Self-report and behavioural approaches to the measurement of self-control: Are we assessing the same construct?

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Abstract

The capacity for self-control has been consistently linked to successful execution of health behaviour. However, a lack of consensus remains in the conceptualisation and measurement of the construct. Notably, self-report measures relate to behavioural measures of self-control only weakly or not at all. The aim of the current research was to examine the relationship between self-report and behavioural measures of self-control to determine whether these differentially relate to health behaviour. Participants (N=146) completed questionnaire and behavioural measures of self-control, and reported their physical activity. A direct effect of self-reported self-control on physical activity was observed, qualified by an interaction between self-reported self-control and behavioural measures, whereby greater self-reported self-control was associated with greater engagement in physical activity among those who performed poorly on the stop-signal task and those who performed well on the Stroop task. These results appear to indicate that the combination of trait self-control and behavioural factors leads to facilitative or debilitative effects on behaviour. Self-report and behavioural measures of self-control do not appear to assess the same element of self-control and should not be used interchangeably. It is suggested that these measurement modes reflect a difference between trait self-control and specific self-control processes.

Keywords: measurement of self-control; trait self-control; executive function; inhibition; self-regulation; physical activity

1. Introduction

Self-control refers to the ability to regulate cognition and behaviour in order to achieve long term goals (Baumeister, Vohs, & Tice, 2007). Individual differences in self-control have been shown to be important for the regulation of health behaviours including alcohol consumption, eating behaviour, and physical activity (de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Hagger, Wood, Stiff, & Chatzisarantis, 2010). However, conceptualisation and measurement of self-control varies greatly (Duckworth & Kern, 2011). Therefore, there is a need to examine the association between different measures of self-control, and how individual differences in these measures relate to health behaviour, in order to determine whether these measures are capturing the same construct, and if not, how they may differentially relate to health behaviour.

Common theoretical models of self-control take a dual process approach in which the roles of conscious and non-conscious processes are highlighted (Hofmann, Friese, & Strack, 2009; Strack & Deutsch, 2004). For example, Hofmann et al. (2009) suggest that self-control involves both explicit pursuit of long terms goals and implicit associative processes that promote resistance to temptation. While traditional dual process approaches suggest a conflict between these processes (Strack & Deutsch, 2004), current theorising suggests that these may act in tandem and that explicit and implicit processes operate in all stages of self-control (Fishbach & Shen, 2014). Given the complex and multi-faceted nature of self-control, it is unsurprising that there exist multiple means to assess self-control, and that these measures may not necessarily capture the same construct. In the current study the role of both explicit and implicit self-control is considered in an attempt to demonstrate that these processes are distinct.

Self-control is commonly conceptualised as a relatively broad and stable capacity assessed using self-report measures including the Tangney Self-Control Scale (Tangney, Baumeister, & Boone, 2004), and the Self-Regulation Questionnaire (Brown, Miller, & Lawendowski, 1999). Personality facets such as the self-discipline facet of the conscientiousness domain, specified within the Revised NEO Personality Inventory (Costa & McCrae, 1995), have also been used (Hoyle, 2006). A meta-analysis revealed that trait self-control and behavioural outcomes share a small-to-medium positive association (de Ridder et al., 2012); however, this relationship varied greatly according to the scale used. This finding demonstrates discrepancies in the relationship between self-control and behaviour even when conceptually and methodologically similar measures of self-control are used, and highlights the need to determine relations among such measures and health behaviour.

Self-control has also been conceptualised as a set of higher order neurocognitive processes that aid in overriding unwanted impulses (Hofmann, Schmeichel, & Baddeley, 2012; Miyake et al., 2000). Measures of self-control operationalised in this way include behavioural tasks such as the stop-signal task, which assesses response inhibition (Verbruggen & Logan, 2008), the Stroop task, which measures attention control (MacLeod & MacDonald, 2000), and the Iowa gambling task used to measure decision making (Bechara, Damasio, Damasio, & Anderson, 1994). While performance on these tasks has been shown to relate to heath behaviour (Allom, Mullan, & Hagger, in press), these measures may be subject to within-person differences in state self-control as often these tasks do not demonstrate good test-retest reliability (Wostmann, Aicherta, Costaa, Rubiab, & Mollera, 2013). As self-control capacity is hypothesised to be a finite resource that may fluctuate in strength depending upon environmental and task demands (i.e., ego-depletion), individuals may perform differently on behavioural measures of self-control over time (Baumeister et al., 2007; Hagger, Wood, Stiff, & Chatzisarantis, 2009).

