, were measured using the Domain-Specific Risk Taking scale [86]. In addition, benefit and risk attitudes, or the weights that were given to the perceived benefit and risk, were estimated using a regression model [96]. The study indicated that the association between ADHD symptoms and likelihood of RTB was mediated by perceived benefits [7•]. These findings highlight the idea that individuals with high levels of ADHD symptoms tend to engage in RTB because they find such behavior particularly appealing, rather than because they give less negative or even positive weight to risk.

Other Decision-Related Variables

Decision theory revealed numerous components of the decision process, including estimation of probabilities of outcomes, the time at which each potential outcome would happen, and the presence of feedback [34••]. ADHD may interact with these variables in a way that favors RTB.

Probability of Outcome *Expected utility models* have inspired the study of ADHD-related differences in the perceived probability, separately for positive and negative outcomes. Among adolescents, inattention was correlated with a lower perceived probability regarding the negative outcomes of cigarette smoking, and hyperactivity/impulsivity was correlated with a higher perceived probability about the positive outcomes of smoking [97]. Moreover, children with ADHD had lower levels of perceived probability of negative alcohol outcomes, although they also had lower levels of perceived probability of positive outcomes [98].

Time Some choices, e.g., the choice to smoke or not, require consideration of both immediate gains (e.g., pleasure of smoking) and long-term losses (e.g., illness). According to *expected utility* inspired models [99], such long-term consequences might be down weighted, which thus may result in RTB. Interestingly, down weighting of long-term consequences has been studied quite extensively in ADHD. In so-called temporal discounting paradigms, in which participants are offered a choice of a small immediate reward or a large delayed reward, participants with ADHD tend to prefer small immediate over large delayed rewards (see [100, 101] for meta-analyses).

Feedback According to *expected utility theory*, the subjective utility of RTB is not fixed, but is rather updated in the light of experience [34••]. Often, RTBs occur more than once in the same individual (e.g., substance use, reckless driving), so risk takers have the opportunity to experience at least some of the consequences of their choices and use this feedback to update utility. Basic aspects of feedback processing were found to be impaired in ADHD, reflected by difficulties in using feedback to improve performance [102–104]. Consequently, it may be concluded that individuals with ADHD are more impaired on risk-taking tasks that involve feedback processing than on tasks that do not.

Relatedly, some of the gambling tasks that are used to study mechanisms underlying RTB are explicit: gain and loss amounts and corresponding probabilities are explicitly provided. Other tasks are implicit: characteristics have to be learned by experiencing feedback [105]. If the link between ADHD and RTB is related to impaired feedback processing, individuals with ADHD would have greater difficulty on implicit gambling tasks. Indeed, a recent meta-analysis found a significant difference between ADHD and control groups on implicit tasks, but not on explicit tasks [32••]. Moreover, when specifically testing this feedback processing, it was found that adolescents with ADHD's performance on an explicit task

was different than controls, but only when feedback was provided [5]. Altogether, this suggests that ADHD-related suboptimal decision making is mediated by an abnormal response to feedback [64].

Heuristics Finally, one study inspired by theory on heuristics showed that adolescents with behavior disorder, including ADHD, were not characterized by the use of different heuristics than typically developing adolescents. This study therefore did not provide evidence that use of heuristics mediates the role between ADHD and RTB [88•].

Summary and Implications

Building upon expected utility, risk return, and heuristic models of risk taking, some variables affecting the link between ADHD and RTB were revealed. Individuals with ADHD are characterized by suboptimal utility maximization, increased benefit perception, steep temporal discounting, and deficient feedback processing. Delineating the underlying mechanisms of ADHD-related RTB may help clinicians to better understand their patients' motivations (e.g., thinking that RTB is beneficial) and help them finding adaptive substitutions (e.g., by fostering rational expectancies regarding the outcomes of RTB).

Treatment of RTB in ADHD

A number of studies examined the efficacy of interventions aimed to treat ADHD, when at least one of the outcome measures was RTB.

