Original Article

Combining Cognitive and Personality Measures of Impulse Control in the Assessment of Childhood ADHD

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Abstract. Impulse control is measured both with personality questionnaires and in cognitive laboratory tasks, yet previous results concerning the convergence of these two types of instruments are inconsistent. The current study measured impulse control of children with and without ADHD with a personality questionnaire and a go/no-go task as well as with parent ratings of ADHD symptomatology. Scores on the two measures correlate weakly with one another, yet both correlate moderately to strongly with parent ratings – and both explain unique variance of parent ratings. Accordingly, the simple sum of the standardized scores from the two measures outperforms the single measures in diagnostic accuracy and association with ADHD symptomatology. Results show that a conjoint application of personality and cognitive measures of impulse control is useful for an extended assessment of ADHD. The adequacy of personality and cognitive measures for assessing distinct facets of impulse control is discussed with regard to theoretical models of impulsivity and with regard to ADHD symptomatology.

Keywords: impulse control, impulsivity, ADHD, inhibition, predictive power

Achieving an adequate level of impulse control is one of the most important developmental tasks during childhood and adolescence (Moffitt et al., 2011; Romer et al., 2009). Among the various cognitive and personality traits, impulse control plays a central role when it comes to predicting important life outcomes. Moreover, deficits in impulse control are a defining characteristic of several psychiatric disorders, including, but not limited to, attention deficit/hyperactivity disorder (ADHD), bulimia nervosa, substance abuse, and a number of less common disorders solely defined on the basis of deficient impulse control (American Psychiatric Association, 2000).

For measuring impulse control both personality measures such as self- or observer-reported questionnaires and cognitive tests are routinely utilized in clinical as well as nonclinical populations (Duckworth & Kern, 2011; Edmonds, Bogg, & Roberts, 2009). Definitions of the construct measured with these two kinds of measures are generally very similar. Most broadly defined, impulsivity – the lack of impulse control – is synonymous with action without foresight (Winstanley, Eagle, & Robbins, 2006). Somewhat more specifically, people high in impulse control follow (socially prescribed) norms and rules, are able to delay gratification, and generally are able to act task- and goal-oriented (Edmonds et al., 2009). Evidence exists that impulse control is not a unitary construct, but instead can be subdivided into related components. For example, using personality measures, Whiteside and Lynam (2001) proposed a four-factor model of impulsivity with the components (1) urgency, (2) lack of premeditation, (3) lack of perseverance, and (4) sensation seeking. In contrast, Eysenck, Easting, and Pearson's (1984) self-report questionnaire distinguishes impulsivity from sensation seeking, and their concept of impulsivity subsumes urgency and lack of planning and forethought. In line with Eysenck et al.'s framework are the results of Duckworth and Kern (2011): In their meta-analysis of multiple measures of impulsivity and self-control, they concluded that the first three components of Whiteside and Lynam's (2001) model "were not consistently different from one another" (p. 266), supporting a more unitary conception of impulsivity.

Cognitive measures of impulse control can be divided into two subcategories: measures of impulsive action and measures of impulsive choice. In measures of impulsive action, impulse control refers to the strength of an inhibitory mechanism which "modulates the internally or externally driven prepotent desire for . . . highly desirable rewards" (Winstanley et al., 2006, p. 380). Consequently, measures of impulsive action are often called measures of *inhibitory control*. Prominent examples of such measures are the go/no-go and the stop-signal task, both of which require fast responses on "go" trials, whereas on a subset

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of trials subjects must refrain from making the prepotent response. Another example are Stroop-like tasks, which require inhibiting a highly automatized reaction. In measures of impulsive choice, impulse control refers to the ability to delay gratification; "impulsive choice reflects . . . decision making processes rather than motoric inhibition" (Winstanley et al., 2006, p. 382). Measures of impulsive choice often require subjects to choose either a smaller, sooner reward or a later, larger reward, rewards being either real or hypothetical. Correlations (convergent validities) of different measures within one of the two categories (impulsive action and impulsive choice, respectively) are higher than between categories, and generally convergent validities seem to be lower for cognitive measures of impulse control than for personality measures (Duckworth & Kern, 2011).

