RUNNING HEAD: Motor Control Accuracy

Motor Control Accuracy:

A Consequential Probe of Individual Differences in Emotion Regulation

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Abstract

Two studies (total N = 147) sought to model emotion-regulation processes in cognitive-motoric terms. Hostile or non-hostile thoughts were primed and, immediately following, individuals held a joystick as accurately as possible on a presented visual target. Study 1 found that the activation of hostile thoughts impaired motor control at low levels of agreeableness, but facilitated motor control at high levels of agreeableness, consistent with emotion-regulation views of this trait. Study 2 did not assess the trait of agreeableness, but rather sought to determine whether better motor control following activated hostile thoughts would predict lesser reactivity to stressors in an experience-sampling protocol. It did and relevant results are reported for daily anger, negative affect, and positive affect. In addition, and consistent with the agreeableness findings of Study 1, better motor control following hostile thoughts predicted greater empathy on high stress days. Motor control probes of the present type thus appear consequential in understanding emotion-regulation processes and successes in emotion regulation.

KEYWORDS: Emotion Regulation, Motor Control, Agreeableness, Stress, Daily Outcomes

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Apparent losses of control are of general interest to psychologists. Social psychologists have shown that taxing the self's resources often results in what might be termed self-control failures (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Personality traits such as impulsivity are based on the premise that some individuals have less control over their behaviors than others (Whiteside & Lynam, 2001). Clinical psychologists view many disorders – such as bulimia nervosa, borderline personality disorder, and drug addiction – at least in part in terms of losses of control (Butcher, Mineka, & Hooley, 2007). Many prominent theories of criminality associate it with losses of self-control as well (Raine, Brennan, Farrington, & Mednick, 1997). Self-control successes and failures, in fact, have emerged as a meta-perspective for multiple areas of psychology (Vohs & Baumeister, 2011).

Many classic cases of apparent self-control failures are ambiguous, however. Alcoholics and drug addicts are surely damaging themselves and their lives, but may be willing participants in doing so (West & Hardy, 2006). Those prone to overeating may do so because they view such behaviors as effective coping strategies in dealing with stress or aversive emotions (Tice, Bratslavsky, & Baumeister, 2001). Criminal behaviors are rational to the extent that an individual's focus is on short-term rewards relative to longer-term negative consequences (Zimbardo & Boyd, 1999). Apparent self-control failures, then, may often be fully endorsed by the individual rather than reflecting losses of self-control, the latter defined as attempts to control one's behaviors without success in doing so (Muraven & Slessareva, 2003; Robinson, Scheichel, & Inzlicht, 2010). In more micro-momentary terms, though, it is clear that behavior cannot be perfectly controlled (Slifkin & Newell, 1998). Accordingly, by developing more micro-momentary probes of self-control, considerable insights into self- and emotion-regulation successes and failures might be modeled and understood. We sought to develop such a probe.

In a seminal series of studies, Luria (1932) showed that inducing individuals to lie resulted in poorer motor control. More recently, cognitive-motoric probes have proven sensitive to several individual differences and manipulations that presumably rely on self-control processes. Motor control improves with feedback (Ranganathan & Newell, 2009), as it should from the perspective of cybernetic theories of self-control (Carver & Scheier, 1998). Young children and old adults show greater motor control difficulties than do young adults and these results make sense from what we know concerning age differences in frontal lobe functioning (Newell, Mayer-Kress, & Liu, 2009). Coombes, Janelle, and Duley (2005) found that exposure to unpleasant pictures led to worse line-tracing performance. Similarly, Noteboom and colleagues (e.g., Noteboom, Barnholt, & Enoka, 2001) found that higher levels of state anxiety led to decreased accuracy on a pinch grip task (for related results in more complex tasks, see Causer, Holmes, Smith, & Williams, 2011; Wilson, Vine, & Wood, 2009). It is clear, then, that cognitive-motoric probes of self-control may have considerable merit.[1]