Given the different conceptualisations and operationalisations of self-control, it should not be surprising that these measures do not correlate highly, or indeed at all. A meta-analysis of 236 studies revealed that self-report measures tended to have moderate convergent validity while behavioural measures demonstrated low convergent validity (Duckworth & Kern, 2011). Further, the relationship between self-report and behavioural measures was small (r = .10).

Similarly, Cyders and Coskunpinar (2011) conducted a meta-analysis of 27 studies comparting self-report and behavioural measures of impulsivity and failed to demonstrate a significant relationship between the two (r = 0.097), further demonstrating that self-report and behavioural measures of the same construct often do not relate. However, Sharma, Markon, and Clark (2014) suggested that this is not necessarily problematic when these measures are used to predict a third variable, namely; health behaviour. Given that self-report and behavioural measures do not share common-method variance any consistent relationship between these measures and behaviour is likely due to unique variance in each type of measure.

Further, given that the two measurement methods represent different elements of self-control, an interaction between self-report and behavioural measures of self-control may exist, and account for additional variance in health behaviour (Sharma et al., 2014). Sharma et al. (2014) base this assumption on their own observations and that of Baskin-Sommers et al. (2012), in which the tendency to exert self-control was facilitated among externalising individuals when attentional resources were also supported. Previous research has also indicated that people high in trait self-control are more capable of overriding their impulses, while poor self-control has been linked to impulse control disorders, and excessive food and alcohol consumption (Marteau & Hall, 2013; Tangney et al., 2004). As the behavioural tasks described previously tap processes such as response inhibition and attention control, which all require impulse control, it may be the case that these processes will moderate the relationship between trait self-control and health behaviour such that trait self-control facilitates the execution of health behaviour according to level of specific self-control processes.

The primary purpose of this study was to assess the pattern of relationships between self-report and behavioural measures of self-control, and the health-related behaviour of physical activity. Self-control plays a key role in physical activity as individuals need to defy the impulse to rest as soon fatigue or tiredness sets in and resist the temptation to engage in more attractive sedentary alternatives that are less effortful and physically demanding (Hagger et al., 2010). It was hypothesised that low self-reported self-control would result in lower levels of physical activity overall (Tangney et al., 2004). Secondly, it was hypothesised that behavioural measures will not relate to self-report measures. Thirdly, that particular processes captured by behavioural measures would directly relate to physical activity (Padilla, Perez, Andres, & Parmentier, 2013). Finally, an interaction between self-report and behavioural outcomes is hypothesised such that trait self-control may be differentially important for the execution of physical activity depending upon the level of particular self-control processes.

2. Method

2.1. Participants and Procedure

The sample consisted of 146 undergraduates from the University of [University name omitted for masked review, name will be included post-review], United Kingdom (*M* age = 23.43, *SD* = 6.26, range 18-52) who received US$5 for participation and were recruited using flyers circulated on the noticeboards of clubs and societies and student information noticeboards in academic Schools, email lists of students supplied by the academic departments of the University, and an online research participation scheme involving all students from the University Department of Psychology who participate in studies for course credit. After providing informed consent, participants completed three self-report measures of self-control, a self-report measure of physical activity, and computerised versions of the stop-signal, Stroop and Iowa gambling tasks. To ensure maximum quality of data, participants completed measures in a sound-proof experimental cubicle while the researcher waited outside. One participant was excluded due to a colour vision deficiency. The study took 30 minutes, and participants were debriefed.

2.2. Measures

2.2.1. Self-reported self-control

Participants completed the brief 13-item Tangney self-control scale (Tangney et al., 2004), the 63-item Self-Regulation Questionnaire (Brown et al., 1999), and the 10-item self-discipline facet of the conscientiousness domain of the Revised NEO Personality Inventory (Costa & McCrae, 1995), with higher scores on each indicative of better self-control. The Tangney self-control scale included items such as: “I am good at resisting temptation”, and demonstrated good reliability, $\alpha = .84$. Responses were made on five-point Likert scales ranging from 1 (not at all like me) to 5 (very much like me). The Self-Regulation Questionnaire included items such as: “I have a lot of will power”, and demonstrated good reliability, $\alpha = .89$. Responses were made on five-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree). The self-discipline facet included items such as: “I start tasks right away”, and demonstrated good reliability, $\alpha = .83$, with responses made on five-point Likert scales ranging from 1 (inaccurate) to 5 (very accurate).

