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Jingle Jangle: A Meta-Analysis of Convergent Validity Evidence for Self-Control Measures

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Appendix (references used only for meta-analysis): 7,661 words

Abstract

Self-control is one of the most widely-studied constructs in psychology, but dissent regarding its definition and measurement has impeded comparison and synthesis of findings across studies. The present investigation used meta-analytic techniques (number of samples = 282; number of distinct self-control measures = 154; number of intercorrelations = 916) to examine evidence from multi-method studies for convergent validity among self-control measures. Overall, self-control measures demonstrated statistically significant but modest convergent validity, mean $r = .23$, 95% CI = [.22 to .25]. There was considerable heterogeneity in the observed correlations ($Q = 6067.80$, $df = 915$, $p < .001$). Questionnaire measures demonstrated stronger convergent validity evidence than did either delay of gratification or neuropsychological task measures. Among questionnaire measures, there was evidence that scales designed to assess variation in self-control among non-clinical individuals tap the same underlying construct as do scales assessing attention deficit/hyperactivity disorder (ADHD) symptomology.

Keywords: Self-regulation, impulsivity, measurement, validity, multi-method

Jingle Jangle: Meta-Analysis of Convergent Validity Evidence for Self-Control Measures

Since the dawn of modern psychological research, the construct of self-control has attracted substantial attention from researchers working within a variety of theoretical and methodological frameworks. As shown in **Figure 1**, interest in self-control as a research topic has accelerated over the last century. Currently, more than 1% of all PsycINFO articles are indexed by self-control, impulsivity, or synonyms as keywords.

Despite consensus among psychologists on the centrality of self-control for any complete account of human nature, there remains considerable dissent over how to name, define, and measure this construct. The self-control literature appears to suffer from both the *jingle* (Thorndike, 1904) and *jangle* (Kelley, 1927) fallacies (Block, 1996; Gwin, 1998). In the former case, common terms refer to different underlying conceptions (e.g., self-control defined as the ability to delay gratification vs. self-control defined as the tendency to think before acting). In the latter, different terms are used to describe common underlying conceptions (e.g., self-control, self-discipline, self-regulation). Although the jingle and jangle fallacies are prevalent in many areas of psychology, they seem especially pernicious in the self-control literature. Confusion over how to conceptualize and operationalize self-control has discouraged the comparison and synthesis of results across studies (Evenden, 1999; Kochanska, 1996; Reynolds & Schiffbauer, 2005; White et al., 1994).

Variety in approaches to the conception and assessment of self-control beg the questions we asked in the current investigation: First, what evidence is there that diverse measures of self-control tap the same underlying construct? In particular, do self-control measures demonstrate what Fiske (1971) noted as “a minimal and basic requirement for the validity” of a trait measure: “If the two tests measure the same traits, the two scores for each trait should be positively related…this convergent validation is a modest requirement, and yet one that is often not met" (p. 164). In other words, how jingly is the self-control literature? Conversely, what evidence is there that diverse concepts in this literature, named differently and assumed to be distinct, are in fact identical? For example, do measures of attention-deficit/hyperactivity disorder (ADHD) assess a construct essentially equivalent to self-control (or its lack) as it is studied among non-clinical individuals? How jangly is the self-control literature? In the current investigation, we addressed both questions by summarizing correlations across 282 published and unpublished studies that employed multiple measures of self-control.

We began with a broad and agnostic review of the research literature. We discovered three distinct approaches to the measurement of self-control: *delay of gratification tasks*, *executive function tasks*, and *personality questionnaires*. With rare exceptions, we found minimal evidence of either cross-fertilization across measurement traditions or cross-referencing across research literatures. Moreover, specific assessment approaches -- and corresponding conceptualizations of self-control -- varied considerably among researchers working *within* each of these three traditions, suggesting that the jingle fallacy might operate not only across research traditions but also within them.

Delay of Gratification Tasks

In the early 1960s, Walter Mischel published the first research in which self-control was measured as the ability to choose a larger, deferred reward over a smaller, immediate reward. The ability to delay discharge of impulses figured prominently in Freud's (1922) psychoanalytic theory of ego development, but prior to Mischel's experiments had been operationally defined (without much evidence of reliability or validity) as the tendency to see images of humans in action in Rorschach ink blots (Singer, 1955).

In Mischel's research, we found archetypes for three out of four subtypes of delay of gratification tasks: In a *hypothetical choice delay task*, subjects make a series of choices between smaller, immediate rewards and larger, delayed rewards, most or none of which they expect to actually receive. For instance, in Mischel (1961), children were asked to answer questionnaire items such as, "I would rather get ten dollars right now than have to wait a whole month and get thirty dollars then" (p. 3). More recently, such questionnaires have been used by economists and psychologists to estimate a discount rate for each individual that relates the subjective value of a delayed reward to the delay required to receive it (e.g., Green, Fry, & Myerson, 1994; Kirby, Petry, & Bickel, 1999). In a *real choice delay task*, subjects make an actual (i.e., not hypothetical) choice between a small, immediate reward and a larger, delayed reward (e.g., Mischel, 1958; Duckworth & Seligman, 2005). This decision happens at a single point in time after which there is no revoking the decision.

The third subtype, the *sustained delay task,* differs from both of the above in that all subjects first choose the preferred delayed reward; unanimity is virtually assured by presenting a choice in which the delayed reward is clearly "worth the wait." Subsequently, the ability to delay gratification is measured as the time subjects are willing to continuously resist the smaller, immediate reward in order to obtain the larger, deferred reward (e.g., Mischel & Shoda, 1989; Solnick, 1980). As Reynolds and Schiffbauer (2005), the ability to sustain choices for delayed choices and the initial preference for later, larger rewards seem, on face, to reflect separate psychological processes. As they point out, many overweight individuals decide to lose weight but fewer are able to sustain that choice by adhering to a restricted diet.

