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Are personality and behavioral measures of impulse control convergent or distinct predictors of health behaviors?

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ABSTRACT

Both traditional personality measures of impulse control and behavioral measures of impulse control have been shown to predict health behaviors. Despite a strong conceptual overlap between these two approaches to measuring impulse control, it is unclear how these two modes of measurement converge. We tested three different models relating behavioral and personality measures to a broad measure of health behaviors. Participants ($N = 147$) completed a series of behavioral measures of impulse control along with a lexically-based adjective checklist for conscientiousness, and Eysenck's I_7 impulsiveness scale. Participants' personalities were also evaluated via peer-ratings. Health behaviors were assessed using the health behaviors checklist (HBC). Across most domains of health behaviors both types of measures operated as parallel independent predictors.

1. Introduction

Impulse control involves the ability to inhibit responses or actions in a variety of situations. It is one of the most important facets of conscientiousness for predicting health behaviors (Roberts, Walton, & Bogg, 2005). Meta-analytic results indicate that the relationship between trait measures of impulse control and health behaviors holds across multiple personality and health behaviors measures (Bogg & Roberts, 2004). Impulse control has been operationalized in several ways (White et al., 1994). The two dominant modes of measurement are (1) personality measures, such as the broad big five dimension of conscientiousness and (2) laboratory behavioral measures of inhibitory control such as the GoStop task. The first type of measure consists of a broad assessment of typical thoughts feelings and behaviors referring either to impulsivity or, in the case of conscientiousness, the absence of impulsivity and the exercise of forethought and restraint (Srivastava, 1999). Broad measures of this type can be further broken down into more narrowly constructed higher fidelity predictors or facets which have been found to be stronger predictors with respect to specific domains than broader measures (Hogan & Roberts, 1996; Lynam & Miller, 2004; Miller, Lynam, & Jones, 2008; Paunonen & Ashton, 2001).

The second type of measure, often referred to as cognitive measures of impulsivity (White et al., 1994) includes a diverse array of tasks each of which are meant to tap a discreet underlying component of impulse control. Here we refer to these measures as laboratory behavioral measures of impulse control. Within the rubric of laboratory behavioral measures of impulse control, a further distinction can be made between rapid response measures and reward-delay measures (Swann, Bjork, Moeller, & Dougherty, 2002). Rapid response measures entail a speeded reaction time task focusing on visual and auditory stimuli presented in a well-controlled setting, while the second class of measures focuses on a participant's ability to favor a larger distal reward in favor of a smaller proximal one.

At the definitional level traditional personality measures of impulse control are described in nearly identical terms as laboratory behavioral measures. One of the most commonly cited definitions of conscientiousness includes a propensity to follow socially prescribed norms for impulse control, to be task- and goal-directed, to be planful, delay gratification, and follow norms and rules (Srivastava, 1999). A broad definition of inhibitory control, which many behavioral measures of impulse control are meant to measure, includes planning, goal-directed or intentional action, inhibition and resistance to distraction, problem-solving and strategy development, selection, and monitoring, and maintenance of persistence toward attaining a goal (Barkley, 2000). Further, measures that evaluate an individual's propensity to prefer a proximal reward over a distal one correspond explicitly with the components of conscientiousness that involve being planful and delay of gratification. Despite the diversity of methods employed across

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different measures, each one is conceptualized as an indicator of impulsive behavior at a broader level, which we term impulse control. Clearly, both personality and laboratory behavior approaches to impulse control are conceptually indistinguishable if methodologically quite different.

Given the conceptual overlap between these two distinct methods of measuring impulse control, we conducted a study to determine: (1) the relation between these two ways of measuring impulse control, (2) the relation between personality and laboratory behavior measures of impulse control and health behaviors, and (3) whether laboratory behavior measures of impulse control could account for the relation between personality measures of impulse control and health behaviors. As will be seen below, despite the clear conceptual overlap, the empirical linkages among these three sets of variables have as yet, not been clarified.

2. Personality and laboratory behavioral measures of impulse control

As noted above, at a conceptual level, personality and laboratory behavioral measures of impulse control have been defined in almost identical terms. Despite this, there is mixed evidence for such a clear association between personality and laboratory behavioral measures of impulse control. Numerous studies have demonstrated a positive association between these two approaches to assessing impulse control, and this relationship has been found across laboratory behavioral measures falling into both the rapid response classification, such as the immediate and delayed memory tasks (IMT/DMT), and measures of reward delay such as the Iowa gambling task (IGT). Participants who were slower to inhibit responding to stop trial stimuli in the go/no-go task also scored higher on self-reported impulsivity (Logan, Schachar, & Tannock, 1997). Similarly, trait impulsiveness was most strongly correlated with performance on a go/no-go task even when adjusting for age and education (Keilp, Sackeim, & Mann, 2005). In a sample of parents of children diagnosed with disruptive behavioral disorders and parents of normal controls, self-reported impulsivity scores were correlated with commission errors on the IMT/DMT (Dougherty et al., 2003). In a sample of adult women, split with respect to scores on the Eysenck impulsivity scale, high impulsive women made more commission errors than low impulsive women on the IMT/DMT and the GoStop task (Marsh, Dougherty, Mathias, Moeller, & Hicks, 2002). In a sample of both cocaine dependent adults and normal controls, self-reported impulsivity was positively correlated with commission errors on the IMT and the ratio of commission errors to correct detection on the DMT (Moeller et al., 2004). In a sample of adult inter-episode bipolar participants and normal controls, self-reported impulsivity scores were positively correlated with IMT/DMT commission error rate (Swann, Anderson, Dougherty, & Moeller, 2001). Using Whiteside and Lynam's (2001) UPPS Impulsive Behavior Scale, Zermatten, Van der Linden, D'Acremont, Jermann, and Bechara (2005) found that greater impulsivity was associated with impulsive decision making assessed via the IGT (Bechara, Damasio, Damasio, & Anderson, 1994). Schmeichel and Zell (2007) found modest correlations between self-reported self-control and participants ability to inhibit eye blinking and persistence in a cold pressor task. In yet another sample of normal young adults performance on the mazes test, a laboratory behavioral measure meant to tap planning and impulse control, was positively correlated with a self-reported measure of impulse control (Pietrazak, Sprague, & Snyder, 2008).