Reactivity and Regulation in the Context of Activated Hostile Thoughts

The state of anger is widely viewed in terms of losses of self-control (Tavris, 1989; Wilkowski & Robinson, 2010) and many findings in the social-cognition literature on anger and anger-motivated aggression have shown that the activation of hostile thoughts precipitates such outcomes (Anderson & Bushman, 2002). Berkowitz (1993) contends that hostile thoughts automatically prime tendencies toward anger and aggression – and associated losses in self-control – through spreading activation networks. Because such networks are well-established and over-learned, their influence may be difficult to escape (Bargh & Chartrand, 1999). Individuals, then, are often viewed as victims of their own activated hostile thoughts even in cases in which such thoughts are primed by irrelevant manipulations (e.g., pre-exposure to pictures of weapons, violent film clips, or violent song lyrics).

Agreeable individuals, on the other hand, are not typically angry and aggressive, but rather seem to be able to resist provocation-related influences toward anger and anger-motivated aggression (Bettencourt, Talley, Benjamin, & Valentine, 2006). In understanding results of this type, Wilkowski and Robinson (2008) suggested that agreeable individuals recruit self-control in the context of accessible hostile thoughts, thereby mitigating their influence. There are preciously few findings of this type and certainly none involving behavioral probes of self-control. In Study 1 of the present investigation, then, we primed hostile thoughts versus neutral thoughts prior to assessing motor control accuracy. We hypothesized that disagreeable individuals would lose motor control following activated hostile thoughts, consistent with their reactivity to such thoughts (Meier & Robinson, 2004). On the other hand, we hypothesized that agreeable individuals would, perhaps paradoxically, exhibit better motor control accuracy following activated hostile thoughts. Results of this type would challenge the idea that all individuals are victims of their activated hostile thoughts. Study 2 sought to extend such ideas to the context of daily experiences and reactions to stress (see below).

Study 1

In both studies, a within-subject priming design was used in which some trials primed hostile thoughts and others primed neutral thoughts. Subsequently, motor control was defined in terms of the accuracy with which a joystick cursor could be held constant in relation to a visual target. In Study 1, we predicted that the activation of hostile thoughts would disrupt motor control at low levels of agreeableness, but facilitate motor control at high levels of agreeableness.

Method

Participants and General Procedures

Participants were 67 (39 female) undergraduates from North Dakota State University who received course credit. Sessions included groups of six or fewer individuals. The motor control task was first administered and then the personality trait of agreeableness was assessed.

Motor Control Task and Its Quantification

Participants were told that we were interested in their abilities to "alternate between two very different tasks." The first task involved "rehearsing and memorizing a word". The second task involved "moving the joystick cursor to a target location presented on the screen…for several seconds." More specific instructions followed. Participants were told that each trial would end with "a recall screen in which you will be asked to identify the word you saw at the beginning of the trial." In describing the motor control portion of the trial, we asked participants to "move the joystick cursor so that it is flush with the target." After having done so, the "cursor will change from white to yellow" and when this happens, they should hold the joystick cursor "as close to the target as possible" until instructed to do otherwise.

Each trial began with one of 20 words presented at center screen for 2000 ms. Ten of them involved hostile actions (argue, blackmail, harass, harm, hurt, injure, insult, kill, pummel, & stab). The other ten action verbs were from a coherent category as well, but involved cleaning actions, a control condition (bathe, brush, mop, neaten, polish, rinse, scrub, shower, sweep, & vacuum). Words were randomly assigned to trial number in a within-subject design.

After the trial prime disappeared, a stationary target (a + sign with 1 pixel thickness and 10 pixel length cross-hatches) occurred in a random location within the 1280 by 1024 pixel space defined by the computer screen. Participants used a Saitek Aviator-01 dual throttle joystick to move a central cursor (also a + sign with 1 pixel thickness and 10 pixel length cross-hatches) to the location of the spatial target for the particular trial. Movement control was not assessed until the joystick cursor was less than 5 pixels away from the target along both x and y axes. Then, the target turned yellow, indicating that the motor control portion of the trial had begun. Position (in x and y coordinates) was sampled every 40 ms for 2000 ms (50 samples).