2.2.2. Behavioural tasks

The stop-signal task comprised of ‘go’ and ‘stop’ trials. During the ‘go’ trials, participants discriminate between square and circle images presented in the centre of a computer screen for 1000ms by pressing a left-hand key for square and a right-hand key for circle. On ‘stop’ trials (25%), participants were instructed to inhibit this response if they heard a tone, which was initially presented 250ms after visual stimuli and then varied by 50ms, increasing after successful inhibition of response or decreasing after unsuccessful inhibition. The task consisted of 32 practice trials and three experimental blocks of 64 trials with a 10-second interval between each block. The stop-signal reaction time (SSRT) was used to measure response inhibition with longer SSRT times indicating lower response inhibition and therefore poorer self-control (Verbruggen & Logan, 2008).

The Stroop task required participants to name the ink colour of words (i.e., “red”, “blue”) by pressing a key corresponding to that colour. Both congruent (matched ink colour and name of colour) and incongruent (mismatched ink colour and name of colour) stimuli were presented. The task consisted of 12 practice trials and 48 experimental trials. Attention control was assessed using the Stroop interference score, where the difference in reaction time between congruent and incongruent trials is calculated, and a lower interference score indicated greater self-control (MacLeod & MacDonald, 2000).

In the Iowa gambling task (Bechara et al., 1994) participants received a 'virtual' sum of $2000 and were invited to maximise their profit by selecting a card from any of four decks on the screen. Two decks were "disadvantageous" and provided an immediate large gain ($100) but a loss of $250 after 10 selections, and two decks were "advantageous" and provided an immediate lower reward ($50) but after 10 selections they earned $250. The percentage of advantageous choices across 100 trials was used to index decision making, where a higher proportion indicated greater self-control.

2.2.3. Physical activity

Self-reported physical activity was measured by two items: "In the course of the past four weeks, how often have you participated in vigorous exercise for 20 minutes at a time?", rated on a five-point Likert scale ranging from 1 (a few times) to 5 (every day), and "I have participated in vigorous exercise for 20 minutes at a time the past four weeks with the following regularity:" answered on a five-point Likert scale ranging from 1 (never) to 5 (most days). These items have demonstrated adequate concurrent validity with more objective measures of physical activity (Godin & Shephard, 1985), and adequate reliability, $\rho = .86$.

3. Results

3.1. Relations among Study Variables

Means, standard deviations and correlation coefficients between all measures are displayed in Table 1. Analyses revealed strong inter-correlations among the self-report measures and to physical activity such that greater self-reported self-control capacity was associated with greater physical activity. No behavioural measures correlated with physical activity. There was a theoretically consistent set of inter-correlations among behavioural measures such that Stroop performance was related to both stop-signal and Iowa gambling task performance. However, the latter two measures were unrelated. Finally, Iowa gambling task performance was related to responses on the self-regulation questionnaire, such that better decision making was associated with greater self-reported self-control.

Insert Table 1 near here

3.2. Regression Analyses

A hierarchical regression analysis was conducted using physical activity as the dependent variable. All independent variables were standardised prior to the calculation of interaction terms, and these standardised variables were used in the regression analysis. Sex and age were entered in the first step of the analysis as control variables as previous research has demonstrated differences in self-control measures and outcomes based on these factors (Byrnes, Miller, & Schafer, 1999; Hall, 2012). Self-reported self-control was entered in the second step as the average of the three standardised scales. Behavioural measures of self-control were entered in the third step, and the interactions between the self-control composite and each behavioural measure were entered in the final step[1].

Scores on the self-control composite measure were significantly related to physical activity, $\beta = .208$, $t = 2.567$, $p = .011$ and accounted for 4.3% of variance, $\Delta F(1, 142) = 6.590$, $p = .011$, above control variables. Behavioural measures of self-control did not add significantly to the explained variance in step 3, and none of the behavioural measures were independently related to physical activity. In the final step, the interaction terms for stop-signal task performance, $\beta = .204$, $t = 2.499$, $p = .014$, and Stroop interference, $\beta = -.247$, $t = -3.013$, *p*

[1]We found no statistically significant correlations among the behavioural measures of self-control (Iowa Gambling Task score, Stroop interference score, SSRT) and physical activity behaviour, which supported our premise that these tasks may tap different components of self-control. This led us to hypothesize that the effects of the different types of behavioural components of self-control may interact with each other, in addition to our a priori hypothesis of interactions of the behavioural measures with self-reported trait self-control. We therefore conducted a post-hoc moderated linear regression analysis in which the main and two-way interactive effects of the three behavioural self-control measures served as predictors of physical activity. The analyses revealed no statistically significant two-way interaction effects leading us to conclude that the behavioural measures did not interact with each other and that the interactive effects with trait self-control are unique to each behavioural measure.