Evidence in support of a relationship between laboratory behavioral and personality measures of impulse control can be also be seen indirectly, where both constructs seem to share a similar relationship to a third construct. The indirect evidence comes from the literature on delinquency and Attention Deficit Hyperactivity Disorder (ADHD). In a study focusing on predicting adolescent delinquency, White et al. (1994) found that a composite of personality measures of impulsivity and a composite of laboratory measures of impulsivity were highly correlated. Individuals identified as following a life-course persistent antisocial path, which is correlated with scoring higher on personality measures of impulsivity (Miller & Lynam, 2001), were also prone to performing poorly on laboratory measures of impulsivity (Raine et al., 2005). Analogously, adolescents diagnosed with a disruptive behavioral disorder displayed higher rates of commission errors on the IMT/DMT and a GoStop task when compared a group of control subjects (Dougherty et al., 2003). Furthermore, children diagnosed with ADHD showed poor impulse control on multiple laboratory measures, including the go/no-go test (Van der Meer, Marzocchi, & De Meo, 2005). The link to ADHD is more compelling when one considers that one of the key elements of the personality profile for ADHD includes low conscientiousness (Nigg et al., 2002). In school age children, parent and teacher ratings of DSM IV criteria for ADHD are moderately related to multiple laboratory behavioral measures of impulse control (Avila, Cuenca, Félix, Parcet, & Miranda, 2004). That both behavioral measures of impulse control and trait measures are related to ADHD diagnosis suggests a link between measures of impulse control and both peer- and self-reported personality. Taken together, the direct and indirect research suggests a systematic link between different types of impulse control measures.

However, there are instances where these measures have shown little or no association. For example, in a sample that included both adolescents and their parents, IMT/DMT error rates showed positive correlations with self-reported impulsivity in adults only; their adolescent children showed near zero correlations on the same measures (Dougherty, Bjork, Harper, et al., 2003). Similarly, in a sample of adults that included patients diagnosed with bipolar disorder and normal controls IMT/DMT outcomes were not correlated with self-reported impulsivity (Swann, Pazzaglia, Nicholls, Dougherty, & Moeller, 2003). In another sample consisting of normal young adults there was a complete lack of significant correlations between four different laboratory measures of inhibitory control and self-reported impulsivity (Cheung, Mitsis, and Halperin (2004). Finally, Reynolds, Ortengren, Richards, and de Wit (2006) used a battery of both personality measures of impulsivity and laboratory measures of impulsivity, including the go/no-go and delay discounting tasks, and found little or no substantive correlations across multiple measures.

The mixed results with respect to the relationship between laboratory behavioral measures and traditional personality measures of impulse control are difficult to interpret. The inconsistency may be attributable to the particular laboratory measure, which is often used in isolation. Or, the inconsistency may be attributable to the vagaries of self-report personality measures, which most, if not all of the above studies relied upon. In order to address these potential confounds, we used multiple laboratory measures and both self-report and observer ratings of personality in order to provide a more definitive test of the link between personality and laboratory measures of impulse control. Further, our self- and peer-report measures of personality allowed for both broad level measurement of impulse control, and for a finer grained analysis at the level of the five most replicated facets of conscientiousness.

3. Personality and laboratory behavioral measures of impulse control and health behaviors

Personality measures of impulse control are related to a broad spectrum of health behaviors that includes both positive behaviors that promote health outcomes, and risky health behaviors that undermine health (Bogg & Roberts, 2004). The role of impulsivity and impulse control in the health process becomes clearer when impulsivity is located within the Big Five framework. Across two comprehensive studies of the structure of conscientiousness, it was found that impulse control was best considered as a facet of conscientiousness (Roberts et al., 2005). Research at the facet level of conscientiousness has shown that specific aspects of conscientiousness, including impulse control, account for the strong and consistent relationships between conscientiousness and health behavior. Specifically, the impulse control facet of conscientiousness is one of the most consistent and robust predictors of health behaviors (Bogg & Roberts, 2004; Hagger-Johnson & Whiteman 2007). Furthermore, the impulse control facet of conscientiousness predicts health behaviors across both self- and peer-reports (Jackson et al., 2009). The relationship holds across both traditional pen and pencil and computer based testing mediums (Chuah, Drasgow, & Roberts, 2006).