Convergence of Cognitive and Personality Measures of Impulse Control

Evidence for the convergence of cognitive and personality measures of impulse control is less consistent than for the convergence of instruments within one type of measure. After assessing impulse control with several personality instruments and several cognitive tasks in a sample of 31 adults, Enticott, Ogloff, and Bradshaw (2006) found that only a spatial Stroop task correlated with the personality instruments, whereas three other cognitive tasks did not. Similarly, Reynolds, Ortengren, Richards, and de Wit (2006) reported that only one of several cognitive tasks correlated with personality measures. For a community sample of preadolescents, Romer et al. (2009) found comparatively low correlations of a personality measure of impulse control with several cognitive tests, yet in a structural equation model, both types of instruments loaded on a single impulsivity factor, which in turn predicted risk taking and externalizing problems.

The results are also mixed regarding children and clinical samples. Braet, Claus, Verbeken, and van Vlierberghe (2007) found that, while both obese boys and girls responded more impulsively on a cognitive measure, only obese boys reported being more impulsive than typically developing children on a self-report measure. In children samples, the usage of parent or teacher ratings of impulsivity is more common than the use of self-reports. Applying both parent and teacher ratings, Avila, Cuenca, Félix, Parcet, and Miranda (2004) found a strong correlation of several cognitive measures of inhibitory control (stop-signal task, continuous performance task, matching familiar figures) with parent and teacher ratings of impulsivity and other ADHD symptoms, whereas a Stroop task was more strongly related to externalizing symptoms. In a similar approach, Bezdjian, Baker, Lozano, and Raine (2009) reported a strong association between the number of errors on a go/no-go task and caregiver and teacher reports of hyperactivity and impulsivity. In sum, these results indicate that cognitive and personality measures of impulse control do not address a unitary construct. Instead, different instruments both within and between types of measures seem to tap separable, yet related components of a multifaceted construct.

Measures of Impulse Control in ADHD

Together with hyperactivity and inattention, impulsivity is a core symptom of ADHD. For diagnostic purposes, clinicians most often utilize semistructured interviews and rating scales inquiring about the ADHD core symptoms from parents and teachers. Yet even if cognitive measures of impulse control are not routinely applied in the assessment process, they play a central role in current research on ADHD. In one of the most prominent theories of ADHD, Barkley (1997) posited deficient inhibition to be the primary deficit associated with the disorder, leading to secondary deficits in other executive functions such as working memory, set shifting, planning, and further constructs. Executive function deficit (EFD) theories of ADHD such as that of Barkley (1997) triggered an enormous amount of research, although results have not been unequivocal: No single EFD, including deficient impulse control, turns out to be a unique marker of ADHD, and EFDs are neither large enough to uniquely classify individuals with and without ADHD, nor can significant group differences be replicated in every case (Castellanos, Sonuga-Barke, Milham, & Tannock, 2006; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005).

Nevertheless theoretical and empirical evidence for the association of ADHD symptomatology with EFDs is pervasive (Willcutt et al., 2005). For that reason several attempts have been made to utilize laboratory measures of EFD for the diagnostic classification of individuals with ADHD. Several studies showed that a combination of different cognitive measures of impulse control generally performs better than any single measure (e.g., Berlin, Bohlin, Nyberg, & Janols, 2004; Doyle, Biederman, Seidman, Weber, & Faraone, 2000; Grodzinsky & Barkley, 1999), yet a battery of cognitive measures alone is not sufficient for the identification of all children with ADHD. A general conclusion of such studies is that, whereas specificity, i.e., the probability that a person is correctly classified as a noncase, is high, sensitivity, i.e., the probability that a person is correctly classified as a case, is relatively low (Doyle et al., 2000; Drechsler, Rizzo, & Steinhausen, 2009; Grodzinsky & Barkley, 1999). This is because a subgroup of children with ADHD without EFDs performs at a similar level with typically developing children (Lambek et al., 2010; Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005). However, Berlin et al. (2004) reported that the sensitivity and specificity of a test battery were high when they combined a number of cognitive measures with parent ratings of children's ability for emotion regulation.