Psychostimulant intervention is the most studied treatment for children and adults with ADHD [106]. Meta-analyses revealed that stimulant use in childhood was associated with a reduction in the risk for subsequent drug and alcohol use disorders [107, 108]. Stimulant treatment was also found to be associated with lower cigarette smoking rates in another meta-analysis [109].

With regard to risky driving, stimulant use was found to be effective in reducing the risk of collisions and accidents [110]. In a large cohort of individuals with ADHD that compared the risk for motor crashes in months receiving medication treatment to months without medical treatment, a medication-related reduction of about 40% in motor crashes was found [111•]. A reduction in self- and spouse-reported driving-related RTB was also documented after a 6–12-month period of medical intervention in a cohort of 1100 individuals with ADHD aged 16–52 [112]. Overall, different stimulants and different release methods are effective in improving driving performance, while rebound effects may worsen it [113].

Furthermore, psychostimulants reduce conduct problems and aggression in youth with ADHD, with and without comorbid behavior disorders [114]. Using Swedish national registers, Lichtenstein et al. compared the crime conviction rates of individuals with ADHD in periods of receiving ADHD medication as opposed to periods without medication [115]. Receiving ADHD medication was associated with a significant reduction in the criminality rate of 32–41%.

In a recent meta-analysis [32••], no difference in experimental risk taking was observed between studies in which all or a proportion of the ADHD participants were taking medication and studies disallowing stimulant medication use. However, follow-up analyses indicated that differences in risky decision making between ADHD and control groups were not significant when participants were allowed to take stimulant medication. In a within-subject, double-blind placebo-controlled trial of methylphenidate, it was found that stimulant medication reduced risk-prone betting behavior of boys with ADHD on an explicit gambling task [62].

Finally, non-pharmacologically, a meta-analysis revealed that behavioral interventions have a positive effect on comorbid conduct problems in children with ADHD [116]. Also, a parent-teen driving intervention program was modified to help adolescents with ADHD to become independent drivers, with promising first results [117].

Future Directions

Future directions may address the difficulties that were revealed in the review of potential mechanisms of the link between ADHD and RTB. (i) In the study of individual differences, the variables (e.g., comorbidity, executive functioning) should always be tested as mediators, rather than only as correlates of both ADHD and RTB. (ii) As can be seen from the conceptual framework (Fig. 1), the influence of individual-differences variables on RTB in ADHD can now be hypothetically explained by all theoretical models. Future research should spell out which of these decision theory models is most adequate for explaining how individual-differences variables influence ADHD-related RTB. This would yield specific hypotheses that would advance our knowledge on how underlying mechanisms influence ADHD–related RTB. (iii) There is a still a disturbing gap between real-life RTB and laboratory tasks, with only small correlations between these two types of indices [65, 118]. Bridging this gap is crucial for pursuing valid explanations for the link between ADHD and RTB, as well as for the translation of basic research into effective prevention and intervention protocols.

Other directions may also prove fruitful: (iv) Increased engagement in RTB may also characterize other psychiatric disorders, and dysfunctional decision making has been suggested as a transdiagnostic mechanism in psychiatry [119]. Pioneering efforts to compare RTB across different disorders and to identify both common and unique aspects of this link

have appeared [34••] and should be further developed. (v) There has been a long-standing debate whether mental disorders are best classified using dimensional or categorical approaches, and both of them appear to have a value [120]. Interestingly, a significant proportion of the literature on ADHD and RTB used a dimensional conceptualization of ADHD and reported a correlation between levels of ADHD symptoms and RTB. Further studies may examine which conceptualization of ADHD may advance the field more successfully.

Conclusions

A literature review establishes the link between ADHD and RTB, both in real life across several domains and in laboratory risk–taking tasks. Individual differences and decision-related variables both serve as potential mechanisms explaining this link. Decision theory models may serve as conceptual framework for explaining underlying mechanisms and for directing future research. A number of studies showed that interventions designed for ADHD might reduce RTB. Decision theory–based clinical studies may be a promising direction for future research.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- •• Of major importance

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