= .003 with self-reported self-control accounted for an additional 9.3% of variance, $\Delta F(3, 136) = 5.140$, $p = .002$. The final model explained 17.7% of the variance in physical activity behaviour, $F(9, 136) = 5.591$, $p = .001$, and self-reported self-control remained a significant predictor in the final model, $\beta = .231$, $t = 2.833$, $p = .005$.

Insert Table 2 near here

Simple slope analyses were conducted in accordance with Aiken and West (1991) to explore the interaction effects revealing that scores on the composite self-control measure were not associated with physical activity for those who performed well on the stop-signal task (i.e., low SSRT- 1*SD* below mean), $\beta = .027$, $t = .182$, $p = .856$. Conversely, for those who performed poorly on the stop-signal task (i.e., high SSRT- 1*SD* above the mean), self-control was associated with physical activity such that those who reported low self-control tended to report less engagement in physical activity, $\beta = .435$, $t = 2.511$, $p = .013$; see Figure 1A. Secondly, for those who performed poorly on the Stroop task (i.e., high interference- 1*SD* above the mean), self-control was not associated with physical activity, $\beta = -.016$, $t = -.103$, $p = .9919$. However, for those who performed well on the Stroop task (i.e., low interference- 1*SD* below the mean), self-control was associated with physical activity such that those who reported high self-control were more likely to engage in physical activity, $\beta = .478$, $t = 2.986$, $p = .003$; see Figure 1B.

Insert Figure 1 near here

4. Discussion

The aim of the current study was to examine the relationship between self-report and behavioural measures of self-control and physical activity. Strong correlations between self-report measures of self-control were found, and these measures were associated with physical activity. No behavioural measures were directly related to physical activity; however, stop-signal and Stroop task performance were associated, and Iowa gambling task performance was related to scores on the self-regulation questionnaire. Two interaction effects between self-report and behavioural measures were observed. Scores on the stop-signal and Stroop tasks moderated the relationship between self-reported self-control and physical activity such that greater self-control was associated with greater engagement in physical activity among those who performed poorly on the stop-signal task, and among those who performed well on the Stroop task.

Consistent with previous research, a direct positive relationship between self-reported self-control and physical activity was found, suggesting that individuals higher in trait self-control are more likely to engage in health-protective behaviours (Tangney et al., 2004). No significant direct relationships were found between behavioural tasks and physical activity measures, in contrast to previous research on physical activity using these tasks (Joyce, Graydon, McMorris, & Davranche, 2009). It may be that there are self-control processes other than those measured in the current study that are more consistently related to physical activity. It has been demonstrated that inhibitory processes have a stronger relationship to behaviours that require an avoidance response, rather than those that require an approach response (Allom & Mullan, 2014). Although engaging in physical activity involves resisting the temptation to perform more enjoyable and less effortful activities, this behaviour primarily requires the activation of a response. Thus, self-control tasks that measure approach processes such as planning may be more relevant to this behaviour.

Self-report measures of self-control correlated strongly, consistent with results of a meta-analysis that demonstrated moderate convergent validity of these measures (Duckworth & Kern, 2011). Behavioural measures of self-control were weakly related or not at all, which was also in line with previous results (Duckworth & Kern, 2011), and suggests that these measures assess distinct processes (Hofmann et al., 2012). However, there was some overlap between the Stroop task and both the stop-signal and Iowa gambling tasks. While the Stroop task has been hypothesised to measure attention control (MacLeod & MacDonald, 2000), previous research has also suggested that this task is a ‘complex’ self-control task in that it may be assessing more than one process (Miyake et al., 2000).

As expected, there was little overlap between self-report and behavioural measures of self-control. This is similar to findings in the impulsivity literature, which demonstrate that while there is conceptual overlap between self-report and behavioural measures of impulse control these measures are not identical or interchangeable (Caswell, Bond, Duka, & Morgan, 2015; Sharma et al., 2014). It is suggested that behavioural measures assess particular self-control processes particularly that related to resisting temptation, whereas self-report measures reflect trait self-control: an individual’s general tendency to effortfully exert self-control across a variety of situations and contexts. This lends support to dual process theories of self-control that suggest the role of both explicit and implicit processes in the regulation of behaviour (Hofmann et al., 2009).