Likewise, there is ample evidence supporting the fact that laboratory behavioral measures of impulse control also predict health behaviors. Errors on the Stroop task, where participants are required to quickly name the color of the ink in which different color names are printed rather than reading the color names themselves, are associated with risky health behaviors and also negatively correlated with preventative health behaviors on the Health Behaviors Checklist (HBC; Hall, Elias, & Crossley, 2006). More concrete evidence of an association between performance on laboratory behavioral measures of impulse control and health behaviors can be seen in studies linking these tasks to suicide and drug use. Performance on the IMT/DMT has been shown to distinguish between groups based on their suicide attempt history and levels of suicidal ideation. Individuals with a greater number of suicide attempts tended to make more errors on the IMT/DMT compared to individuals with a history of fewer or no (Dougherty et al., 2004; Swann et al., 2005). Similarly, adolescents with greater levels of suicidal ideation performed worse on the IMT/DMT (Dougherty, Mathias, Marsh, Moeller, & Swann, 2004). IMT/DMT commission errors are also associated with earlier onset of drinking in women (Dougherty, Mathias, Tester, & Marsh, 2004), greater likelihood of abusing drugs, and reduced success in drug addiction rehabilitation, (Moeller & Dougherty, 2002). Performance on the IGT has been linked to both drug use (Hanson, Luciana, & Sullwold, 2008), and risky driving behaviors (Lev, Hershkovitz, & Yechiam, 2008). Thus, both standard personality measures and laboratory behavioral measures of impulse control predict health behaviors.

4. Do laboratory behavioral measures of impulse control account for the relation between personality measures of impulse control and health behaviors?

There is sufficient evidence to argue that personality and laboratory behavioral measures of impulse control are conceptually and empirically linked and that they both predict health behaviors. Given this foundation of associations, the clear question is how the three sets of variables should be organized. We see several possibilities. First, the two types of impulse control measures may be redundant and account for similar variance in health behaviors. We describe this as the *interchangeable model*. Evidence for this model would come in the form of exceptionally high correlations between traditional personality measures of impulse control and laboratory measures of impulse control. Alternatively, the relation between personality versions of impulse control and laboratory behavioral measures may be hierarchical (Bogg, 2008; Roberts, 2009; Roberts & Pomerantz, 2004). Specifically, a laboratory behavioral measure of impulse control could be construed as a lower-order manifestation of the personality trait of impulse control. Personality traits are defined as relatively enduring patterns of thoughts, feelings, and behaviors. Behavioral measures of impulse control are typically narrower than the personality variant of impulse control. For example, the go–no-go task entails inhibiting a response to a neutral stimuli when a sound occurs (normally a fast response would be required). The function of responding or not responding in the go–no-go task is largely perceptual and cognitive. Little in the way of emotions or broad-spectrum behaviors is involved. Therefore a second possibility is that the laboratory behavioral measures of impulse control will mediate the relation between personality measures of impulse control and health behaviors. We refer to this as the *mediation model*.

A third and final possibility would be that the measures of impulse control, though conceptually indistinguishable, are complementary predictors of health behaviors. We refer to this as the *complementary model*. This complementary model could arise for two reasons. First, the modalities involved in the typical assessment of personality measures and laboratory measures are quite distinct, and past research has shown that highly differentiated modalities often provide complementary versions of constructs (Roberts, Harms, Smith, Wood, & Webb, 2006, Chap. 22; Vazire & Mehl, 2008). The second reason would be because the constructs represented by personality and laboratory measures of impulse control are actually not overlapping as much as the definitions would lead one to believe. For example, another factor associated with the ability to plan and delay gratification is intelligence. Behavioral measures of impulse control and attentional functioning are known to correlate with intelligence (White et al., 1994). Thus, it may be that the definition shared by these two sets of measures is misleading.

4.1. Present study

Capitalizing on previous research in the domain of impulsivity, we constructed a battery of tests meant to give broad assessment of impulse control that attempt to cover the whole domain. Following White et al. (1994), we included measures that cover both traditional personality measures of impulse control, and laboratory behavioral tests of impulse control meant to tap a cognitive dimension. Since the domain of laboratory behavioral measures of impulse control can be classified in terms of both speeded tests and delayed reward tests, we included measures from both of these domains. While these tests differ widely in their method of measurement, each has been previously used as an indicator of impulse control in multiple studies (Logan et al., 1997; Malloy-Diniz, Fuentes, Leite, Correa, & Bechara, 2007; Swann et al., 2002). Additionally, we assessed personality using both self- and peer-reports for a more comprehensive methodological approach to the assessment of personality. By assessing similar constructs using multiple methods, we can capitalize on the potential advantages of each method. In selecting personality measures, it is important to consider the level of measurement that will yield the highest validity (Hogan & Roberts, 1996). We selected measures that allowed for a broad assessment of the domain of impulse control, but also allowed for a finer grained analysis using more discreet facets related to impulse control.

When considering the validity of any measure, it is vital to have meaningful criteria that can be reliably evaluated. In the current study, we take a multivariate perspective on health behaviors. The Health Behavior Checklist (HBC, Vickers, Conway, & Hervig, 1990) is a 27 item inventory measuring four dimensions of health behaviors: (1) wellness maintenance, (2) accident control, (3) traffic risk, and (4) substance risk. By using a measure that divides health behaviors into categories that represent specific classes of preventative or risky behavior, it is possible to evaluate different measures of impulse control with respect to each different class of health behavior.