Goals of the Present Study

The results presented in the preceding sections show that even if cognitive and personality measures of impulse control are routinely applied, evidence about the convergence of the two types of measures is mixed. Generally, different instruments from both types seem to measure related, yet separable facets of impulsivity. In the clinical assessment of ADHD, personality measures or observer ratings of impulse control are standard diagnostic tools. Cognitive measures, on the other hand, are routinely used only in research settings, despite their potential for adding clinical information that is unaffected by observer- or self-report bias. Previous efforts to utilize cognitive measures of impulse control for diagnosis have shown that the specificity of these measures is generally low. In the present study, we aim to show that the distinct nature of facets of impulse control measured by cognitive and personality measures can be utilized for the assessment of ADHD. We expect that both types of measures contribute to the diagnostic utility, so that a combination of both types of measures is superior to using one type of measure in isolation. Finally, we analyze the correlation of both measures with parent-reported ADHD symptoms. We expect that both measures are associated with ADHD symptoms, especially parent-rated impulsivity, and that both measures will at least explain unique variance of the parent ratings.

Materials and Methods

Participants

Altogether, 35 children aged between 9.1 and 12.9 years participated in the study, 18 of whom had been previously diagnosed (see below) with ADHD (mean age = 11.2, *SD* = 14.7 months; 3 female). Mean age for the 17 typically developing (TD) children was 11.1 (*SD* = 11.8 months; 1 female). The study was approved by the institutional ethics committee; the parents of all participants gave written consent, and all children gave verbal assent.

Children with ADHD were recruited in collaboration with two different local child psychiatric outpatient centers and a resident psychotherapist specializing in such children. In all cases ADHD was diagnosed by a licensed psychologist or psychiatrist according to ICD-10 criteria using developmental history, parental interview, rating forms, behavioral observation, and medical evaluation for diagnosis. Additionally, for each child in the ADHD group, one parent completed several standardized rating scales. Children with ADHD were considered for participation in the current study only if they fulfilled all of the following criteria: (1) T score > 67 on the attention problem scale of the parent-rated Child Behavior Checklist (CBCL; Arbeitsgruppe Deutsche Child Behavior Checklist, 1998); (2) Stanine score ≥ 7 on the overall ADHD scale of the German ADHD symptom list (FBB-ADHS; Döpfner, Lehmkuhl, & Steinhausen, 2006); and (3) raw score ≥ 6 on the Hyperactivity scale of the Strengths and Difficulties Questionnaire (SDQ; Woerner, Becker, & Rothenberger, 2004). The children's general cognitive ability was estimated using five subtests (Digit Span, Block Design, Picture Concepts, Similarities, Vocabulary) from the German Wechsler Intelligence Scale for Children (HAWIK-IV, Petermann & Petermann, 2007). All of the children had an estimated IQ of higher than 85. Children using stimulants (N = 16) had to be off medication for at least 48 h before testing.

TD children were recruited in collaboration with local primary schools, daycare centers, and via an advertisement in a local newspaper. Children were accepted in the TD group only if they fulfilled the following criteria:

1. absence of any present or past psychiatric diagnoses determined by parental report;
2. Stanine score ≤ 6 on the overall ADHD scale of the FBB-ADHS;
3. raw score ≤ 5 on the Hyperactivity scale of the SDQ;
4. an SDQ total difficulties score ≤ 16; and
5. estimated IQ ≥ 85 (see above).

Measures

Impulsivity Questionnaire

The impulsivity scale of the IVE inventory (Stadler, Schmeck, & Janke, 2004) was used as a personality measure of impulse control. The IVE inventory is a German adaptation of Eysenck et al.'s (1984) impulsivity questionnaire. Impulsivity is defined here as the counterpart of impulse control, measuring cognitive as well as motivational impulsivity and a deficient behavioral and motor control. The impulsivity scale comprised 16 items such as "Sometimes I get so restless that I cannot sit in a chair long," which are answered on a yes/no scale. Stadler et al. (2004) report adequate reliability (α = .82) as well as mean differences for a small sample of ADHD children and typically developing controls.

Go/No-Go Task

The go/no-go task was programmed with E-Prime® (Psychology Software Tools, Inc., Sharpsburg, PA, USA) and was administered on a laptop computer and an external E-Prime® Stimulus Response Box placed between the subject and the monitor. Participants sat approximately 50 cm away from the monitor. Children were asked to press the response button with the index finger of their dominant hand as quickly as possible whenever one of five cartoon animals appeared on the screen, though they should refrain from pressing the button whenever a sixth animal appeared. Each trial began with a fixation cross presented for a variable time (600 to 1200 ms), followed by target stimuli that remained on the screen for a maximum of 450 ms, followed by a fixed interstimulus interval (ISI, 1550 ms). During the first 550 ms of the ISI, the color of the computer screen was white and the participants' responses were still recorded. After that, the color of the computer screen turned black. Responses were recorded for 1000 ms after stimulus onset. Altogether, 300 stimuli were presented in the same pseudorandom order for each child with a no-go stimulus rate of 20%.