Mischel and colleagues did not use the *repeated trials delay task*, games in which subjects complete a series of trials, on each of which they choose between a smaller, more immediate reward and a larger, delayed reward (e.g., Newman, et al., 1992). As in choice delay procedures, subjects receive actual rewards (e.g., nickels or candy) and are not given the opportunity to revoke their decision.

In terms of cost and ease of administration, hypothetical choice tasks are both the easiest and quickest tasks to implement. Not surprisingly, therefore, hypothetical choice tasks were the most common delay measures in the multi-method studies included in our meta-analysis (see **Table 1**).

Executive Function Tasks

In the field of neuropsychology, self-control has been assessed with the Stroop task, go/no-go task, and other tests of executive function. Burgess (1997) points out that *executive function* is a relatively new construct and, like the much older construct of self-control, continues to be inconsistently defined and measured. In general terms, the term executive function refers to goal-directed, higher-level cognitive processes that exert top-down control over lower-level cognitive processes. As with delay of gratification, there is growing evidence that executive function is not unitary in nature, but rather a collection of distinct processes (Kramer, Humphrey, Larish, & Logan, 1994; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). At present, “there is little agreement on the cardinal prefrontal functions” (p. 449, Miller, 2000; also see Banfield, Wyland, Macrae, Munte, & Heatherton, 2004, for a review of the cognitive neuroscience of self-control).

We used three guides in our attempt to organize the universe of executive function tasks. First, we consulted reviews of the executive function literature (Garon, Bryson, & Smith, 2008; Hull, Martin, Beier, Lane, & Hamilton, 2008; Zaparniuk & Taylor, 1997). Second, we noted when authors explicitly referred to measures as belonging to a particular family of executive function tasks (e.g., sun-moon Stroop task). Third, we used published descriptions of measures to group them according to shared task characteristics. We ultimately identified 12 subtypes of executive function tasks (see **Table 2**). These tasks ranged from the simple (e.g., Stroop task) to the complex (e.g., Wisconsin Card Sorting Task) and variously required the use of attention, working memory, set shifting, and response inhibition.

Personality Questionnaires

Our review and meta-analysis revealed over 100 unique self-report and informant-report questionnaires As shown in **Table 3**, even the tenth most commonly used questionnaire was included in only 10 multi-method studies, and by far the modal number of studies in which a given questionnaire was used was 1. A few of these questionnaires were subscales from omnibus inventories of adult personality and childhood temperament. For example, the NEO-PI-R questionnaire includes separate subcales for self-discipline and impulsivity (Costa & McCrae, 1992), Buss and Plomin's (1975) EASI-III questionnaire includes impulsivity as one of four dimensions of temperament, and the Child Behavior Questionnaire includes subscales for aspects of effortful control (Rothbart et al., 2001).

The majority of published self-control questionnaires were designed as stand-alone measures. As a group, there was considerable heterogeneity in the underlying traits these questionnaires were designed to assess. For instance, the Eysenck I_7 Impulsiveness Scale conceptualizes impulsiveness as doing and saying things without thinking (Eysenck, Easton & Pearson, 1984). The Barratt Impulsiveness Scale Version 11 (BIS-11) includes three separate scales for motor impulsiveness, non-planning impulsiveness, and cognitive impulsiveness (Barratt, 1985). More recently, Tangney, Baumeister, and Boone (BSCS; 2004) published the Self-Control Scale, which measures "the ability to override or change one's inner responses, as well as to interrupt undesired behavioral tendencies (such as impulses) and refrain from acting upon them" (p. 274).

ADHD and self-control

Numerous different appellations have been used interchangeably to refer to the construct of self-control. The use of synonyms in the research literature, albeit confusing, gives rise to the jangle fallacy only if there is the accompanying misunderstanding that terms correspond to different underlying concepts. Thus, there is nothing necessarily "jangly" about employing the terms "self-regulation" and "self-control" interchangeably. Our review suggested that ADHD and the personality trait of self-control, in contrast, are widely assumed by researchers to be distinct constructs.

Among the most commonly diagnosed childhood clinical disorders, ADHD is characterized by developmentally inappropriate inattention or hyperactive-impulsive behavior that significantly impairs functioning in at least two settings (e.g., home and school). Examining the specific items of these ADHD questionnaires and the corresponding Diagnostic and Statistical Manual (DSM) criteria for diagnosis (e.g., has difficulty organizing tasks or activities, is easily distracted, interrupts or intrudes on others) suggested nearly complete overlap in content with questionnaires designed to assess self-control in the non-clinical population. We therefore included ADHD questionnaires in our meta-analysis and specifically examined evidence for convergent validity with non-ADHD questionnaires.

Rationale for Current Study

Prior attempts to investigate convergent validity among self-control measures have involved the administration of a battery of self-control measures (or questionnaire items) to a common sample of participants. As shown in **Table 4**, this approach has produced at least a dozen different proposed factor structures for self-control. Because factor-analytic solutions are contingent upon the particular measures and subjects included, it is not clear which of these proposed structures is most accurate. Moreover, no study has administered a sufficiently representative array of self-control measures to a sufficiently representative sample of participants to draw general conclusions about the convergent validity of self-control measures used in psychological research.

The current investigation examined evidence for convergent validity among a wider range of measures from the universe of self-control measures than has been included in any prior multi-method study. All available published and unpublished studies that used at least two different measures of self-control contributed to a matrix of correlations among measures, which we synthesized with meta-analytic methods. Our analyses addressed three related questions: First, what evidence is there that the various measures used by psychologists to measure self-control are positively correlated? Second, can we identify moderating factors (e.g., type of measure, popularity of measure; publication type) that explain variance in convergent validity? Finally, is there evidence that questionnaires designed to measure ADHD are distinct from those measuring trait-level self-control in the non-clinical population?