Subsequently, the word for the trial appeared along with a randomly selected word that had not been shown. Such words were randomly assigned to left versus right boxes. Participants were to move the joystick to the box containing the word shown on that trial and to press a joystick button to indicate their word identifications. Incorrect responses were penalized by a 1500 ms visual error message. Subsequently, participants were told to return to center screen, which was followed by a 250 ms blank delay before the prime word for the next trial was presented. There were 80 paired trials in all (i.e., 40 involving primes of each type).

Mistaken word identifications were rare ($M = 0.6\%$) and such trials were deleted. Motor control accuracy versus inaccuracy was quantified in the following manner. For each sample of each trial, both the target position and the joystick position were defined in terms of the two-dimensional Euclidean space defined by the computer screen, with pixel as the unit of analysis. The Pythagorean theorem was then used to calculate the shortest (squared) distance between the two locations.

Subsequently, we averaged across samples of individual trials. Higher scores thus represent trials on which motor control was relatively inaccurate and lower scores thus represent trials on which motor control was relatively accurate. Such trial-specific scores were positively skewed and they were therefore log-transformed for analysis purposes, though original units will be reported for descriptive purposes (Robinson, 2007). We then computed two means for each participant, one averaging across trials involving hostile primes and one averaging across trials involving neutral (non-hostile) primes, a within-subject design.

Agreeableness

Individual differences in agreeableness were assessed using Goldberg's (1999) broad-bandwidth scale, which correlates highly with alternative measures of agreeableness (John & Srivastava, 1999) and has been shown to be reliable and valid in many previous studies (e.g., Meier & Robinson, 2004). Participants reported on the extent (1 = *very inaccurate;* 5 = *very accurate*) to which they could generally be characterized as disagreeable (e.g., insult people) versus agreeable (e.g., have a soft heart) in relation to 10 items (α = 87). Agreeable feelings were also assessed, following Meier, Robinson, and Wilkowski (2006). Participants indicated the extent to which (1 = *very slightly or not at all*; 5 = *extremely*) they felt 5 agreeable feelings (caring, empathetic, helpful, kind, & loving). This scale, too, was very reliable (α = 94). The statement-based and feeling-based agreeableness scales were moderately correlated, $r = .49$, $p < .001$, and resulted in parallel findings. Accordingly, we standardized the two agreeableness measures and then averaged across them.

Results

Motor control accuracy versus inaccuracy was examined in a General Linear Model analysis (Robinson, 2007) as a function of Agreeableness (a continuous between-subject predictor) and Prime Type (a discrete within-subject predictor). There was a main effect for Agreeableness, F (1, 64) = 5.63, $p = .02$, $\eta^2 = .08$, such that agreeable (+1 *SD*) individuals exhibited greater motor accuracy (*M* = 51.94) than did disagreeable (-1 *SD*) individuals (*M* = 136.16). This is an interesting and novel finding, but one that comports with suggestions that agreeableness may relate to self-control broadly defined (e.g., Tangney, Baumeister, & Boone, 2004). By contrast, there was no main effect for Prime Type, $F < 1$. Thus, hostile thought activation did not disrupt motor control among the sample as a whole.

Of most importance, there was an Agreeableness by Prime Type interaction, F (1, 64) = 9.58, p = .003, η^2 =. 13. Estimated means for individuals low (-1 *SD*) and high (+1 *SD*) in agreeableness, based on regression output, are displayed in Figure 1. The figure suggests that hostile primes led to worse motor control at low levels of agreeableness and to better motor control at high levels of agreeableness. To examine such simple slope effects, it is necessary to modify the procedures of Aiken and West (1991) in a way capable of using such procedures in the context of *within-subject* predictions (Robinson, 2007). The within-subject effect can be transformed into a mathematically equivalent difference score (Wilkowski & Robinson, 2007), here hostile-primed inaccuracy minus neutral-primed inaccuracy. Having done so, the procedures of Aiken and West can then be applied.

