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# The personality-related implications of Stroop performance: Stress-contingent self-control in daily life

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ABSTRACT

People with higher levels of executive control, relative to low levels, should be more capable of responding to the problems and stressors of their lives, yet we know very little concerning this lab-to-life interface. Two studies (total $N = 254$) sought to speak to questions of this type using the Stroop task, a classic measure of executive control. Individual differences in Stroop costs were assessed in the laboratory, following which the same people completed daily diary protocols for two weeks. Consistent with neurocognitive theories of executive control, both studies found that people capable of overriding the Stroop effect tended to recruit self-control in response to the stressful circumstances of their lives. By contrast, people with high Stroop costs did not exhibit this problem-focused form of recruitment. The findings extend our knowledge of individual differences in executive control and the manner in which they operate in daily life.



## 1. Introduction

Some people respond to the stresses and strains of their lives better than others. In the domain of major life events, serious traumas such as the death of a spouse destabilize the lives of about half of the population, but not the other half (Mancini & Bonanno, 2009). Similar dynamics characterize responses to more minor stressors. Some people become disorganized or apathetic when stressors happen, but others become energized and capable (Kuhl, 2000).

One useful way of thinking about these individual differences is in terms of ego-resiliency (Block & Block, 1980). Different situations call for different actions and the ego-resilient person is one who can flexibility adapt to the circumstances at hand, whether stressful or not (Block & Block, 2006). By contrast, the non-resilient person is someone who does not modify his or her level of control to suit the situation and is therefore seriously disadvantaged when non-habitual ways of responding are called for (Block & Block, 2006).

As Block (e.g., Block & Kremen, 1996) has pointed out, there should be some relationship between ego-resiliency and executive control, at least at the construct level. Habitual ways of responding sometimes serve the self, but they sometimes do not (Norman & Shallice, 1986). Executive control is instantiated when people override habitual ways of thinking or responding when the situation calls for doing so (Diamond, 2013; Goldberg, 2001). Because flexible goal-directed responding should tend to be adaptive, people higher in executive control, much like people higher in ego-resiliency, should be at an advantage when the situation is difficult or requires one to override response tendencies that are not working (Banich, 2009; Block & Kremen, 1996; Diamond, 2013).

Thus, higher levels of executive control should be beneficial (Diamond, 2013), just as higher levels of ego-resiliency tend to be (Block & Block, 2006). There is some support for such ideas, though (in some ways) relevant data are just emerging (Hofmann, Schmeichel, & Baddeley, 2012). People with higher levels of working memory capacity, who are capable of retaining information in working memory while performing other tasks (Conway & Engle, 1996), are less prone to mind-wandering, particularly under stressful or challenging circumstances (Kane et al., 2007). Working memory capacity also seems to benefit emotion regulation and self-regulation as well (Hofmann, Schmeichel, et al., 2012). In the latter case, for example, one study found that people with higher levels of working memory capacity were more capable of resisting tempting food when they had the goal of doing so (Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008).

Perhaps a larger body of work has focused on inhibitory abilities, which can be assessed in tasks like the Stroop task that require

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people to override dominant ways of responding (Miyake et al., 2000). Frontal lobe damage leads to difficulties in response inhibition (Stuss, Floden, Alexander, Levine, & Katz, 2001). Moreover, inhibitory deficits have been found in a number of clinical conditions such as attention deficit hyperactivity disorder (Nigg, 2001), obsessive-compulsive disorder (Enright & Beech, 1993), schizophrenia (Nestor & O'Donnell, 1998), and psychopathy (Morgan & Lilienfeld, 2000). Within normal populations, too, individual differences in inhibitory ability seem consequential. Young et al. (2009) found that people with poorer inhibitory abilities were more prone to disinhibited behavior like substance use and conduct disorder and several studies have linked inhibitory abilities to better self-regulation (Hofmann, Schmeichel, et al., 2012). For example, Pronk, Karremans, and Wigboldus (2011) showed that people with higher Stroop costs were more tempted by attractive strangers despite their committed relationships (also see Houben & Wiers, 2009; von Hippel & Gonsalkorale, 2005).

Even so, executive functions in general, and inhibitory abilities in particular, do not seem to consistently map onto the major dimensions of intelligence or personality. Considering intelligence first, Friedman et al. (2006) found no relationship between inhibitory abilities and either fluid intelligence or crystalized intelligence. Of more interest are possible correlations with personality. Enticott, Ogloff, and Bradshaw (2006) reported positive correlations between Stroop costs and self-reported impulsivity, but the sample size of this study was small. Jensen-Campbell et al. (2002) expected negative relationships between agreeableness and conscientiousness, as possible manifestations of effortful control (Rothbart, Sheese, & Posner, 2007), and the magnitude of Stroop interference. They found a significant relationship of this type for agreeableness, but not conscientiousness. However, Murdock, Oddi, and Bridgett (2013) found no relationships between inhibitory control and any of the traits of the Big 5 and Fleming, Heintzelman, and Bartholow (2016) similarly report no correlations between any of the Big 5 traits and the magnitude of the Stroop effect. Thus, it appears difficult to find consistent personality-related correlates of Stroop performance (Jensen & Rohwer, 1966).