Scores on the self-control composite measure were only related to physical activity among those who performed poorly on the stop-signal task. This indicated that for those who were unable to inhibit a pre-potent, undesired response and were concomitantly low in trait self-control were less likely to engage in physical activity. Taking a dual-process approach to self-control, these results clarify the relationship between the two sets of processes indicating that effortful self-control is hindered by poor response inhibition. In contrast, scores on the self-control scale were only related to physical activity for those who performed well on the Stroop task. These findings indicate the potential for a facilitative effect of high attentional control and effortful self-control on health behaviours. Overall, these results suggest that specific behavioural self-control factors, reflecting implicit processes, will moderate the effect of trait self-control resulting in debilitative or facilitative effects on behaviours requiring self-control (c.f., Zabelina, Robinson, & Anicha, 2007). However, the fact that we found these effects in a single behavioural domain means that they should be treated as preliminary.

Galla and Duckworth (2015) demonstrated that the relationship between trait self-control and the amount of effortful inhibition required to perform a health behaviour was mediated by beneficial habits. This finding suggested that individuals high in trait self-control require less effortful inhibition to execute behaviour as they rely on beneficial habits. In the current study, trait self-control was shown to be comparatively related to health behaviour depending upon individual differences in specific inhibitory processes. While it was demonstrated that these individuals have a greater inhibitory capacity, we cannot determine whether they need to exercise this ability, or whether they rely on beneficial habits, to engage in health behaviour. Future research should include measures of automaticity and amount of inhibitory effort required to engage in behaviour to clarify whether those high in both trait self-control and inhibitory processes are more successful at executing behaviour due to reliance on habitual action or inhibitory effort.

4.1. Limitations

The correlational design represents the most substantive limitation of the current study. A prominent problem with all correlational designs is that causal relationships cannot be inferred. While we hypothesised predictive main and interactive effects of the behavioural and self-control constructs on physical activity based on theory, an equally plausible alternative model from a statistical would be to examine effects of the behaviour on the self-control measures. However, that model, theoretically plausible or otherwise, would also have no basis on which to infer causality. Adoption alternative designs in future studies would provide some resolution to the causal nature of the proposed effects. For example, a cross-lagged panel design in which the behavioural and self-control measures were measured at two points in time and the reciprocal relations among the variables tested would permit the directional nature of effects to be better inferred. In addition, there is some preliminary evidence to indicate causal relationships between some of the self-control behavioural measures and physical activity using experimental designs (Bray, Graham, & Saville, 2015; Joyce et al., 2009). It would be beneficial to experimentally manipulate these variables in order to confirm the directional nature of the observed relationships. In addition, replication in other domains is needed to provide converging evidence for the behavioural and trait self-control interactive effects on health behaviours. It is especially important to examine these findings in light of behaviours that require an inhibitory response (e.g., refraining from eating too much food, resisting the temptation to drink alcohol or smoke cigarettes) rather than an engagement response. Further, it is suggested that performance on behavioural measures of self-control may be subject to within-person differences in self-control. Given this, it may be beneficial to administer these tasks several times, or controlling for external influences such as mood, in order to accurately gauge individual differences in these self-control processes.

4.2. Conclusions

The results of the current study shed light on the relationship between self-report and behavioural measures of self-control, and their relationship to physical activity. It appears that self-report measures assess a trait-like self-control capacity that is directly related to engagement in physical activity, while behavioural measures assess distinct self-control processes that qualify the relationship between general self-control capacity and physical activity behaviour. The interaction between these measures demonstrates that the combination of trait self-control and behavioural inhibition factors lead to facilitative or debilitative effects on self-control behaviours. It is recommended that future research uses both types of measures in order to attain a more accurate understanding of the relationship between self-control and health behaviour.

References

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, London: Sage.

Allom, V., & Mullan, B. (2014). Individual differences in executive function predict distinct eating behaviours. *Appetite, 80*, 123-130. doi: 10.1016/j.appet.2014.05.007

Allom, V., Mullan, B., & Hagger, M. S. (in press). Does Inhibitory Control Training Improve Health Behaviour? A Meta-Analysis. *Health Psychology Review, accepted 07-May-2015*.

Baskin-Sommers, A. R., Curtin, J. J., Larson, C. L., Stout, D., Kiehl, K. A., & Newman, J. P. (2012). Characterizing the anomalous cognition–emotion interactions in externalizing. *Biological psychology, 91*, 48-58.

Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science, 16*, 351-355. doi: 10.1111/j.1467-8721.2007.00534.x

Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition, 50*, 7-15. doi: 10.1016/0010-0277(94)90018-3

Bray, S. R., Graham, J. D., & Saville, P. D. (2015). Self-control training leads to enhanced cardiovascular exercise performance. *Journal of sports sciences, 33*, 534-543. doi: 10.1080/02640414.2014.949830

Brown, J. M., Miller, W. R., & Lawendowski, L. A. (1999). The self-regulation questionnaire. In L. VandeCreek & T. L. Jackson (Eds.), *Innovations in clinical practice: A source book* (Vol. 17, pp. 281-292). Sarasota, FL: Professional Resource Press.

Byrnes, J. P., Miller, D. C., & Schafer, W. D. (1999). Gender differences in risk taking: A meta-analysis. *Psychological bulletin, 125*, 367. doi: 10.1037/0033-2909.125.3.367

Caswell, A. J., Bond, R., Duka, T., & Morgan, M. J. (2015). Further evidence of the heterogeneous nature of impulsivity. *Personality and Individual Differences, 76*, 68-74. doi: 10.1016/j.paid.2014.11.059

Costa, P. T., & McCrae, R. R. (1995). Domains and facets: Hierarchical personality assessment using the Revised NEO Personality Inventory. *Journal of personality assessment, 64*, 21-50. doi: 10.1207/s15327752jpa6401_2

Cyders, M. A., & Coskunpinar, A. (2011). Measurement of constructs using self-report and behavioral lab tasks: Is there overlap in nomothetic span and construct representation for impulsivity? *Clinical Psychology Review, 31*, 965-982. doi: 10.1016/j.cpr.2011.06.001

de Ridder, D., Lensvelt-Mulders, G., Finkenauer, C., Stok, F. M., & Baumeister, R. F. (2012). Taking stock of self-control: A meta-analysis of how trait self-control relates to a wide range of behaviors. *Personality and Social Psychology Review, 16*, 76-99. doi: 10.1177/1088868311418749

Duckworth, A. L., & Kern, M. L. (2011). A meta-analysis of the convergent validity of self-control measures. *Journal of Research in Personality, 45*, 259-268. doi: 10.1016/j.jrp.2011.02.004

Fishbach, A., & Shen, L. (2014). The explicit and implicit ways of overcoming temptation. In J. W. Sherman, B. Gawronski & Y. Trope (Eds.), *Dual Process Theories in the Social Mind* (pp. 454-467). New York: NY: The Guilford Press.

Galla, B. M., & Duckworth, A. L. (2015). More Than Resisting Temptation: Beneficial Habits Mediate the Relationship Between Self-Control and Positive Life Outcomes. *Journal of Personality and Social Psychology, 109*, 508-525. doi: http://dx.doi.org/10.1037/pspp0000026

Godin, G., & Shephard, R. (1985). A simple method to assess exercise behavior in the community. *Canadian journal of applied sport sciences, 10*, 141-146.

Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2009). The strength model of self-regulation failure and health-related behaviour. *Health Psychology Review, 3*, 208-238. doi: 10.1080/17437190903414387

Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2010). Self-regulation and self-control in exercise: The strength-energy model. *International Review of Sport and Exercise Psychology, 3*, 62-86. doi: 10.1080/17509840903322815

Hall, P. A. (2012). Executive control resources and frequency of fatty food consumption: Findings from an age-stratified community sample. *Health Psychology, 31*, 235-241. doi: 10.1037/a0025407

Hofmann, W., Friese, M., & Strack, F. (2009). Impulse and Self-Control From a Dual-Systems Perspective. *Perspectives on Psychological Science, 4*, 162-176.

Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in cognitive sciences, 16*, 174-180. doi: 10.1016/j.tics.2012.01.006

Hoyle, R. H. (2006). Personality and Self-Regulation: Trait and Information-Processing Perspectives. *Journal of personality, 74*, 1507-1526. doi: 10.1111/j.1467-6494.2006.00418.x

Joyce, J., Graydon, J., McMorris, T., & Davranche, K. (2009). The time course effect of moderate intensity exercise on response execution and response inhibition. *Brain and Cognition, 71*, 14-19. doi: 10.1016/j.bandc.2009.03.004