Method

Literature Search

We used two strategies to search the PsycINFO database for published articles and unpublished dissertations available by February 2008 that used more than one measure of self-control. First, searches were conducted for references containing at least one keyword from each of the following lists: (1) *self-control, self-discipline, self-regulation, delay of gratification, impulsivity, impulsiveness, ADHD, attention deficit, attention deficit disorder, attention deficit* *hyperactivity disorder, hyperactivity, impulse control, emotional regulation*, *cognitive control*, and (2) *multi-method, multi-source, measure, assess, validity*. Second, we completed a series of keyword searches using all possible pairwise combinations of the following popular self-control measures and terms: *Matching Familiar Figures, circle tracing, draw-a-line, walk-a-line, draw-a-star, Stroop, Gordon diagnostic, go/no-go, Wisconsin card sort, trail making, Eysenck impulsiveness, Dickman impulsivity inventory, Barratt impulsiveness, EASI-III impulsivity, child behavior-checklist, Conners rating scale, self-control rating scale, California Q-set, delay of gratification, discount delay, time preference*. Additional studies were obtained by identifying relevant studies cited by articles in this search and from the library of the first author.

Over 7,000 study abstracts were screened before obtaining 1,280 relevant manuscripts. For studies that did not report all intercorrelations among the self-control measures used, we emailed authors to request this information. Of the 542 authors we emailed, 101 (18%) authors sent correlation matrices. In total, we obtained correlations from 236 articles and dissertations, reporting data from 282 independent samples. Citations for these articles are included in the Appendix. The total number of participants in these 282 studies was 34,204 (Mean sample size = 121, SD = 208, Min = 6, Max = 1638), and the total number of effect sizes culled from these study reports was $k = 916$.

Criteria for Inclusion/Exclusion

Studies selected for this meta-analysis reported at least one bivariate correlation coefficient for two measures from the domain of interest. We excluded a very small number of studies that reported correlations of $r = 1$ or reported only Spearman rank or partial correlations. We also excluded correlations between subscores of a common measure.

Coding Procedure and Measures

A total of five trained coders recorded the study characteristics and correlations. Each correlation was coded independently by at least two coders to ensure reliability. Conflicts were resolved by discussion and re-examination of studies in question. In addition to sample sizes and the correlation coefficients, the coders recorded the following variables:

Name, type, subtype and popularity of measure. We recorded the name of each measure and classified each according to one of four types: delay of gratification task, executive function task, self-report questionnaire, or informant-report questionnaire. Delay of gratification and executive function tasks were also categorized according to subtype (see **Tables 1** and **2**). Questionnaires were further categorized as either ADHD/non-ADHD questionnaires (see **Table 3**). We quantified the popularity of a self-control measure as the number of studies in which it was included.

Publication type. Each correlation was classified as originating from one of three publication types: published articles or book chapters (k = 422), email correspondence with study authors (k = 304), and dissertations (k = 190).

Age. Because many studies did not report standard deviations for age, we analyzed age categorically according to mean age. Mean ages were divided into the following categories: 0-2, 3-5, 6-12, 13-17, 18-21, 22-29, 30-39, 40-49, 50-59, 60-69, and 70+ years. For samples that reported age ranges but not means, we categorized each sample in the age bracket in which most of the sample fell. For example, if a study listed the age range of its participants as aged 17 to 22, the study was coded as belonging to the age 18 to 21 category.

Gender. We recorded the number of males, females, and persons of unspecified gender for every study that reported the relevant descriptive statistics. Studies that did not report gender information were excluded from moderator analyses involving gender.

Sample type. We recorded whether the study sample represented clinical, normal non-clinical, non-normal non-clinical, or a mixed population. *Clinical* disorders for child studies included attention deficit/hyperactivity disorder (ADHD), learning disorders, behavior problems, juvenile delinquency, developmental disorders and mental retardation. *Clinical* disorders for adult studies included adult ADHD, affective disorders, anxiety disorders, schizophrenia, personality disorders, substance abuse, eating disorders, anti-social personality disorder, neurological impairment, Alzheimer's disease, and dementia. *Normal non-clinical* samples included randomly-chosen participants from the community or randomly-chosen university students. *Non-normal non-clinical* samples included participants who had not been diagnosed with a clinical disorder but were otherwise different from the general population. Such samples included professional football players, relatives of schizophrenics who were not themselves schizophrenic, and individuals who were incarcerated. *Mixed* samples were combinations of the above three sample types and most often took the form of a clinical group and a control group. Samples that included participants who had been administered psychoactive medication were excluded from all analyses.

Cultural background. Cultural background was included as a potential categorical moderator and coded as follows: United States, non-United States Western country, and non-Western country.

Analyses

Effect Sizes. The effect size (ES) measure used in this meta-analysis was the Pearson correlation coefficient for continuous variables. All studies reported correlations coefficients, so there was no need to use transformations from reported statistics or other measures of ES. Because the Pearson correlation coefficient is a slightly biased estimate of the population correlation, we used an approximation to the unique minimum variance unbiased estimator *G* of the population correlation (Olkin & Pratt, 1958):

$$G = r\left(1 + \frac{1 - r^2}{2(n - 4)}\right).$$

This statistic has been shown to have superior statistical properties as compared to the uncorrected correlation or other transformations of the correlation coefficient (Schulze, 2004).

In the vast majority of studies in our database, more than one correlation coefficient based on a single sample was reported. This dependency of effect sizes represents a violation of basic statistical assumptions of many meta-analytic models and suggested multivariate methods for meta-analysis (e.g., Cheung & Chan, 2005; Raudenbush, Becker, & Kalaian, 1988). One requirement of multivariate analyses is that correlations are based on a set of sufficiently similar variables. Because a substantially large subset of studies using identical measures could not be identified, we instead computed *synthetic effect sizes* by aggregating homogeneous dependent effect sizes within studies. This approach assumes that correlations within a study are based on measures of a common latent variable and produces accurate, if somewhat conservative, meta-analytic estimates of effect size (Hedges, 2007).