Regardless, individual differences in Stroop magnitude are reliable (Bender, Filmer, Garner, Naughtin, & Dux, 2016) as well as moderately heritable (Johnson, Bouchard, Segal, Keyes, & Samuels, 2003). People who have difficulty with the Stroop task also have difficulty with other cognitive control tasks (Miyake et al., 2000) and they tend to score lower in working memory capacity (Kane & Engle, 2003). Further, investigators have shown that individual differences in Stroop performance can predict real-world behaviors such as problematic drinking (Houben & Wiers, 2009), giving into temptation (Hofmann, Adriaanse, Vohs, & Baumeister, 2014), or socially inappropriate expressions (von Hippel & Gonsalkorale, 2005). Given this constellation of findings, we could consider the Stroop task as an implicit measure of personality (Robinson & Wilkowski, 2015): It is a process-oriented assessment, with marked individual differences, that seems to predict real-world outcomes despite modest or non-existent relationships with explicit, self-reported personality traits.

Establishing what an implicit measure of personality does is not necessarily an easy task. Continuing to correlate the measure with explicit measures of personality can be a futile exercise, especially when such correlations seem to be modest at best. This appears to be true with respect to the Stroop color-word task (Duckworth & Kern, 2011; Fleming et al., 2016). In this sort of context, Robinson and colleagues have advocated the use of daily diary designs (Robinson & Wilkowski, 2015). Such designs can show that implicit measures of personality predict daily functioning despite modest, or even non-existent, correlations with explicit personality traits (e.g., Robinson & Liu, 2013; Wilkowski, Robinson, & Troop-Gordon, 2010). The present studies sought to apply this method in understanding key differences between people capable of overriding the Stroop effect versus not capable of doing so.

### 1.1. The Stroop effect: A self-control recruitment analysis

The Stroop task asks people to categorize words by font color and the Stroop effect emerges from the difference between congruent and incongruent conditions (MacLeod, 1991). In the congruent condition, the words and font colors match (e.g., the word "red" in a red font color) and the task is relatively easy. In the incongruent condition, by contrast, the words and font colors mismatch (e.g., the word "green" in a red font color) and the task is comparably harder (Bugg, 2012). People must override word meaning in the second condition and this requires cognitive control (Bugg, 2012) of an inhibition-related type (Miyake et al., 2000).

From a neurocognitive perspective, reducing Stroop costs would seem to require at least two skills or mechanisms (van Veen & Carter, 2006). One must be sensitive to problematic, conflicting stimuli. In the neurocognitive literature, this can be termed a *monitoring* process and its locus appears to be the anterior cingulate cortex (Botvinick, 2007). Once a conflict is detected, the person needs to recruit resources to override the conflicting response (triggered by word reading) in favor of the correct response (reflecting font color). In neurocognitive models, this second process can be termed an *operating* process and its instantiation relies on regions of the prefrontal cortex (Braver, 2012). If these processes are performing their functions effectively, Stroop costs can be substantially reduced if not eliminated (Chuderski & Smolen, 2016).

Although it makes theoretical sense to distinguish the monitoring and operating processes, they typically work in concert with each other (van Veen & Carter, 2006). That is, greater attunement to conflict means that the person will typically recruit executive resources under the right circumstances (Lieberman & Eisenberger, 2005). Thus, we can think of Stroop costs in terms of executive control *recruitment*. People who are capable of mitigating the Stroop effect presumably recruit executive control precisely when it is needed – namely, under problematic conditions or those of conflict (Robinson, Schmeichel, & Inzlicht, 2010). People with high Stroop costs do not, thus rendering them ineffectual on those trials on which their automatic habits will not serve them.

This recruitment-based model should have systematic implications for the manner in which people recruit self-control in everyday life. People with smaller Stroop costs, we propose, should tend to recruit self-control on days on which they encounter problems or stressors. By this reasoning, the conflicts present in the Stroop task can be mapped onto stressors present in daily life (Compton et al., 2008). By contrast, this problem-sensitive form of recruitment should be less pronounced among people with high Stroop costs, precisely because they do not seem to recruit self-control when it would be useful to do so (Robinson et al., 2010).

Although the present studies are the first to test these ideas, there are sources of data consistent with their rationale. For example, just as the anterior cingulate (responsible for monitoring) responds to conditions of conflict (Botvinick, 2007), it also responds to a wide variety of aversive circumstances, including stress and pain (Bush, Luu, & Posner, 2000; Lieberman & Eisenberger, 2005). In addition, it is clear that the frontal cortex (responsible for operating) does more than resolve cognitive conflicts; it also supports effective behavior (Goldberg, 2001), perhaps most specifically in the form of self-control (Miller & Cohen, 2001; Robinson et al., 2010). Thus, there are reasons for thinking that executive control recruitment within the Stroop task may parallel, and predict, self-control recruitment in daily life.