At the beginning of the task participants received two training blocks with a standardized oral instruction that emphasized to respond as quickly and as accurately as possible. Trainings blocks were repeated if necessary. The total task duration was approximately 20 minutes. Total number or errors (commission errors + omission errors) was used as the dependent variable.

Combined Measure

In order to evaluate whether the combination of measures has a better diagnostic utility than each measure alone, scores from both instruments were *z*-standardized and then added.

Analyses

ROC Analysis

The predictive power of the two impulse control measures was evaluated with receiver operating characteristic (ROC) curve analyses (McNeil & Hanley, 1982). In such an analysis, each value across the range of possible scores is used as a cutoff value for classifying a case, and this classification is compared to the true diagnosis. Then, sensitivity (the probability of an abnormal score given the child has ADHD) versus 1 minus specificity (specificity is the probability of a normal score given the child is TD) is plotted in the ROC curve across the range of scores. A major result of this analysis is a statistic called the area under the curve (AUC), which is proportional to the overall ability of the scale across all possible cutoff values to correctly classify subjects.

Diagnostic Efficiency

In order to evaluate the diagnostic efficiency of the measures, it is necessary to designate cutoff values distinguishing "normal" from "abnormal" scores. As there are no prespecified cutoff scores for both measures, the following strategy was adapted from previous research: Scores 1 *SD* above mean of the control group (higher scores indicate less impulse control for all measures) were designated as cutoff values for both the go/no-go task and for the sum of standardized scores; for the impulsivity scale, for which standard scores can be obtained from the test manual, scores 1 *SD* above the mean of the age group were designated as cutoff values. In addition to these prespecified cutoff values, results from the ROC analysis can be used to select a cutoff value that maximizes classification accuracy. In the following, the cutoff value is selected that maximizes the sum of sensitivity and specificity.

For all cutoff scores generated in the analysis, two statistics are reported in addition to sensitivity and specificity: the positive predictive power (PPP), that is, the probability of having ADHD given an abnormal score, and the negative predictive power (NPP), that is, the probability of being TD given a normal score.

Results

Descriptive Results and Group Differences

Table 1 displays the means and standard deviations for the impulsivity scale, go/no-go total errors, and the sum of standardized scores from both measures. Somewhat contrary to expectations, the mean impulsivity scores of TD children were about seven points below their age norms on the T scale, whereas the mean impulsivity score of ADHD children was only about five points above their age norms on the T scale.

Group differences were significant in all cases: Children with ADHD scored higher on the impulsivity scale ($t(33) = 4.51$, $p < .001$, $d = 1.57$) and committed more errors on the go/no-go task ($t(33) = 3.49$, $p < .001$, $d = 1.22$) than TD children. For the simple sum of standardized scores from both measures, the effect was even stronger ($t(33) = 6.73$, $p < .001$, $d = 2.23$).

Table 1. Means and standard deviations for the Impulsivity Scale, go/no-go total number of errors, and the sum of standardized values from both measures

		ADHD	TD
Impulsivity Scale	Mean	54.83	42.82
	SD	6.47	9.12
Go/no-go total errors	Mean	35.78	21.00
	SD	15.62	8.03
Standardized sum	Mean	1.09	–1.15
	SD	1.01	0.95

Notes. ADHD = children with attention-deficit/hyperactivity disorder (ADHD); TD = typically developing children.

ROC Analysis

ROC curves were obtained using the pROC package (Robin et al., 2011). The AUC for the combined measure ($AUC_c = .94$) was greater than for both of the single measures ($AUC_{gng} = .81$; $AUC_{imp} = .86$).

Diagnostic Efficiency

Impulsivity Scale

For the impulsivity scale, using a cutoff value of 1 *SD* above age yielded a very unsatisfactory sensitivity (.11). Selecting the cutoff value that maximizes the sum of sensitivity and specificity from the ROC analysis results in a cutoff value of 45.5 with associated sensitivity = 1.00, specificity = .58, PPP = .72, and NPP = 1.00.