Aggregation of Effect Sizes. An important conceptual question for a meta-analysis of correlations is whether to assume a fixed or random effects model (cf. Field, 2001; Hunter &

Schmidt, 2004; Schulze, 2007). The random effects model has some conceptual advantages for data in psychology (Hunter & Schmidt, 2004) but may also have statistical disadvantages when the number of studies *k* for any particular analysis is small. In our major analysis of convergent validity between and within type of self-control measure, we report the results for both the fixed and random effects models. As predicted, fixed effects model estimates were very slightly higher than their random effects counterparts. Thus, we report estimates based on the random effects model in subsequent analyses.

The weights used in the aggregation of correlation coefficients can heavily influence the results (Schulze, 2004, 2007). Because the true standard errors of individual effect sizes were not known, we followed the recommendation of Hunter and Schmidt (2004) and used sample sizes as weights in the meta-analysis.

Correcting statistical artifacts. Failure to correct for range restriction or measurement error can produce incorrect meta-analytic estimates of mean effect size and variance. Procedures to correct for measurement error require estimates of measure reliability (e.g., Cronbach's α, test-retest reliability coefficient), and corrections for range restriction require estimates of population variance. Because this information was not available for most measures of self-control, our analyses did not correct for either of these artifacts.

Moderator Analyses. For the moderator analyses, we used a mixed-effects model. In most analyses, predictors were tested in separate meta-analytic models to facilitate interpretation of the results. When predictors were highly correlated, effects were also tested in models with all the predictors to guard against misinterpretations when predictors are redundant. For all computations, the *R* functions provided by Viechtbauer (2006) and the recommended restricted maximum likelihood estimation was used.

Results

Based on the total sample of 916 correlation coefficients and using a random effects model, the mean effect size for the strength of relationships between self-control measures was small-to-medium in size and statistically significant, $r = .23$, 95% $CI = [.22, .25]$. However, the estimate of the heterogeneity variance for the entire database was substantial, $\tau^2 = .038$, 95% CI [.032, .041]; $Q(915) = 6067.80$, $p < .001$.

Moderator Analyses

We undertook a series of moderator analyses to explain heterogeneity in effect sizes. The difference in variance between models with and without moderators provides a descriptive statistic of the explanatory power (i.e., amount of variance explained) of a moderator. In preliminary analyses, moderators as main effects as well as moderator-by-moderator interaction terms were simultaneously included in the statistical models. Since no significant interactions were found, we present only analyses of moderators as main effects. The number of studies *k* varied somewhat among moderator analyses because information for moderators was missing in a small proportion of articles.

Within-method vs. cross-method correlations. The meta-analytic estimate for the overall within-method correlation based on all the $k = 534$ effect sizes in the diagonal of **Table 5** was .29 (95% CI [.27, .31]). The estimate for the $k = 382$ off-diagonal correlations in **Table 5**, the cross-method correlations, was comparatively smaller ($r = .16$, 95%CI [.14, .18]). Including type of correlation as a dichotomous moderator decreased unexplained heterogeneity variance in effect sizes to $\tau^2_{res} = .034$. The moderator for this small decrement was significant ($Q_{ME} = 81.87$, $df = 1$, $p < .001$), but significant unexplained variance also remained ($Q_E = 5365.25$; $df = 914$; $p < .001$).

Type of measure. As a categorical predictor, type of measure reduced by more than half the initial unexplained overall heterogeneity in effect sizes, τ^2_{res} = .016. Correspondingly, the omnibus test for the moderator was significant (Q_{ME} = 657.58, *df* = 6, *p* < .001). However, even after accounting for type of measure, a substantial amount of heterogeneity remained, Q_E = 2701.14; *df* = 909; *p* < .001. This finding corroborated visual inspection of correlations both within and between measure type. As shown in **Table 5**, correlations were all statistically different from zero at the .05-level but differed considerably in magnitude.

The size of correlation between executive function tasks and other self-control measures (i.e., delay tasks and questionnaires) was relatively small, *r* = .11 to .14. In fact, the average correlation among various measures of executive function was only *r* = .16. Delay of gratification tasks, which appeared more rarely in the reviewed literature than other types of measures, also only modestly correlated with other measures, *r* = .11 to .20. The average correlation among measures of delay of gratification was *r* = .21.

In contrast, effect sizes for correlations within the self-report and informant-report questionnaires categories were noticeably higher, *r* = .46 and *r* = .48, respectively. Self-report questionnaires were slightly less associated with executive function and delay tasks (*r* = .11 and *r* = .14, respectively) than were informant-report questionnaires with these measures, *r* = .14 and *r* = .20, respectively. Only the correlation between self-report and informant-report questionnaires approached a size (*r* = .38) that could reasonably be interpreted as strong evidence of convergent validity across measurement type.

Publication year and type. Using year of publication as a moderator reduced the initial heterogeneity estimate by only .002 to τ^2_{res} = .036; Q_{ME} = 53.99, *df* = 30, *p* = .005. This effect, albeit statistically significant, was minuscule in magnitude, suggesting that the convergent validity of self-control measures has not changed systematically over time. Using publication type as a moderator changed the estimate of residual heterogeneity by less than .001, and an omnibus test of the moderators was only barely significant, $Q_{\mathrm{ME}} = 10.12$; $df = 2$; $p = .006$. Therefore, there was no evidence that correlations from unpublished sources (i.e., dissertations and correspondence with authors) differed substantively from those derived from publications.

Mean age of participants and other sample characteristics. We found a very weak and inconsistent trend for weaker correlations in studies using older subjects. The reduction in residual variance, albeit statistically significant, was only .002, $Q_{\mathrm{ME}} = 53.50$, $df = 10$, $p < .001$. Neither gender, sample type, nor cultural background accounted for statistically significant ($p < .001$) and substantial amounts of variance in observed effect sizes.