When agreeableness levels were altered to reflect low (-1 *SD*) levels of this trait, the intercept was significant and *positive*, p = .04, indicating a greater loss of motor control following hostile (versus neutral) primes. When agreeableness levels were altered to reflect high (+ 1 *SD*) level of this trait, on the other hand, the intercept was significant and *negative*, p = .03, indicating better motor control following hostile (versus neutral) primes. Thus, priming hostile thoughts had quite different effects at low versus high levels of agreeableness. Viewed in another way, higher levels of agreeableness were predictive of better motor control in the hostile-priming condition, r = -.32, p = .008, but only marginally better motor control in the neutral-priming condition, $r = -.24$, $p = .051$. These results, too, support the idea that hostile primes engendered better motor control at high levels of agreeableness.

Discussion and Study 2

Hostile thoughts are generally regarded as disruptive to control (Berkowitz, 1993). On the other hand, Wilkowski and Robinson (2008) suggested that such disruptive effects may be particular to disagreeable relative to agreeable individuals. In support of this point, we found that hostile (relative to neutral) primes undermined motor control at low levels of agreeableness, but actually facilitated motor control at high levels of agreeableness. The results, therefore, support self- and emotion-regulation perspectives of agreeableness (Graziano & Eisenberg, 1997).[2]

We regard the motor control task of Study 1 as a promising probe of emotion-regulation. On the other hand, we agree with others (e.g., Bolger, Davis, & Rafaeli, 2003; Tennen, Affleck, Armeli, & Carney, 2000) that emotion-regulation processes are perhaps best examined in terms of reactions to stressful events in daily life. Accordingly, and in contrast to Study 1, we used an experience-sampling protocol in which difficulties in motor control following hostile primes, irrespective of trait considerations, were used to predict reactivity to daily stressors.

We hypothesized that individuals exhibiting worse motor control following the activation of hostile thoughts would display greater reactivity to daily stressors as defined by higher levels of anger, higher levels of negative affect, and lower levels of positive affect. The daily protocol also assessed experiences of empathy because such experiences are likely to mitigate and therefore control antisocial reactions to stress (Batson, 2011; Meier, Wilkowski, & Robinson, 2008) and – in addition – empathy is central to theoretical conceptions of agreeableness (Graziano & Eisenberg, 1997), with was the focus of Study 1. Accordingly, individuals exhibiting better motor control following the activation of hostile thoughts might experience higher levels of empathy on high-stress days.

Method

Participants and General Procedures

Ninety (40 female) undergraduates, who had not participated in Study 1, completed both the laboratory session and at least 12 of the 15 daily reports. Participants were awarded course credit for the laboratory portion of the study, which assessed motor control following hostile and neutral primes. Following this baseline assessment, the same individuals were to log onto a SONA-programmed website and report on stressful events and their emotional experiences for a given day for 15 days in a row. They did so between the hours of 8 p.m. and bedtime and received monetary compensation for this portion of the study.

Motor Control Task and Its Quantification

The motor control task, including its instructions and quantification algorithms, were identical to Study 1. That is, the same hostile and neutral primes were used, the same sample-specific distance scores were computed, and such procedures were used to quantify the extent to which particular trials were associated with poor (inaccurate) motor control on the one hand versus good (accurate) motor control on the other hand. Further, as in Study 1, such trial-specific scores were log-transformed to reduce positive skew and then averaged across trials involving hostile primes on the one hand versus neutral (non-hostile) primes on the other hand as we sought to contrast motor control following hostile primes with that following neutral primes.

Study 2 did not assess agreeableness. Rather, the more ambitious purpose was to determine whether greater control following hostile primes would predict better emotion-regulation in daily life. To create a single “level 2” or individual difference predictor (Nezlek, 2008), we subtracted motor control inaccuracy following neutral primes from motor control inaccuracy following hostile primes. Higher scores thus reflect greater losses in motor control following the activation of hostile thoughts relative to a procedure-matched control condition.[3]

Experience-Sampled Measures

For each daily report, participants were asked to indicate the extent to which (1 = *not at all true today*; 4 = *very much true today*) four common daily stressors occurred (had a deadline, had a lot of responsibilities, not enough time to meet obligations, & too many things to do at once). Such stressors were selected from the College Inventory of Daily Stressors (Kohn, Lafreniere, & Gurevich, 1990) and were chosen because they are frequent to everyday life and consequential in such protocols (e.g., Compton et al., 2008). Alpha for this scale was .85.

