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Choice-impulsivity in children and adolescents with attention-deficit/hyperactivity disorder (ADHD): A meta-analytic review

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HIGHLIGHTS

- Meta-analytic methods examined choice-impulsivity in children and adolescents with and without ADHD.
- Children and adolescents with ADHD, relative to healthy controls, exhibited moderately more choice-impulsivity.
- Limited study-wise methodological variability highlights the need for additional studies.

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ABSTRACT

Impulsive behavior is a core DSM-5 diagnostic feature of attention-deficit/hyperactivity disorder (ADHD) that is associated with several pejorative outcomes. Impulsivity is multidimensional, consisting of two sub-constructs: rapid-response impulsivity and reward-delay impulsivity (i.e., choice-impulsivity). While previous research has extensively examined the presence and implications of rapid-response impulsivity in children with ADHD, reviews of choice-impulsive behavior have been both sparse and relatively circumscribed. This review used meta-analytic methods to comprehensively examine between-group differences in choice-impulsivity among children and adolescents with and without ADHD. Twenty-eight tasks (from 26 studies), consisting of 4320 total children (ADHD = 2360, TD = 1,960), provided sufficient information to compute an overall between-group effect size for choice-impulsivity performance. Results revealed a medium-magnitude between-group effect size ($g = .47$), suggesting that children and adolescents with ADHD exhibited moderately increased impulsive decision-making compared to TD children and adolescents. Further, relative to the TD group, children and adolescents with ADHD exhibited similar patterns of impulsive decision-making across delay discounting and delay of gratification tasks. However, the use of single-informant diagnostic procedures relative to multiple informants yielded larger between-group effects, and a similar pattern was observed across samples that excluded females relative to samples that included females.

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Attention-deficit/hyperactivity disorder (ADHD) is a highly prevalent neurodevelopmental disorder that affects approximately 5% of children worldwide (Polanczyk, Silva de Lima, Horta, Biederman, and Rohde, 2007). Impulsive behavior, one of the core, DSM-5 (American Psychiatric Association, 2013) diagnostic features of ADHD, is associated with a multitude of negative behaviors such as social/peer difficulties (Gadow et al., 2000), academic difficulties (Merrell and Tymms, 2001), conduct problems (Grizenko, Paci, and Joober, 2010), and interrupting others (Marcus, Fox, and Brown, 1982). Moreover, ADHD-related impulsivity that persists into adulthood is associated with increased risk for pathological gambling (Grall-Bronnec et al., 2011), substance abuse (Verdejo-Garcia, Lawrence, and Clark, 2008), poor interpersonal skills (Ingram, Hechtman, and Morgenstern, 1999), vehicle accidents (Barkley, Murphy, DuPaul, and Bush, 2002), and incarceration (Retz et al., 2004). Extant research of ADHD-related impulsivity has adopted methodology from basic animal models that provide two major models of the construct; *rapid-response impulsivity* (Evenden, 1999) and *reward-delay impulsivity* (Monterosso and Ainslie, 1999).

1. Rapid-response impulsivity

Rapid-response impulsivity is the more commonly examined construct, and is most often reified as a response style that sacrifices accuracy for speed (Evenden, 1999). This relatively broad definition lends itself to an equally broad array of experimental measures, as nearly any task that yields a dependent variable reflecting response time and/or accuracy may provide a metric of rapid-response impulsivity. For example, the matching familiar figures test (MFFT) that was originally developed as a measure of behavioral inhibition in children with anxiety (Kagan, 1966), is frequently used as a measure of ADHD-related impulsivity, such that commission errors are examined in context of response latencies (Avila, Cuenca, Felix, Parcet, and Miranda, 2004; DuPaul, Anastopoulos, Shelton, Guevremont, and Metevia, 1992). Similarly, performance on standardized, timed-measures of processing speed, such as the Symbol Search and Coding Subtests from the WISC-V (Wechsler, 2014), allows clinicians to infer impulsive behavior when children exhibit low scores due to inaccurate responding across a relatively high number of attempted items.

Examples of other measures that are frequently considered metrics of rapid-response impulsivity include continuous performance tests (CPT; Avila et al., 2004; Swann, Bjork, Moeller, and Dougherty, 2002), stop-signal tasks (Verdejo-Garcia et al., 2008), and go/no-go tasks (Bezdjian, Tuvblad, Wang, Raine, and Baker, 2014). Unlike the previously discussed examples that are relatively self-paced, CPTs, stop-signal tasks, and go/no-go tasks present prepotent stimuli serially with predetermined stimulus-presentation times, inter-stimulus intervals, and response opportunities (i.e., numbers of trials). Children are generally considered impulsive when they exhibit a high number of commission errors, such as with the CPT (Denney, Rapport, & Chung, 2005; Raiker, Rapport, Kofler, and Sarver, 2012) or go/no-go task (Bezdjian et al., 2014), and/or fail to withhold or discontinue responses when secondary stop-stimuli are presented, such as with the stop-signal task (Logan, Schachar, and Tannock, 1997). These operationalizations of impulsivity, however, contrast a large body of extant cognitive (Logan and Cowan, 1984; Verbruggen and Logan, 2008) and clinical (Berlin, Bohlin, Nyberg, and Janols, 2004; Nichols and Waschbusch, 2004; Oosterlaan, Logan, and Sergeant, 1998) research that suggest that performance on these measures reflects behavioral inhibition processes, rather than impulsivity. That is, while the disinhibition and impulsivity constructs are frequently conflated in clinical research (Enticott, Ogloff, and Bradshaw, 2006), findings from extant studies provide strong evidence that the constructs are discrete (Dalen, Sonuga-Barke, Hall, and Remington, 2004; Solanto et al., 2001). Moreover, previous findings that suggest impulsivity and inhibition are related but different constructs, are consistent with current models of ADHD that suggest that behavioral disinhibition serves as a central deficit that underlies impulsivity (Barkley, 1997), and/or reflects one of multiple paths (i.e., disinhibition, delay aversion, timing deficits) that result in the ADHD phenotype (Sonuga-Barke, Bitsakou, and Thompson, 2010). Therefore, while a dysfunctional inhibition system would result in increased impulsivity, a functional inhibition system does not guarantee that an individual will possess a self-controlled decision-making style (i.e., inhibition and impulsive decision-making are not synonymous processes).

2. Reward-delay impulsivity

Reward-delay impulsivity is defined as a choice for small-immediate reinforcers over larger-delayed reinforcers (Muraven & Baumeister, 2000; Olson, Schilling, and Bates, 1999; Swann et al., 2002), and is associated with several DSM-5 defined psychological disorders including ADHD (Solanto et al., 2007; Sonuga-Barke, Taylor, Sembi, and Smith, 1992), gambling disorder (Alessi and Petry, 2003), and substance use disorder (Stanger et al., 2012). The reward-delay impulsivity construct is, to some extent, muddled due to variability in terms/operational definitions that are used across studies and disciplines. For example, studies frequently refer to the opposite of reward-delay impulsivity as *self-control*, which is defined by a choice for the inverse reinforcement schedule (i.e., choice of large-delayed reinforcers over small-immediate reinforcers; Logue, 1988; Logue, King, Chavarro, and Volpe, 1990). Moreover, the terms self-control and *delay-of-gratification* are frequently used interchangeably in extant research (Mischel, Shoda, and Rodriguez, 1989), albeit the terms connote subtly different meanings. For the sake of clarity, the current study will use the umbrella term *choice-impulsivity* – choice of immediate-small reinforcers over