By including a broad measure of impulsivity, along with a comprehensive measure of a consequential outcome, we have the ability to test multiple models of prediction. Previous research has typically not entertained the interchangeable, mediation, or complementary models simultaneously. The present study allows for all of the possible relationships described to be elucidated. We tested the three models that could explain the relations among personality and laboratory measures of impulse control and health behaviors using correlation and multiple regression. If the personality and laboratory versions of impulse control are interchangeable, then we would expect correlations between these measures that would be close to the limits of reliability, and preclude using both variables in a regression model. The mediational and complementary models are tested simultaneously with multiple regression. If the mediational model holds, we would expect the relation between personality measures of impulse control and health behaviors would be attenuated when laboratory measures of impulse control were also entered in the prediction equation (Baron & Kenny, 1986). Alternatively, if there is no evidence for mediation but both sets of variables predict health behaviors independently, this would be consistent with the complementary model.

4.2. Materials

4.2.1. Sample

One-hundred and forty-seven students in an introductory psychology course at a large Midwestern university participated in the study. Six participants failed to adequately follow instructions on more than one task in the study, and were excluded from analysis. One participant was excluded on the basis of random responding on the personality questionnaire portion of the study. Data from three participants was excluded based on their elevated filler error rates (greater than 3%) on the IMT/DMT. Therefore, 137 participants were included in the final analyses. Participants also provided contact information for close associates who could provide peer-ratings of personality. Close associates were not compensated for their ratings. Due to a combination of experimenter error, participant error, and random equipment failure the *N*'s for each measure varied. Participants received course credit for their participation.

4.2.2. Cognitive measures of impulsivity

4.2.2.1. IMT/DMT. This task is a tool for measuring attention and impulsive responding (Dougherty & Marsh, 2003). The task consisted of two parts, the immediate memory task and the delayed memory task. One testing session consisted of alternating five minute blocks of the two tasks with 30 s breaks in between. This resulted in a total testing time of 21.5 min. The immediate memory task (IMT) asks participants to attend to five digit numbers that flash in succession on a computer screen. Each number appears for 500 ms with a 500 ms interval between stimuli. The participant is instructed to respond by clicking a mouse button whenever two identical five digit numbers appear in succession. Three types of responses are recorded: (1) correct detections of the target stimulus (2) commission errors, where the participant responds to a number that differs in just one digit from the one preceding it (3) and a filler error, where the participant responds incorrectly to a random filler number. Both commission errors and the ratio of commission errors to correct detections can serve as measures of impulsive responding. Filler errors are rare, and are not treated as an outcome here. Participants with elevated filler error rates (greater than 3%) across both the IMT and DMT were excluded from analyses on those measures (Dougherty & Marsh, 2003). For each trial, target and catch stimuli have a 33% chance of being displayed, and filler stimuli have a 34% chance. The delayed memory task (DMT) is nearly identical to the IMT. The only change is that a distracter stimulus, consisting of the five digit number 12345, is flashed three times between the salient comparison stimuli. The distracter stimuli are presented at the same rate as the comparison stimuli. This increases the total time between comparison stimuli from 500 ms to 3500 ms. Commission error rates were employed as outcome measures for both the IMT and DMT. Commission errors were calculated as the percentage of commission errors based on the number of commission errors recorded and the total number of trials on which a commission error could occur (*N* = 124).

4.2.2.2. GoStop task. This task measures participants' ability to inhibit responding to a target stimulus (Dougherty, Mathias, & Marsh, 2003). A series of five digit numbers are presented on a computer screen. The randomly generated numbers appear for 500 ms once every 2 s (500 ms on, 1500 ms off). Similar to the IMT/DMT, participants are instructed to click a mouse button when a target stimulus appears, namely when two identical numbers appear in succession. If a target stimulus turns red, participants are told to inhibit their response. In half of the target trials, the target stimulus turns red after 50, 150, 250, or 350 ms. These trials are referred to as stop trials. Target and stop trials each occur 25% of the time. The other 50% of trials are randomly generated five digit numbers that differ from the preceding number. Stop trial delay times of 50, 150, 250, and 350 ms occur randomly with equal probability. The testing session takes 12 min.

For stop trials, the average time between stop signal onset and a response represents the stop latency. Stop latency is the most commonly used outcome derived from tasks like the GoStop. For this reason, we include the stop latency for participants in the 350 ms stop trials. Inhibition rates for the 350 ms stop trials were also used as an outcome measure. Inhibition rates on the GoStop task are calculated as the percentage of stop trials where a participant effectively inhibited responding. The inhibition rate is analogous to the commission error rate employed for the IMT and DMT, but is effectively reverse scored, since it represents a percentage of successful inhibitions rather than a percentage of errors (*N* = 131).

4.2.2.3. Iowa gambling task. In this task participants draw cards from one of four decks (IGT; Bechara et al., 1994). The four decks of the IGT are presented to participants on a computer screen. Participants are told that each deck provides a gain in a certain amount of money with the risk of loss of money and that the decks differ in the amount of money that can be gained. Participants are told that the goal is to accrue as much money as possible over the 100 trails. The schedule of gains and losses is taken from Bechara et al. (1994). Two of the decks provide small cash rewards ($50) and also small losses, such that over time choice of the two decks with this payback structure results in a net gain in money. The remaining two decks provide a larger cash reward ($100) and larger losses, such that over time choices made from these two decks result in a net loss in money. A running tally of the participants' earnings is shown above the decks as participants make their choices. The outcomes assessed are percentage of choices made for the "bad" decks and the amount of money accrued over the course of the trials (*N* = 126).