Four types of emotional reactions were also assessed. The common question asked was "To what extent did you feel each of the following today?" and the response scale varied from 1 (*very slightly or not at all*) to 5 (*extremely*). There were two items per emotion type. The anger items were annoyed and angry, the empathy items were caring and empathetic, the negative affect markers were distressed and nervous, and the positive affect markers were enthusiastic and excited. Items were generally selected on the basis of Watson and Clark's (1994) psychometric work, though the empathy items were selected on the basis of the results of Meier et al. (2006). Alphas for these scales varied from .64 to .78.

Results and Discussion

In an initial ANOVA, there was no effect for Prime Type on mean target distance scores, p = .87. Accordingly, the motor control task contrasts hostile-regulating versus hostile-reactive individuals. As mentioned above, a single dimensional score, termed Hostile Priming for ease of exposition, was computed to reflect such differential motoric reactions to hostile primes.

Daily reports were nested within individuals and therefore analyzed as a function of multi-level modeling (MLM) procedures. Such analysis techniques are robust to differences in the number of completed reports across individuals and partition sources of variance in a recommended manner (Singer & Willett, 2003). Four MLM analyses were conducted, one for each of the emotional outcomes. Daily stressful events (the Level 1 predictor) were centered within-individuals (Enders & Tofighi, 2007) and individual differences in hostile priming (the Level 2 predictor) were centered across individuals (Enders & Tofighi, 2007). It is worth mentioning that the hostile priming variable did not predict mean levels of daily stress, nor the variability of stressful events across days, *p*s > .10, and thus relevant findings cannot be due to individual differences in stress exposure (Bolger & Schilling, 1991).

Table 1 displays unstandardized regression coefficients for each model. Of most importance, daily stress levels interacted with the continuous hostile priming variable to predict all four daily emotion outcomes. To better understand the nature of these interactions, we calculated estimated means (Aiken & West, 1991; Judd, Kenny, & McClelland, 2001) at low (-1 *SD*) versus high (+1 *SD*) levels of the hostile priming variable and did so in relation to low (-1 *SD*) versus high (+1 *SD*) person-centered stress levels. Note that these are estimated means, based on regression equations, and therefore not of a dichotomized type. Estimated means for the interactions are graphically displayed in Figure 2. Dashed lines reflect low levels of the hostile priming variable and solid lines reflect high levels of the hostile priming variable. The graphs suggest that high levels of daily stress precipitated higher levels of anger and negative affect, as well as lower levels of empathy and positive affect, particularly so among individuals displaying losses of motor control following hostile primes in the laboratory assessment.[4]

Follow-up simple slopes tests (Preacher, Curran, & Bauer, 2006) were performed to better understand the nature of the interactions reported in Figure 2. Specifically, we examined stress-reactivity slopes at low (-1 *SD*) versus high (+1 *SD*) levels of the continuous hostile priming predictor, with higher scores representing losses of motor control following hostile thought activation. Stress precipitated anger at high (b = .19, $t = 3.69$, $p < .001$), but not low (b = -.00, $t = 0.07$, $p = .94$), levels of hostile priming. Stress led to greater negative affect at high (b = .44, $t = 10.53$, $p < .001$) than low (b = .21, $t = 4.36$, $p < .001$) levels of hostile priming, though both simple slopes were significant. Stress also undermined positive affect at high (b = -.27, $t = -5.03$, $p < .001$), but not low (b = .07, $t = 1.26$, $p = .21$), levels of hostile priming. Finally, stress undermined empathy at high levels of the hostile priming variable (b = -.09, $t = -2.02$, $p = .04$), but was predictive of *higher* levels of empathy at low levels of the hostile priming variable (b = .14, $t = 2.67$, $p = .007$). Although the empathy graph suggests that high levels of hostile priming were predictive of greater empathy on low stress days, this was not the case, $p = .71$. Thus, findings should be interpreted in terms of the simple slopes reported.