MacLeod, C. M., & MacDonald, P. A. (2000). Interdimensional interference in the Stroop effect: Uncovering the cognitive and neural anatomy of attention. *Trends in cognitive sciences, 4,* 383-391. doi: 10.1016/S1364-6613(00)01530-8

Marteau, T. M., & Hall, P. A. (2013). Breadlines, brains, and behaviour. *British Medical Journal, 347,* f6750. doi: 10.1136/bmj.f6750

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive psychology, 41*, 49-100. doi: 10.1006/cogp.1999.0734

Padilla, C., Perez, L., Andres, P., & Parmentier, F. B. (2013). Exercise improves cognitive control: evidence from the stop signal task. *Applied Cognitive Psychology, 27*, 505-511. doi: 10.1002/acp.2929

Sharma, L., Markon, K. E., & Clark, L. A. (2014). Toward a theory of distinct types of “impulsive” behaviors: A meta-analysis of self-report and behavioral measures. *Psychological bulletin, 140*, 374. doi: 10.1037/a0034418

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review, 8*, 220-247.

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of personality, 72*, 271-324. doi: 10.1111/j.0022-3506.2004.00263.x

Verbruggen, F., & Logan, G. D. (2008). Automatic and controlled response inhibition: Associative learning in the go/no-go and stop-signal paradigms. *Journal of Experimental Psychology: General, 137*, 649-672. doi: 10.1037/a0013170

Wostmann, N. M., Aicherta, D. S., Costaa, A., Rubiab, K., & Mollera, H.-J. (2013). Reliability and plasticity of response inhibition and interference control. *Brain and Cognition, 81*, 82-94. doi: 10.1016/j.bandc.2012.09.010

Zabelina, D. L., Robinson, M. D., & Anicha, C. L. (2007). The psychological tradeoffs of self-control: A multi-method investigation. *Personality and Individual Differences, 43*, 463-473. doi: 10.1016/j.paid.2006.12.015

Tables

Table 1

Means, Standard Deviations, Pearson Correlation Coefficients between Self-Reported and Behavioural Measures of Self-Control, and Physical Activity

Variable	1	2	3	4	5	6	7	8
1. PA	–							
2. SCS	.162*	–						
3. SRQ	.163*	.610**	–					
4. NEO-C	.177*	.594**	.605**	–				
5. SC	.195*	.857**	.861**	.855**	–			
6. SSRT	.004	.067	.012	.049	.050	–		
7. Stroop	-.058	-.033	-.067	.045	-.022	.182*	–	
8. IGT	.021	.157	.217**	.083	.178*	-.127	-.213**	–
M	2.808	3.194	3.508	3.270	0.000	277.091	1414.158	58.687
SD	1.401	0.639	0.338	0.804	0.858	67.105	227.709	22.668

Note. PA = Physical activity; SCS = Tangney Self-Control Scale; SRQ = Self-Regulation Questionnaire; NEO-C = Self-Discipline; SC = self-control composite measure – average of standardised scores on SCS, SRQ, NEO-C; SSRT = Stop-signal reaction time; Stroop = Stroop interference score; IGT = Iowa gambling task score. $^{*}p < .05$; $^{**}p < .01$.

Table 2

Hierarchical Regression Analysis for Physical Activity

	Step 1			Step 2			Step 3			Step 4		
	β	ΔR^2	Δ*F*	β	ΔR^2	Δ*F*	β	ΔR^2	Δ*F*	β	ΔR^2	Δ*F*
Sex	.179*	.039	2.879	.200*	.043	6.659*	.207*	.002	.107	.149	.093	5.140**
Age	.055			.034			.032			.024		
SC				.208*			.210*			.231**		
SSRT							-.046			-.078		
Stroop							-.011			-.029		
IGT							.008			-.014		
SCxSSRT										.204*		
SCxStroop										-.247**		
SCxIGT										-.019		

Note. SC = Self-control composite measure; SSRT = Stop-signal reaction time- score on stop-signal task Stroop = Stroop interference score; IGT = Iowa gambling task score; SCxSSRT = interaction between SC and SSRT; SCxStroop = interaction between SC and Stroop; SCxIGT = interaction between SC and IGT. β = standardised regression coefficients. Intercept = 2.523; overall R^2 = .177, *p < .05; **p < .01.

Figure Caption

Figure 1. Interaction between self-reported self-control, and Stop Signal Task performance (SSRT; Panel A), and Stroop Task performance (Interference; Panel B). For both SSRT and Interference- higher scores indicate poorer performance, and lower levels of response inhibition and attention control respectively. Simple slopes plot the association between self-reported self-control and physical activity separately for high (1*SD* above the mean) and low (1*SD* below the mean) levels of each moderator.