4.2.3. Personality measures

4.2.3.1. Self-reported personality. Participants completed a lexically-based adjective checklist (Jackson et al., 2009) to measure extroversion, agreeableness, conscientiousness, emotional stability, and openness. All items were rated on a 1–5 scale. Alpha's ranged from .77 to .91. This lexically-based checklist also includes the subfacets of conscientiousness that replicate across methods, including impulse control, responsibility, industriousness, orderliness, and conventionality. With the exception of industriousness, the alphas of these factors were acceptable ranging from .61 to .85. The industriousness facet had an alpha reliability of .37. Removal of problematic items resulted in a reduced industriousness scale with three items with an alpha reliability of .52 ($N = 134$).

Participants also completed the 19-item Eysenck impulsiveness subscale from the I_7 impulsivity scale (Eysenck, Pearson, Easting, & Allsopp, 1985). The I_7 impulsiveness scales showed an alpha reliability of .76 ($N = 134$).

4.2.3.2. Peer-reported personality. Close associates rated the participants' personality using the same adjective checklist described above. The instructions were altered so that close associates were asked to rate the participants' personality rather than their own. For peer-reported conscientiousness, $\alpha = .96$. For the five facets of peer-reported conscientiousness alpha reliabilities ranged from .71 to .91. A total of 163 peer-reports were collected for 88 distinct participants. For each of those participants the number of peer raters ranged from 1 to 4. In order to estimate the reliability or the peer-ratings, we calculated ICC [1, k] across raters and corrected this value using the Spearman-Brown prophesy formula based on the average number of peer raters for each participants, in this case two. The corrected ICC for peer-rated conscientiousness was .42. Corrected ICC's for the facet level measures of peer-reported conscientiousness ranged from .35 to .54.

4.2.4. Health behavior checklist

The health behavior checklist (HBC, Vickers et al., 1990) is a 27-item measure assessing four dimensions of health behaviors. These are: (1) wellness maintenance, with 10 items such as "I exercise to stay healthy", (2) accident control, with six items such as "I have a first aid kit in my home", (3) traffic risk, with seven items such as "I cross busy streets in the middle of the block", and (4) substance risk, with four items such as the reverse scored "I don't smoke". All measures were rated on a 1–5 scale. Alpha reliabilities for the four HBC scales ranged from .52 to .70 ($N = 134$).

4.2.5. Procedure

Participants were run in a computer lab with 12 computers. Groups ranged in size from 2 to 12 participants. Instructions for the IMT/DMT were given by the researcher to the entire group. After completing both a practice trial and the actual IMT/DMT, participants were then given instructions on how to complete the GoStop test. When all participants had completed the GoStop test, participants then completed the personality measures on the same computer they had used for the previous two tasks. On two occasions, the server holding the personality questionnaires was not available; as a result these participants completed paper versions of the same questionnaires. After completing the personality measures, participants then completed the IGT. When they had completed the IGT, participants were asked to fill out a close associate form, indicating the names and contact information of individuals who knew them well, and might be willing to provide ratings on their personality. Participants were then debriefed, thanked for their time, and allowed to go. After the testing session, the experimenters contacted close associates via e-mail using the information provided by the participants. Close associates who agreed to participate were directed to a website where they could log-in. Close associates performed their ratings using the same adjective checklist participants had used to rate themselves.

4.3. Results

4.3.1. Are personality and laboratory behavioral measures of impulse control interchangeable?

Table 1 shows the correlations across all of the measures of impulse control employed in this study. The model correlation between self- and peer-reported personality traits was consistent with past research on self-other agreement with moderate levels of convergence across scales. In contrast, the correlations between self- and peer-reported personality and laboratory measures of impulse control clearly contradict the assumption that they are interchangeable versions of the same construct. Out of 65 correlations, only six were statistically significant. Interestingly, out of those six correlations, three were attributable to the impulse control facet of conscientiousness. The impulse control facet was positively correlated with the total amount of money earned on the IGT ($r = .21$, $p < .05$) and also with the difference between advantageous and disadvantageous deck draws on the IGT ($r = .18$). It was also negatively related to DMT errors and ($r = -.18$, $p < .05$). Unfortunately, these correlations were replicated with neither the peer-rated impulse control measure nor the I_7 impulsiveness scale. Of the remaining statistically significant correlations, the total self-reported conscientiousness score was positively correlated with ($r = .18$, $p < .05$) as was the conventionality facet of conscientiousness ($r = .18$, $p < .05$). Finally, the self-reported orderliness scale was also positively correlated with the difference between advantageous and disadvantageous deck draws on the IGT ($r = .20$, $p < .05$). These positive results are countered with the fact that none of the peer-rated personality dimensions correlated with laboratory measures of impulse control. Overall, the inconsistent and low correlations between personality and laboratory measures of impulse control would appear to disconfirm the interchangeable model.

4.3.2. Do personality and laboratory behavioral measures of impulse control predict health behaviors?

Table 2 shows correlations between the four HBC scales, laboratory behavioral measures of impulsivity, and peer- and self-reported measures of impulse control. Consistent with past research, personality measures of impulse control were correlated with health behaviors. Self-report measures showed correlations at a magnitude and level of differentiation quite consistent with past research (e.g., Bogg & Roberts, 2004). The impulse control facet was most strongly correlated with traffic risk ($r = -.40$, $p < .05$) and substance risk ($r = -.26$, $p < .05$), which is consistent with past research showing that this facet correlates most strongly with risky health behaviors. The I_7 impulsivity scale was also a strong predictor of the traffic risk ($r = -.37$, $p < .05$) and substance risk ($r = -.31$, $p < .05$) health behavior scales. Also consistent with past research, the industriousness facet was the best predictor of wellness maintenance ($r = .37$, $p < .05$). Likewise, the orderliness facet was the least efficacious predictor of health behaviors. Interestingly, the peer-rated personality measures showed strong, undifferentiated correlations with only one health behavior scale, traffic risk (rs $-.21$ to $-.39$, $ps < .05$). This would seem to indicate that the peer-ratings of personality were not effectively capturing the facets of conscientiousness as much as a single dimension of impulse control.