Popularity of measure. Because popularity was confounded with measure type (i.e., delay tasks were least common and executive function tasks were most common in the multi-method studies included in this meta-analysis), we tested popularity of measure as a moderator separately for each type of self-control measure. Overall, we found no evidence that measures used more frequently correlate more robustly with alternative measures of self-control. More specifically, the popularity analyses for the subtypes of executive function measures used all $k = 300$ correlations between executive function tasks and other measures of self-control (see **Table 2** for their respective popularity scores). The mean effect size estimate for convergent validity was $r = .13$, 95% CI = [.11, .14] and the estimate of heterogeneity variance was $\tau^2 = .005$, CI = [.003, .008]. When using popularity as a moderator, the estimate of the residual heterogeneity was reduced by less than .001, a statistically insignificant effect, $Q_{\mathrm{ME}} = 0.35$; $df = 1$; $p = .55$.

For delay of gratification measures, the mean effect size estimate for convergent validity for the underlying $k = 92$ effect sizes was $r = .14$ [.11, .17], $\tau^2 = .005$ [.001, .011]. When using popularity as a moderator, the estimate of the residual heterogeneity was reduced by less than .001, a statistically insignificant effect, $Q_{ME} = 0.01$; $df = 1$; $p = .94$. The popularity scores for the 44 unique self-report questionnaires ($k = 182$) and the 60 unique informant-report measures ($k = 190$) produced a significant effect only for the self-report measures. However, the reduction in heterogeneity variance from $\tau^2 = .023$ to $\tau^2_{res} = .019$ was small and not in the hypothesized direction. That is, the estimate for the moderator weight of -.0035 suggested that there was a very slight tendency for more popular self-report questionnaires to show weaker convergent validity evidence.

Evidence of Convergent Validity between ADHD Questionnaires and Other Questionnaires

As suggested by Campbell and Fiske (1959), we used a multimethod-multitrait matrix to investigate the hypothesis that questionnaire measures of ADHD and self-control tap the same underlying construct. See **Table 6** for correlations among both informant-report and self-report questionnaires measuring both ADHD and self-control. Whereas this analytic strategy is typically used to establish discriminant (and convergent) validity, we used it to test our prediction of *no* evidence for discriminant validity between self-control and ADHD measures.

Consistent with our hypothesis, the correlations in the validity diagonal were the smallest in the entire matrix. That is, informant-report and self-report questionnaires of self-control were only moderately associated, $r = .33$. Similarly, the association between informant report and self-report questionnaires for ADHD was only $r = .44$. The only heterotrait-heteromethod correlation in the matrix was larger than both of these estimates, $r = .50$. Moreover, within monomethod blocks, heterotrait correlations were intermediate in size between monotrait correlations. Specifically, among informant-report questionnaires, ADHD and self-control were correlated at $r = .63$. Among self-report questionnaires, ADHD and self-control were correlated at $r = .64$. On the whole, the correlations within and between different types of questionnaires did not support a distinction between ADHD and self-control questionnaires.

Discussion

The overall average correlation among self-control measures in multi-method studies was small-to-medium in magnitude, $r = .23$, $p < .001$. Self-report and informant-report questionnaire measures demonstrated the largest correlations with alternative methods for assessing self-control. Apart from measurement type, no other tested moderators explained a substantial and statistically significant proportion of heterogeneity in effect sizes.

The statistically significant but moderate correlations observed in this meta-analysis suggest a jingle problem of several, non-mutually exclusive origins. First, error and task-specific variance are notoriously high for executive function tasks in particular (Rabbitt, 1997) and performance task measures in general. Proportionally higher error and task-specific variance would explain why, for instance, correlations among neuropsychological tasks was only $r = .16$, indicating that on average, when two different neuropsychological tasks are administered to the same individual, the shared variance among these tasks is less than 3%.

Second, personality questionnaires typically assess self-control as a *propensity* (i.e., how often does this individual act in a self-controlled way?) whereas delay of gratification and neuropsychological tasks measure self-control as a *capacity* (i.e., when motivated, how self-controlled does this individual act?) (Duckworth, 2009). The capacity to act in a certain way and the propensity to do so in daily life are conceptually distinct and surprisingly weakly correlated, even when the measurement method is identical. For instance, Sackett, Zedeck, and Fogli (1988) found that the correlation between the items per minute scanned by supermarket cashiers in a 25-

item work sample observed by a supervisor (maximum performance) and the same rate measured over an extended period was .14 in one sample and .24 in another.

Further, within-individual, domain-specific variance in self-control may also have attenuated correlations among measures. Our recent research suggests, in fact, that variation in impulsive behavior *across* domains (e.g., food, work, finances, etc.) *within* individuals is dramatically greater than the variance in average impulsive behavior between individuals (Tsukayama & Duckworth, 2009). Within-individual variation is largely explained by individual differences in the degree to which particular temptations are pleasurable. Unbelievably, some people don't enjoy, and therefore have no trouble, resisting chocolate. The same is true for beer, exercise, impulse buying, and procrastination. To the extent that questionnaire or task measures target or emphasize temptations of distinct domains (e.g., a delay of gratification task involving food and a questionnaire asking about procrastination), correlations among these measures will be diminished.

Finally, as shown in **Table 4**, none of the published factor-analytic studies on self-control produced a single-factor solution. While the present meta-analysis adds little to the debate over the "right" number and characterization of dimensions of self-control, it does strongly corroborate the view that self-control is not a unitary construct. Rather, our analysis is consistent with the view that self-control is organized hierarchically, with each higher level comprising correlated but distinct lower-level dimensions. In principle, at the lowest level, dimensions of self-control may correspond to separate psychological processes engaged in situations pitting immediate reward against long-term gain (Evenden, 1999). In theory, these processes could interact in complex ways. Some processes may interact as "substitute goods" in the economic sense, while others might interact as "complementary goods." That is, deficiency in certain self-control processes might be compensated by strength in others but might also exacerbate the effects of other deficiencies.