Fig. 1A

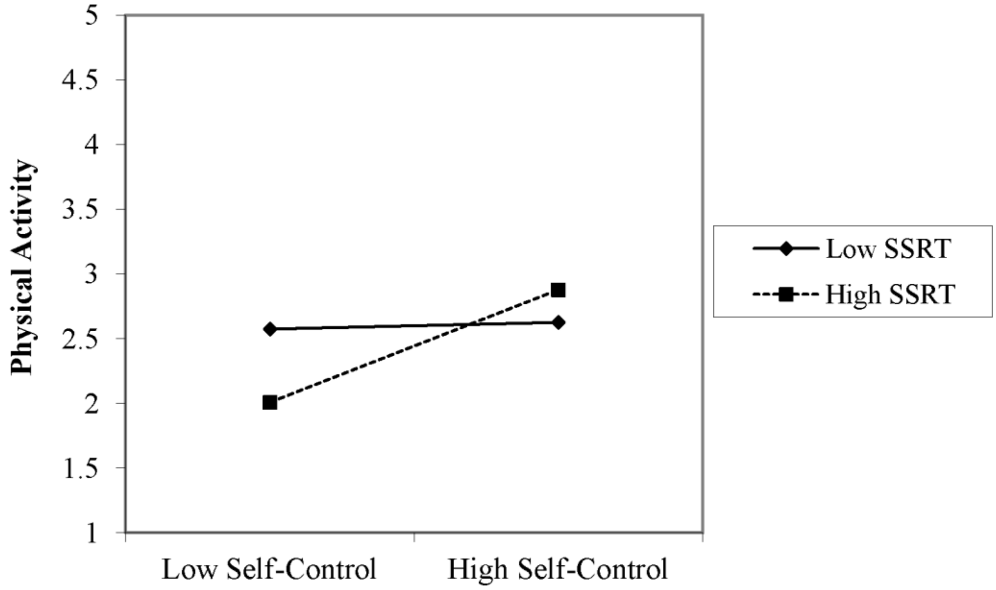
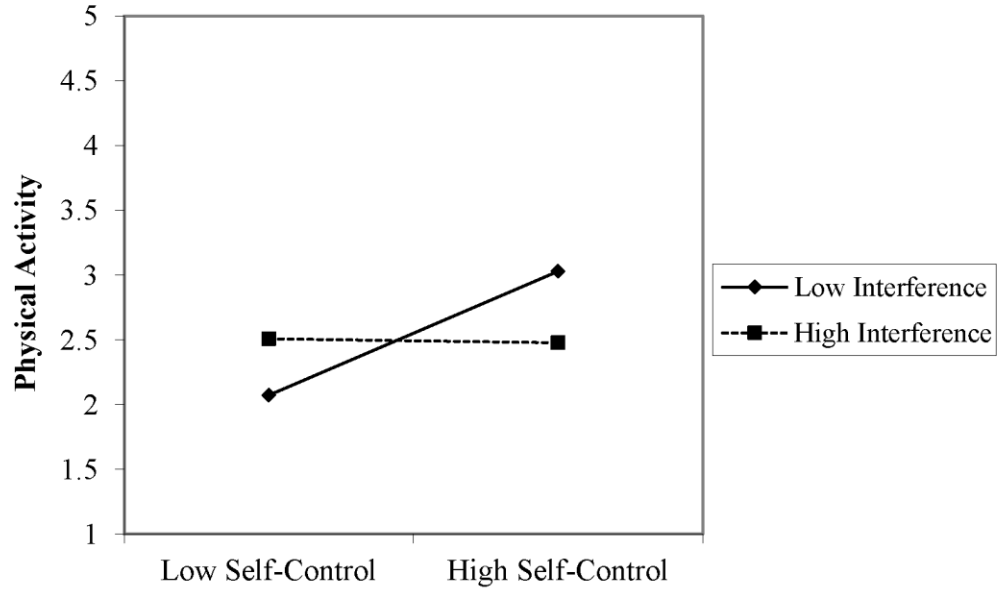

5
4.5
4
3.5
3
2.5
2
1.5
1
Physical Activity
Low Self-Control
High Self-Control
Low SSRT
High SSRT

Fig. 1B


5
4.5
4
3.5
3
2.5
2
1.5
1
Physical Activity
Low Self-Control
High Self-Control
Low Interference
High Interference