The findings of Study 2 extend those of Study 1 considerably. Motor control difficulties following hostile thought activation predicted greater anger and lesser empathy to daily stressors, a pattern consistent with a disagreeable response to life's difficulties. On the other hand, individuals displaying greater motor control following hostile thought activation were not angrier on high stress days and in fact experienced more empathy for others on such days, a pattern consistent with an agreeable response to life's difficulties. Further, worse motor control following hostile thoughts was predictive of emotional reactivity to stress in more general terms as well. Accordingly, our motoric probe was a consequential one in predicting the extent to which individuals react to versus regulate their emotions in response to stressful life events.

General Discussion

A novel motoric probe proved to have considerable value in understanding individual differences in emotion-regulation. Worse motor control following the activation of hostile thoughts was observed at low levels of agreeableness (Study 1) and predicted greater emotional reactivity to daily stressors (Study 2). By contrast, better motor control following the activation of hostile thoughts was observed at high levels of agreeableness (Study 1) and predicted lesser reactivity to daily stressors (Study 2). Such process-oriented results are informative to several literatures, though further research is advocated in extending the present findings.

One can interpret Berkowitz (1990; 1993) to suggest that people generally lose control in the context of activated hostile thoughts. In our studies, there was no normative effect of this type. Rather, our findings are consistent with an emerging perspective suggesting that some individuals (but not others) are less susceptible to their activated hostile thoughts precisely because they recruit the controlled resources of the brain in such contexts (Mauss, Bunge, & Gross, 2007; Wilkowski & Robinson, 2008). Meier and Robinson (2004) suggested that agreeable individuals, in particular, self-regulate their hostile thoughts by recruiting such resources, though they did not provide direct evidence for this idea. The results of Study 1, we believe, offer more definitive evidence than any previous study that has examined this hypothesis. The results of Study 2, moreover, show that the motor probe predicted responses to stressors in daily life. Such findings should be extended. For example, better motor control following hostile thoughts should predict lesser behavioral aggression in response to violent media exposure (Bushman & Anderson, 2001) or provocation (Bettencourt et al., 2006) in laboratory aggression paradigms.

Our probe of implicit emotion regulation processes was novel, but can be linked to Gross' (1998) model of emotion regulation in certain ways. An important feature of his model is the distinction between regulatory processes that occur prior to the arousal of emotion versus those that occur subsequent to it. To the extent that emotion control processes occur early enough – that is, subsequent to the provocative event but prior to emotional arousal – emotional reactivity to the event can be circumvented. Our paradigm focused on such early-acting processes in that we primed individuals with hostile thoughts rather than inducing anger. Consistent with Gross' model, individuals displaying a hostile-regulating motor pattern were less emotionally reactive (e.g., less angry) in response to stressors in daily life. It remains to be seen whether such individuals are less physiologically reactive to stressors in the laboratory, but the findings of Mauss, Evers, Wilhelm, and Gross (2006) would seem to encourage this direction of research.

In contrast, emotional arousal is viewed as destabilizing popularly (Stearns, 1994) and in several scientific theories of emotion (e.g., Mandler, 1999). Further, the neuroscience literature has often shown that activation in purported emotion-related brain structures (e.g., the amygdala) predicts lesser activation in the prefrontal cortex (Davidson, 2000; Ochsner & Gross, 2005), generally thought to mediate multiple forms of control (Berkman, Burlund, & Lieberman, 2009; Miller & Cohen, 2001). Consistent with this view, several studies have shown that state anxiety undermines motor control accuracy (Coombes et al., 2005; Noteboom et al., 2001). Thus, it is possible that the induction of anger rather than simply hostile thoughts might precipitate general losses of motor control. This is possible, but it is also true that individuals differ greatly in their motivations and abilities to control their anger (Wilkowski & Robinson, 2008). What we emphasize, then, is the importance of individual differences in understanding the extent to which emotional arousal may undermine controlled behavior.