Go/No-Go Task

For the go/no-go task, the following statistics were obtained for a cutoff value of 1 *SD* above the mean of the TD group (more than 29 errors) and the best cutoff value from the ROC analysis (23 errors) (separated by a slash): sensitivity = .55/.94, specificity = .76/.76, PPP = .71/.81, and NPP = .62/.93.

Combined Measure

For the combined measure, statistics were calculated and reported as for the go/no-go task: sensitivity = 1.00/1.00, specificity = .53/.88, PPP = .67/.90, and NPP = 1.00/1.00.

Association with Parent-Rated ADHD Symptoms

Table 2 shows the correlations of the go/no-go task, the impulsivity scale, and their combination with the ADHD symptom ratings by one parent on the FBB-ADHS (Döpfner et al., 2006). Child-reported impulsivity did not correlate significantly with go/no-go total errors (r = .12, p = .502). Somewhat surprisingly, child-reported impulsivity correlated more strongly (r = .64) with parent-reported inattention than with parent-reported impulsivity (r = .53). In almost all cases, child-reported impulsivity correlated more strongly with parent-reported symptoms than go/no-go total errors, and correlations for the combined measures were higher than for the two single measures in all cases.

Table 2. Correlations between parent ratings of ADHD symptoms and self-reported impulsivity, go/no-go total errors, and combined impulsivity measure

	Parent ratings (FBB-ADHS)			
Child measures	Hyperactivity	Impulsivity	Inattention	Total ADHD score
Impulsivity Self-Report	.48	.53	.64	.60
Go/no-go total errors	.49	.37	.48	.48
Combined measure	.65	.62	.74	.72

Note. All correlations $p < .05$.

Discussion

The present study had two goals: First, to show that both cognitive and personality measures of impulse control can be utilized in the assessment of childhood ADHD; and second, to show that the two types of measures are to some extent uniquely associated with ADHD symptomatology. In general, we succeeded with regard to both goals.

We used a go/no-go task and an impulsivity scale for children as examples of cognitive and personality measures of impulse control. Group means of children with ADHD and TD significantly differed on both instruments. Yet in order to be utilized for the purpose of individual classification, group differences are only a necessary precondition. In accordance with previous results (Doyle et al., 2000; Drechsler et al., 2009; Grodzinsky & Barkley, 1999) we found that – despite strong group differences – there was a strong overlap of the group score distributions in both measures, so that individuals cannot be classified successfully using only one of the measures. Again corresponding to previous results, this is due mainly to a low sensitivity of both measures resulting from a comparatively large proportion of ADHD children with scores in the “normal” range. Combining both measures by simply adding the standardized scores resulted in strongly improved classification accuracy and had a stronger impact on sensitivity than on specificity. Tentatively, this might be explained by the distinct facets of impulsivity both instruments measure: Some of the ADHD children had high impulse control (low scores) on one measure but not on the other, so that they can be correctly classified only when both measures are taken into account.

Sources of Distributional Overlap

With regard to the go/no-go task and cognitive measures in general, possible explanations for the lack of general impulse control deficits in ADHD have been explored in the literature. Different explanations can be subsumed under the keyword “heterogeneity.” First, many studies indicate that there are distinct subgroups of ADHD children even within the diagnostically defined subcategory of ADHD-Combined (American Psychiatric Association, 2000; Lambek et al., 2010; Nigg et al., 2005). Second, prominent theories of ADHD propose that there may be multiple developmental pathways to ADHD symptomatology including, among others, impaired impulse control on cognitive tasks (Castellanos et al., 2006; Sonuga-Barke, 2005). Motivational influences on task performance seem to be stronger for ADHD children than for TD children. For example, Liddle et al. (2011) showed that, under motivational incentives, the performance of ADHD children on a go/no-go task was at the same level as TD children’s, and that the effects of motivational incentives on task-related brain default-mode network deactivation was stronger for ADHD children. Moreover, children with ADHD seem to be less persistent than TD children (Hoza, Waschbusch, Owens, Pelham, & Kipp, 2001; Scime & Norvilitis, 2006), which might impair their performance on prolonged tasks such as the go/no-go task we employed, even if their initial performance is comparable to that of TD children. Previous experiences can have a lasting influence on current motivation for children with ADHD (Sonuga-Barke, 2005), so that for some children motivation on cognitive measures might be so low as not to perform at a "normal" level even if there is no underlying general cognitive deficit.