There were also notable correlations between laboratory behavioral indices of impulse control and health behaviors. IMT commission errors were positively correlated with substance risk ($r = .19$, $p < .05$). GoStop inhibition rates, which function as a reversed commission error rate, were positively correlated with wellness maintenance ($r = .18$, $p < .05$). Consistent with expectations, the stop-signal reaction time on the GoStop task was negatively correlated with substance risk ($r = -.22$, $p < .05$). The only laboratory behavioral measures of impulse control not correlated with health behaviors were deck choice from the IGT, IGT total money earned, and DMT commission errors. Based on these results it is clear that traditional personality measures and laboratory measures of impulse control are both correlated with health behaviors.

Given the systematic lack of correlation between the personality and laboratory measures of impulse control, the hypothesis that

Table 1
Correlations between laboratory behavioral and traditional personality measures of impulse control.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. C	(.91)												
2. Ord	**.80**	(.85)											
3. Imp Con	**.77**	**.52**	(.78)										
4. Ind	**.63**	**.43**	**.46**	(.52)									
5. Rel	**.75**	**.54**	**.49**	**.51**	(.82)								
6. Con	**.66**	**.48**	**.44**	**.29**	**.46**	(.63)							
7. Peer-C	**.42**	**.35**	**.32**	.21	**.26**	**.42**	(.96)						
8. I_7	**−.25**	**−.18**	**−.41**	**−.17**	−.05	−.11	**−.30**	(.76)					
9. IMT	−.14	−.01	−.08	**−.21**	**−.28**	.11	−.09	−.01	–				
10. DMT	−.11	−.09	**−.18**	−.15	−.13	.05	.01	.11	**.59**	–			
11. GoStop Inh	**.18**	.10	.12	.15	.15	**.18**	.07	.00	−.12	−.07	–		
12.GoStop lat	.03	−.01	.08	−.03	−.01	.02	−.03	−.14	.00	−.05	**.45**	–	
13. IGT total	.03	−.01	**.21**	−.03	−.02	−.05	−.02	.02	−.14	−.18	.08	.10	–
14. IGT dif	.07	**.20**	**.18**	.03	.04	.03	.03	−.04	−.11	**−.19**	.01	−.04	**.80**

Note: C = conscientiousness; Ord = orderliness; Imp Con = impulse control; Ind = industriousness; Rel = reliability; Con = conventionality; Peer-C = peer-rated conscientiousness; I_7 = I_7 impulsiveness scale; IMT = immediate memory task; DMT = Delayed memory task; GoStop Inh = GoStop inhibition rates; GoStop lat = GoStop stop latency; IGT total = Iowa gambling task total dollars earned; IGT dif = Iowa gambling task number of advantageous deck choices minus disadvantageous deck choices; *N*'s range from 86 to 134; $p < .05$ in bold.

Table 2
Correlations between HBC domains and measures of impulse control.

	Wellness maintenance	Accident control	Traffic risk	Substance risk
C	**.20**	**.24**	**−.27**	−.17
Ord	.10	.14	**−.21**	.02
Imp con	.10	**.19**	**−.40**	**−.26**
Ind	**.37**	**.17**	**−.21**	−.06
Rel	**.17**	.15	−.11	−.09
Con	.16	**.23**	**−.23**	−.14
I_7	−.16	−.17	**−.37**	**−.31**
Peer-	.16	−.04	**−.34**	−.18
Peer-ord	.08	−.09	**−.22**	−.10
Peer-Imp con	.03	−.02	**−.39**	−.13
Peer-Ind	.16	−.10	**−.29**	−.07
Peer-Rel	.06	−.04	−.17	−.06
Peer-Con	.19	.10	**−.35**	**−.25**
IMT	−.14	.01	.05	**.19**
DMT	−.05	.06	.12	.02
GoStop inh	**.22**	.16	−.07	−.08
GoStop lat	.17	**.17**	.04	**−.21**
IGT total	−.04	−.13	−.04	−.08
IGT dif	.00	−.15	−.06	−.08

Note: C = conscientiousness; Ord = orderliness; Imp Con = impulse control; Ind = industriousness; Rel = reliability; Con = conventionality; Peer-C = peer-rated conscientiousness; I_7 = I_7 impulsiveness scale; IMT = immediate memory task; DMT = Delayed memory task; GoStop Inh = GoStop inhibition rates; GoStop lat = - GoStop stop latency; IGT total = Iowa gambling task total dollars earned; IGT dif = Iowa gambling task number of advantageous deck choices minus disadvantageous deck choices; *N*'s range from 81 to 131; $p < .05$ in bold.

laboratory measures would mediate the relation between personality measures of impulse control and health behaviors was clearly refuted. There was one case where mediation was possible involving self-reported conscientiousness, the go-stop task, and wellness maintenance. When HBC wellness maintenance was regressed on self-reported conscientiousness and GoStop inhibition rates the *R* for regression was .26. The standardized regression coefficients (β's) were .19 for GoStop inhibition rates, and .15 for self-reported conscientiousness (original $r = .20$). Given the correlation between self-reported conscientiousness and HBC wellness maintenance, the reduction of the effect of conscientiousness when GoStop commission errors were included in the regression suggested the possibility of mediation. Despite this, a formal test of mediation showed that the decrement in the prediction of the effect of conscientiousness was not statistically significant (sobel $z = 1.51$, $p > .05$).