Parsing the distinct psychological processes that give rise to the overt demonstration of self-controlled behavior through factor analysis was not possible in the current investigation given the large number of missing values in the measure-by-measure correlation matrix. Even if sufficient data were available, factor analysis does not offer an obvious way to avoid the conflation of method and construct factors, among other limitations of this technique (cf. Block, 1995). What are needed to do so – and not likely available in the near future – are equivalent modalities of testing for all proposed facets of self-control. More imminently, brain imaging technologies suggest a promising path forward toward dissociating self-control processes and understanding their interactions (cf. Fellows & Farah, 2005; McClure et al., 2004). Another strategy is to look for divergent developmental trajectories. For instance, sensation seeking, one purported dimension of self-control, increases sharply during late adolescence and then falls again in early adulthood, while the tendency to think about the future increases monotonically during the same period (Romer, Duckworth, Sznitman, and Park, 2009).

Campbell and Fiske (1959) suggest that convergent validity is demonstrated by correlations between measures that are "significantly different from zero and sufficiently large to encourage further examination of validity" (p. 82). In the absence of reliability estimates for most measures of self-control, which provide an asymptotic maximum for correlations among measures, it is difficult to come to a final judgment about whether the observed correlations in this meta-analysis are, as Campbell and Fiske put it, "sufficiently large." One sobering point of comparison is the average correlation between delay of gratification and intelligence measures, $r = .23$ (Shamosh & Gray, 2008). That is, the observed associations among self-control measures of diverse types is, on average, identical in magnitude to the association between self-control and intelligence measures. On the other hand, correlations in every cell of our meta-analytic were statistically significant from zero. Further, correlations among distinct IQ tests are not much greater (r = .37 for subtests of the WISC-III, for example; Wechsler, 1991).

Our summary interpretation of the convergent validity evidence points to several separate causes (e.g., domain-specificity, multi-dimensionality, propensity vs. capacity distinction, measurement error) for moderate correlations among measures of self-control. Further research is needed to explore each of these factors individually and in combination. Accomplishing this work will require self-control researchers to venture into new methodological territory, adding new techniques borrowed from other labs and literatures to their usual stable of methods. Questions about the comparability of measurement approaches and underlying theoretical conceptions should be addressed head-on rather than ignored. In the meanwhile, an important practical implication of the current investigation is that diverse measures of self-control are hardly interchangeable. Because different methods of assessment may provide complementary, as well as overlapping, information (Roberts et al., 2006), there is justification both for aggregating diverse self-control measures to examine self-control at broad levels of abstraction (in the same way that diverse intelligence tests are aggregated to investigate the general factor *g*), but also for examining specific lower-level dimensions independently.

The strong conceptual, operational, and correlational overlap between ADHD and non-clinical self-control questionnaires indicates that, whereas the convergent validity evidence for self-control measures is weak overall, the jangle fallacy also prevails. Our findings support Barkley's (1997) speculation that "ADHD appears to represent the lower end of a continuum of a normal trait or set of traits…" (p. 317). More sophisticated methods for evaluating the latent structure of psychological constructs and distinguishing between categorical and dimensional constructs have been developed (Ruscio & Ruscio, 2008), but were not possible to employ given the data available in this meta-analysis. We hope that future studies use these techniques to test our tentative conclusion that ADHD represents a difference in degree but not kind from the personality trait of self-control.

The promise of psychology as a cumulative science depends not only on unifying theories and well-designed, well-executed studies, but also upon consensually shared measures with demonstrated reliability and validity (Mischel, 2009). On the basis of the current meta-analysis, we suggest that the field of self-control research is at the moment significantly handicapped by both the jingle and jangle fallacies. Nevertheless, we believe that clarity and consensus about the definition and measurement of self-control are attainable goals. We hope the meta-analytic findings of this study serve as a useful way station.

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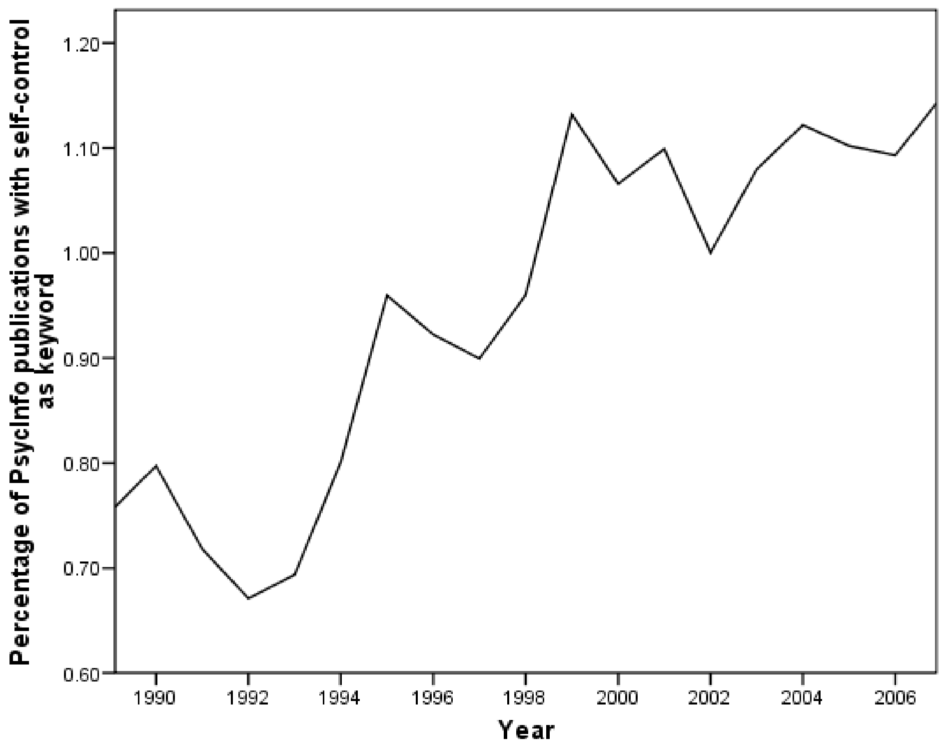
Footnotes

[1] The variance in a set of self-control measures can be apportioned to systematic and random error variance. Systematic variance can be further partitioned into (common) self-control variance and (specific) non-self-control variance. The correlation of two self-control measures will approach the reliability of the measures only if the specific non-self-control variance is zero.