Unlike for cognitive measures, evidence for overlapping profiles of ADHD and TD children on the personality measure of impulse control is sparse. Children with ADHD often exhibit a positive self-illusory bias in self-ratings (Owens, Goldfine, Evangelista, Hoza, & Kaiser, 2007). Yet in our analysis, we found a strong group difference, with ADHD children reporting higher impulsivity. On the other hand, TD children in our sample had strikingly low impulsivity scores compared to the age norms reported in Stadler et al. (2004), so that maybe the distributional overlap caused by ADHD children's positive illusory bias might even be greater in general. Moreover, even with an optimized cutoff value from the ROC analysis there was still considerable overlap of the score distributions.

Distinctness of Impulse Control Facets

Somewhat contrary to expectations, the go/no-go task and the impulsivity scale were not significantly correlated with each other, although both showed a very similar correlation pattern with parent-rated ADHD symptoms. Using the combined measure, all children with ADHD could be identified by their scores (perfect sensitivity) and a "normal" score was indicative of TD status in all cases (NPP = 1.00). Taken together these results indicate that some ADHD children with a "normal" score on one of the measures had an "abnormal" score on the other measure, and some ADHD children had an abnormal score on both measures.

As a consequence, these results lead to two further conclusions: First, the two instruments measure distinct facets of impulse control; second, children with ADHD in our sample are heterogeneous with regard to these facets. In distinguishing the facets of impulse control as measured by the two instruments, an analysis of task requirements is helpful. As noted above, cognitive measures of impulse control such as the go/no-go task are subject to fluctuations in children's performance caused by other factors than impulse control ability itself. For ADHD children, motivational factors are most important (see above). Yet motivation and other states such as fatigue can also have an effect on performance in TD children. In self- and observer-report questionnaires, short-term state variability is usually averaged over into an integrated rating of impulse control in different situations. On the other hand, self-report measures are prone to biases such as the positive self-illusory bias described above.

With regard to facets of impulsivity, the major difference between the two instruments seems to be that the go/no-go task directly and exclusively measures impulsive action (subject to the above-mentioned motivational influences). In contrast, the impulsivity scale also includes items referring to impulsive choice. For example, one item of the impulsivity scale used in our study is "When I see something I like, I want to get it immediately." Other items can be assigned to the "urgency" and "lack of premeditation" facets of Whiteside and Lynam's (2001) models, for example, "I often get into trouble because I didn't think ahead."

In sum, our results add to previous evidence about the multifaceted nature of impulse control (Evenden, 1999; Winstanley et al., 2006). Instead of understanding impulse control as a unitary construct that can be measured by any one of several cognitive or personality instruments, future research should build on existing evidence with regard to the distinct nature of facets of impulse control tapped into by different instruments. Even if Whiteside and Lynam's (2001) model does not seem to capture all facets of impulsivity in their distinctness (Duckworth & Kern, 2011), future work could integrate their model with evidence from clinical and neuroscience studies on impulsive action and impulsive choice (Winstanley et al., 2006). For example, Whiteside and Lynam's (2001) model does not directly include the ability to delay gratification as a primary factor; instead, this ability is addressed in scales measuring lack of premeditation. Winstanley et al. (2006) and others point out that lack of premeditation is not limited to reward-related choices, but there is clear neural and behavioral evidence for the distinct nature of reward-related choice behavior.

Implications for ADHD Assessment

With respect to ADHD assessment, our results convey two opposing messages concerning the utility of cognitive measures of impulse control: On the one hand, we replicated previous results showing that the predictive power of cognitive measures is generally low; on the other hand, we demonstrated that combining a cognitive measure with a personality measure greatly increased predictive power. The latter result is consistent with Berlin et al.'s (2004) conclusion that both impulsive action and emotional or motivational regulation are important and have additive effects on predictive power. Possible reasons for this effect were explored above: Cognitive measures are subject to momentary fluctuations, especially motivational influences. Personality measures instead use ratings of average behavior, and they can potentially tap facets of impulse control beyond impulsive action or impulsive choice. However, personality measures can be subject to observer bias such as the positive self-illusory bias (Owens et al., 2007). Combining the two kinds of instruments leads to an improved predictive power because the disadvantages of one can be compensated by the other.

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