Given the lack of evidence for mediation, we proceeded to test the complementary model by running regression analyses to find the optimal combination of predictors for each health behavior subscale. Regression analyses showing the best predictors for each of the four subscales are reported in Table 3. We achieved the best prediction with respect to wellness maintenance when HBC wellness maintenance was regressed on the industriousness facet of self-reported conscientiousness and GoStop inhibition rates. Thus, individuals making fewer GoStop commission errors also performed more health maintenance behaviors. Likewise individuals scoring higher on industriousness engaged in more of these behaviors as well.

HBC accident control was best predicted by the conventionality facet of our self-reported conscientiousness scale and stop latency on the GoStop task. Thus individuals who scored higher on the facet of conventionality were more likely to engage in behaviors that could reduce the likelihood of accidents and mitigate their severity. Likewise individuals who took longer to respond to a stop signal were more likely to engage in behaviors related to accident control.

The best predictors of HBC traffic risk were self-reported industriousness, peer-reported impulse control and the self-report I_7 impulsiveness scale. None of the laboratory measures contributed to the prediction of the traffic risk scores. Thus, individuals who rated themselves as more impulsive on the I_7, and lower on the industriousness facet of conscientiousness were more likely to engage in risky traffic behaviors. Likewise, individuals who were rated as more impulsive on the impulse control facet of conscientiousness by people who knew them well were likely to engage in these risky behaviors.

The best predictors of substance risk were I_7 impulsivity and GoStop stop latency. Thus participants who scored as more impulsive on I_7 impulsivity were also more likely to endorse behaviors relating to substance risk, while participants with longer stop latencies on the GoStop task were less likely to endorse such behaviors.

4.4. Discussion

We had originally proposed three models which could potentially explain the relationships between personality and laboratory measures of impulse control and health behaviors. First, we proposed that in the case of the interchangeable model, personality and laboratory measures of impulse control might be consistently correlated with each other and overlap in their ability to predict health behaviors. The interchangeable model is most consistent

Table 3
Multiple regression analyses showing the best predictors of the four domains of the HBC.

DV	IV	*F* (*df*)	*R*	*β*	*t*	*p*
Wellness maintenance		12.96 (2.128)	.41			.00
	GoStop inh			.17	2.07	.04
	Ind			.35	4.30	.00
Accident control		5.18 (2.128)	.27			.01
	GoStop lat			.17	1.99	.05
	Con			.21	2.50	.01
Traffic risk		10.03 (3.82)	.52			.00
	Peer-Imp			−.28	−2.69	.01
	ind			−.23	−2.35	.02
	I_7			.23	2.23	.03
Substance risk		8.68 (2.128)	.35			.00
	GoStop lat			−.17	−2.07	.04
	I_7			.28	3.28	.00

Note: GoStop Inh = GoStop inhibition rates; Ind = industriousness; GoStop lat = GoStop stop latency; Con = conventionality; Peer-Imp = peer-rated impulse control; I_7 = I_7 impulsiveness scale.

with the ways that both personality and behavioral measures of impulse control are defined. Additionally, if personality and laboratory measures of impulse control were consistently related to each other and to health behaviors, we might expect to find that behavioral measures of impulse control operate as a mediator between personality measures of impulse control and health behaviors. Finally, if personality and behavioral measures of inhibitory control were not consistently related, we would expect to find that they can operate as independent complementary predictors of health behaviors. Given that health behaviors fall into separate classes, it is also possible that the pattern of relationship varies depending on which class of health behaviors one employs as an outcome.

We found little or no evidence to support the interchangeable model. While there were some correlations between personality and behavioral measures of impulse control, these did not replicate across peer- and self-reports or across different personality scales. In the one case where a behavioral measure and a personality measure of impulse control were correlated with each other and a domain of health behaviors, entering them as simultaneous predictors in a multiple regression showed some overlap. Despite this there was no evidence that the behavioral measure mediated the relationship between the personality measure of impulse control and health behaviors. The lack of mediation we report should be viewed with some caution. Our measure of health behaviors and our facet level measures of personality showed low estimated reliabilities. This was especially true for the substance risk and accident control scales of the HBC. The low reliabilities of these measures likely attenuated our estimated effects, in turn making it more difficult to accurately evaluate the mediation hypotheses. Future research should attempt to measure these constructs more reliably.

Overall, the pattern across predictors supported the complimentary model. Indeed, the industriousness facet of conscientiousness operated as an independent predictor of HBC wellness maintenance when combined with GoStop inhibition rates. Likewise, with respect to HBC substance risk the I_7 impulsivity scale and GoStop stop latency both operated as independent predictors of HBC substance risk. There was no evidence that the behavioral measures mediated the relationship between self-reported personality and HBC substance risk. In the case of accident control, both the conventionality facet of self-reported conscientiousness and GoStop stop latency operated in parallel independent predictors.