[2] When using the ranks instead of the frequencies as a more robust score of popularity, the results are basically the same as reported here.

Figure 1

Increasing popularity of self-control in psychology research over the past two decades



Note. Search terms included the following keywords: *self-discipline*, *self-regulation*, *ego strength*, *willpower*, *effortful control*, and *impulsiveness*.

Table 1

Subtypes of Delay of Gratification Task Ranked by Popularity

Delay task subtype	Examples	Description	Popularity
Hypothetical Delay	Kirby Delay Discounting Questionnaire (Kirby et al., 1999)	The subject makes hypothetical choices, each of which includes a smaller, more immediate reward and a larger, delayed reward.	26
Sustained Delay	Snack Delay Task (Kochanska, et al.,1996)	The subject must wait for the larger reward, while the smaller, immediate reward remains accessible.	9
Repeated Trials Delay	Newman Task (Newman, et al., 1992) Single Key Impulsivity Paradigm (Dougherty, et al., 2005)	The subject plays a game where one type of response is immediately rewarded and another mutually exclusive type of response yields a delayed, but larger reward.	6
Real Choice Delay	Choice Delay Task (Kendall & Wilcox, 1979)	The subject chooses between a smaller, immediate reward or a larger, delayed reward.	5

Note. Popularity refers to the number of multi-method studies in our meta-analytic database in which the measure was used. For delay measures which offered hypothetical choices as well as choices between physical rewards, we coded them according to the category under which the majority of the choices fell. For example, if a task presented 10 different hypothetical delay questions, and the subject was aware that they would receive only 1 of their choices, the measure was coded as hypothetical delay.

Table 2

Subtypes of Executive Function Tasks Ranked by Popularity

Task	Example	General Description	Popularity
Go/No-Go Task	Continuous Performance Task (Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956)	The subject develops a prepotent motor response (e.g., hitting the spacebar) to frequently appearing targets. The task requires inhibition of this prepotent response when a less frequently appearing non-target appears.	139
Stroop Task	Stroop Task (Stroop, 1935)	The subject must respond to a series of stimuli in a way that requires inhibition of a previously overlearned response.	113
Set Switching Task	Wisconsin Card Sorting Task (Heaton, 1981)	The subject learns an initial set of rules, which change during subsequent trials. The task requires inhibition of previously learned rules and the adoption of a new set of rules.	94
Reflection Task	Matching Familiar Figures Task (Kagan et al., 1964)	A stimulus (e.g., a geometric pattern) is presented, and the subject must choose the correct response (e.g., the identical pattern) among very similar responses.	40
Tower Tasks	Tower of London Test (Shallice, 1982, 1988)	The subject must plan ahead and resist immediate action in order to solve a problem.	39
Stop-Signal Task	Stop-Signal Paradigm (Logan, 1994)	The subject performs a primary task and is presented with periodic signals, in response to which they must temporarily stop performing the primary task.	34
Motor Inhibition Task	Draw A Line Slowly Task (Maccoby et al., 1965)	The subject must control or slow motor behavior.	32
Trails Task[2]	Trail Making Task (Reitan & Wolfson, 1985)	Subjects first connect numbered circles in sequential order, and in a subsequent trial, connect numbers in an alternating pattern. Differences in performance between these two trials are recorded.	16
Porteus Maze Task	Porteus Maze (Porteus, 1942)	The subject completes a series of mazes of increasing complexity. Successfully completing the maze requires looking ahead and avoiding dead ends.	13
Iowa Gambling Task	Iowa Gambling Task (Bechara et al., 1994)	The subject chooses among four decks of cards. Each card results in a monetary gain or loss, and some decks yield more long-run gains than others.	12
Attention Task	Flanker Task (Eriksen & Eriksen, 1974)	Subjects must sustain attention to a target stimulus while ignoring distracters.	5
Risk Task	Balloon Analogue Risk Task (Lejuez et al., 2002)	Subjects play a game in which rewards are steadily accrued but the risk of losing all accumulated rewards increases with each trial.	4

Note. Popularity refers to the number of multi-method studies in our meta-analytic database in which the measure was used.

Table 3

Most Popular Personality Questionnaires Ranked by Popularity

Questionnaire	Source	Target	Popularity
Barratt Impulsiveness Scale Version 11 (BIS-11)	Self-Report	Non-ADHD	46
Conners Teacher Rating Scale	Informant Report	ADHD	24
Eysenck I_7 Impulsiveness Questionnaire	Self-Report	Non-ADHD	23
Conners Parent Rating Scale	Informant Report	ADHD	22
Child Behavior Checklist - Parent report form	Informant Report	Non-ADHD	22
Child Behavior Checklist - Teacher report form	Informant Report	Non-ADHD	16
Eysenck I_6 Impulsiveness Questionnaire	Self-Report	Non-ADHD	14
Dickman Dysfunctional Impulsivity Scale	Self-Report	Non-ADHD	12
Behavior Rating Inventory of Executive Function (BRIEF) – Parent Version	Informant Report	Non-ADHD	11
DSM-IV AD/HD Rating Scale	Informant Report	ADHD	10

Note. Popularity refers to the number of multi-method studies in our meta-analytic database in which the measure was used.

Table 4

Proposed Factor Structures for Self-Control

Study	Proposed Factors
Buss and Plomin (1975)	Decision Time, Sensation Seeking, Persistence, Inhibitory Control
Humphrey (1982)	Cognitive Personal Self-Control, Behavioral Interpersonal Self-Control
Eysenck et al. (1984)	Venturesomeness, Impulsiveness
Barratt (1985)	Nonplanning Impulsiveness, Cognitive Impulsiveness Motor Impulsiveness
Gerbing et al. (1987)	Spontaneous, Carefree, Not Persistent
Luengo et al. (1991)	Lack Of Planning, Lack Of Thoughtfulness
Carrillo-De-La-Pena et al. (1993)	Cognitive Impulsivity, Behavioral And Social Impulsivity
Parker et al. (1993)	Methodical Vs. Disorganized, Cautious Vs. Spontaneous
White et al. (1994)	Cognitive Impulsivity, Behavioral Impulsivity
Kindlon, Mezzacappa, and Earls (1995)	Cognitive, Motivational (Insensitivity To Punishment)
Olson et al. (1999)	Delay Of Gratification, Choice Delay, Inhibitory Control
Whiteside and Lynam (2001)	Lack Of Premeditation, Sensation Seeking, Lack Of Perseverance, Urgency
Swann (2002)	Rapid Response, Reward Delay
Miller et al. (2004)	Non-Planning, Dysfunctional, Reward Responsiveness, Drive, Functional, Venturesomeness
Reynolds et al. (2006; Study 2)	Impulsive Disinhibition, Impulsive Decision-Making

Table 5

Strength and Heterogeneity of Relationships Within and Among Types of Self-Control Measures

	Executive Function Task	Delay of Gratification	Self-Report Questionnaire	Informant-Report Questionnaire
Executive Function Task	k = 330 r = .158 [.142, .174] r_{FE} = .153 [.142, .165] τ^2 = .008 [.005, .013] Q = 537.99; <.001	k = 41 r = .110 [.076, .143] r_{FE} = .110 [.076, .143] τ^2 = .000 [.000, .019] Q = 49.07; p = .154	k = 117 r = .112 [.087, .137] r_{FE} = .099 [.079, .119] τ^2 = .005 [.001, .010] Q = 158.51; p = .005	k = 142 r = .140 [.119, .161] r_{FE} = .136 [.119, .153] τ^2 = .005 [.002, .011] Q = 215.45; p <.001
Delay of Gratification		k = 4 r = .211 [.096, .326] r_{FE} = .211 [.096, .326] τ^2 = .000 [.000, .039] Q = 0.61; p = .893	k = 34 r = .137 [.097, .177] r_{FE} = .140 [.108, .172] τ^2 = .003 [.000, .013] Q = 40.36; p = .177	k = 17 r = .202 [.146, .258] r_{FE} = .207 [.167, .247] τ^2 = .006 [.000, .024] Q = 27.49; p = .036
Self-Report Questionnaire			k = 58 r = .455 [.401, .509] r_{FE} = .469 [.453, .485] τ^2 = .037 [.024, .059] Q = 548.41; p <.001	k = 31 r = .380 [.313, .448] r_{FE} = .444 [.423, .464] τ^2 = .030 [.017, .058] Q = 347.07; p < .001
Informant-Report Questionnaire				k = 142 r = .481 [.442, .520] r_{FE} = .512 [.502, .522] τ^2 = .048 [.038, .066] Q = 1371.87; p <.001

Note. k = number of independent effect sizes, r = mean effect size estimate using a random effects model with synthetic effect sizes, r = mean effect size estimate using a fixed effects model with synthetic effect sizes, τ^2 = heterogeneity variance estimate, Q = Q-statistic for homogeneity test, p = p-value associated with the Q-statistic. The degrees of freedom for the homogeneity test based on Q are k–1.

Table 6

Correlations between Informant-Report (IR) Self-Control/ADHD Measures and Self-Report (SR) Self-Control/ADHD Measures

	IR Self-Control	IR ADHD	SR Self-Control	SR ADHD
IR Self-Control	$k = 6$ $r = .657$ [.563, .752] $\tau^2 = .010$ [.002, .077] $Q = 23.49$; < .001			
IR ADHD	$k = 36$ $r = .626$ [.561, .692] $\tau^2 = .035$ [.021, .062] $Q = 422.11$; <.001	$k = 30$ $r = .617$ [.553, .681] $\tau^2 = .026$ [.015, .054] $Q = 179.39$; <.001		
SR Self-Control	$k = 6$ $r = .330$ [.178, .482] $\tau^2 = .030$ [.008, .206] $Q = 30.06$; <.001	$k = 5$ $r = .495$ [.298, .692] $\tau^2 = .042$ [.012, .348] $Q = 67.70$; <.001	$k = 36$ $r = .464$ [.398, .529] $\tau^2 = .032$ [.019, .061] $Q = 292.41$; <.001	
SR ADHD	$k = 0$	$k = 5$ $r = .444$ [.341, .547] $\tau^2 = .008$ [.000, .099] $Q = 9.70$; $p = .05$	$k = 5$ $r = .638$ [.463, .814] $\tau^2 = .036$ [.010, .327] $Q = 55.64$; <.001	$k = 2$ $r = .792$ [.587, .997] $\tau^2 = .021$ [n.a.] $Q = 17.03$; < .001

Note. k = number of independent effect sizes, r = mean effect size estimate using a random effects model with synthetic effect sizes, τ^2 = heterogeneity variance estimate, Q = Q-statistic for homogeneity test, p = p-value associated with the Q-statistic, n.a. = not available

Appendix

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