For the remaining classes of health behaviors, laboratory measures of impulse control were not valuable predictors, while personality measures of impulse control were. Traffic risk was best predicted by a combination of self- and peer-reported personality measures. In every other case, peer-reports of personality closely mirrored self-reports. Traffic risk stands out as the one class of health behaviors where peer-reports contributed valuable information not contained in self-reports of personality.

When viewed as a whole, we can comment on which predictors were most suited to predicting health behaviors as a whole. Self-reported conscientiousness was the most consistent predictor of health behaviors. At the broadest level, self reported conscientiousness was related to three of the four health behaviors measured. In the case of the fourth, substance risk, the correlation was large enough to be almost statistically significant with our given sample size. This replicates previous well established results (Bogg & Roberts, 2004) and highlights the utility of conscientiousness as a broad and powerful predictor of consequential behavior. Furthermore, facet level predictors derived from this broad measure showed stronger correlations with specific health behaviors, highlighting the fidelity bandwidth trade off in personality measurement (Hogan & Roberts, 1996). In contrast, laboratory measures of impulse control were valuable predictors of only two classes of health behaviors, wellness maintenance and substance risk. Additionally, different behavioral measures of impulse control showed virtually no relationship with each other.

In the cases where behavioral measures were predictive of health behaviors, they either operated in a similar fashion to a specific facet of the personality measures used, or as completely distinct predictors. In contrast to the broad predictive ability of personality measures of impulse control, laboratory measures may offer a higher level of specificity when predicting health behaviors. This is consistent with the aims of many laboratory measures of impulse control, which are typically constructed to tap narrow behavioral examples of cognitive impulsivity. For example, if we compare the performance of the IMT and DMT, two very similar tasks, we can clearly see that the IMT was a more valuable predictor of health behaviors in this study. The DMT differs only slightly from the IMT, but in one important aspect, namely that it invokes working memory in a way that IMT does not. Further investigations may elucidate the degree to which these fine distinctions in laboratory measures of impulsivity have utility. In investigating processes involved carrying out very specific health behaviors researchers may be able to capitalize on discrete measures such as the GoStop or IMT/DMT. The value of such research depends partly on demonstrating how behavioral measures fit into a broader picture of impulse control.

Personality and laboratory measures of impulse control can be viewed hierarchically, where personality measures of conscientiousness and impulsivity cover a broad spectrum of thoughts, feelings, and behaviors relevant to impulse control, and discrete behavioral measures operate similarly to the discrete facets of this broad construct. Had we seen more consistent correlations among personality measures and laboratory measures of impulse control, the notion of hierarchical structure including both personality and behavioral measures would fit nicely. When considering the puzzling question as to why behavioral measures of impulse control were not consistently related to each other or to personality level measures, two possibilities are consistent with the results of this study. First, different behavioral measures of impulse control may represent specific aspects of impulsive behavior which are functionally distinct from the broad range of thoughts, feelings, and behaviors tapped by the personality measures we have employed. The hierarchy of impulse control would need to be broadened then to include these other elements. This interpretation is attractive given that the behavioral measures of impulse control we have employed are related to consequential outcomes, namely health behaviors, in precisely the manner that we would expect from measures of impulse control.

An alternate possibility is that these measures are valuable predictors of health behaviors because they represent a construct functionally distinct from that assessed by personality measures of impulse control. One likely candidate that involves speedy responses to novel stimuli and has established relationships with both health behaviors and longevity is fluid intelligence. Behavioral measures of impulse control are typically constructed to evaluate specific cognitive functions. A battery of diverse behavioral tests, some of which are similar to those employed here, has been shown to reliably estimate fluid intelligence (Higgins, Peterson, Pihl, & Lee, 2007). Conscientiousness and impulsivity assessed at the personality level are typically not correlated with general cognitive ability. Additionally, different discrete measures can contribute to estimating general cognitive ability while not showing high correlations with each other. If prediction of health behaviors from behavioral measures of impulse control does in fact represent a component of fluid intelligence, then the degree to which personality predicts health behaviors likely operates through different pathways, and will likely display different relationships with health behaviors and objective health outcomes over long spans of time. Mean levels of personality measures of impulse control increase with age, whereas fluid cognitive abilities appear to decline. Connections between discrete behavioral measures of impulse control and specific behaviors would then help explain the relationship between cognitive functioning and health and longevity. Future research that tests for the degree to which behavioral measures of impulsivity load on measures of fluid intelligence are needed to elucidate the degree to which these measures are actually representing impulse control at the personality level.

Impulse control is a broad construct that can be conceptualized at multiple levels each of which in turn operates across multiple behavioral domains. In the present study, we employed multiple personality and behavioral measures of impulse control as predictors of consequential health behaviors. Whether laboratory behavioral measures of impulse control are best represented as cognitive abilities or not, they clearly have consistent relationships with behaviors that lie within the broad spectrum of impulsivity. Indeed, many outcomes associated with cognitive ability are also linked with traditional personality measures of impulse control such as delinquency (White et al., 1994), longevity (Gottfredson & Deary, 2004), and job performance (Schmidt & Hunter, 2004). Research in impulse control is complicated both by the broad multilevel nature of the construct, and possible confusion when attempting to integrate both sets of predictors with respect to meaningful outcomes. The current research demonstrates both the broad predictive power of personality measures of impulse control, and also introduces the possibility of constructing better multivariate predictors of discrete health behaviors.

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