More generally, we believe that motoric probes of the present type can be used to model and understand self-control processes and outcomes. Individuals may often consent to classic self-control failures such as gambling too much, eating too much, or drinking too much (Baumeister, Heatherton, & Tice, 1994; Robinson et al., 2010). That is, they may simply want to engage in such behaviors despite their potentially negative consequences (Cyders & Smith, 2008; Tice et al., 2001; West & Hardy, 2006). It is for such reasons that we sought to define behavioral self-control in a more ability-related fashion, as can be done through the use of motor control paradigms (Slifkin & Newell, 1998). Study 1 found that agreeable individuals were generally better in the motor control task. Accordingly, motor control tasks of the present type may have utility in understanding other individual differences thought to reflect lesser or greater control such as conscientiousness, impulsivity, or psychopathy. Studies of this type are underway and findings have been supportive of this line of thinking.

In addition, cognitive-motoric probes may have a wide potential value in understanding other cue-reactivity effects. Smokers are thought to lose control in relation to smoking cues (Sayette, 2004) and heavy alcohol users are thought to lose control in relation to alcohol cues (Heather, Booth, & Luce, 1998). By presenting such cues (versus control cues) in motor control paradigms, such purported losses of control can be more directly established than in the implicit cognitive paradigms typically used in this literature (Wiers & Stacy, 2006). Further, aversive experiences are thought to precipitate losses of control among individuals prone to borderline personality disorder (Trull et al., 2008) and states of excitement are thought to undermine control among individuals high in "positive urgency" (Cyders & Smith, 2008). Such hypotheses, as well as many others positing cue-reactivity effects, would seem to benefit from cognitive-motoric probes of the present type.

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Footnotes

[1]The term “cognitive” is often understood in terms of processes responsible for representing or conceptualizing stimulus input. We use this term in a different manner in the present studies. Specifically, a “cognitive-motoric” probe is one that takes advantage of the benefits of cognitive experimental paradigms, which include computerized measurement, a within-subject design, and multiple trials, in assessing the extent to which individuals exhibit better or poorer motor control.

[2]At the sample level, distances between the joystick and the target were quantified in squared (pixel) terms. In a follow-up analysis, we performed a square root transformation of such distance scores before averaging across samples to define trial-specific difficulties in motor control. Both scoring metrics resulted in very similar estimates of the extent to which motor control accuracy was poorer versus better for a given trial, $r = .99$. Additionally, the interaction observed was significant using both quantification metrics. For such reasons, we retained the Study 1 scoring procedures in Study 2 as well.

[3]Individuals displaying better motor control following neutral primes also displayed better motor control following hostile primes, $r = .90$. For this reason, it is necessary to subtract motor performance following neutral primes from motor performance following hostile primes as not doing so would confound hostile priming effects with general tendencies toward better or worse motor control across the two priming conditions.

[4]We also quantified motor control difficulties by averaging across the two priming conditions. Such motor control difficulties were independent of our hostile priming variable, $r = .06$. On the other hand, such general motor control difficulties might predict adverse reactions to daily stressors. In evaluating this idea, we performed MLM analyses parallel to those reported

for the hostile priming variable. No interactions were observed for anger (p = .76), empathy (p = .17), or positive affect (p = .10). An interaction was found for negative affect (p = .01), but its slope indicated lesser rather than greater stress-reactivity among those exhibiting poorer overall motor control (b = -.09). Further, the hostile priming variable continued to interact with daily stressors in predicting all four emotional outcomes when overall motor control difficulties were simultaneously controlled, all ps < .05. In sum, these additional analyses establish that losses of motor control following hostile (versus neutral) primes are consequential in predicting reactions to daily stressors in a manner that motor control difficulties in general are not.

Table 1

Daily Outcomes as a Function of Individual Differences in Hostile Priming, Levels of Daily Stress, and Their Interaction

	Dependent Measure			
Parameter	Anger	NA	PA	Empathy
Intercept	2.01*	2.00*	2.85*	2.94*
Hostile Priming	.24	.22	-.28	-.01
Stress	.09*	.35*	-.09*	.02
Stress x Hostile Priming	.26*	.30*	-.47*	-.31*

NOTE: Hostile Priming = the extent to which motor control was less accurate following hostile primes; NA = Negative Affect; PA = Positive Affect. Reported are unstandardized effect size coefficients.

* = $p < .05$

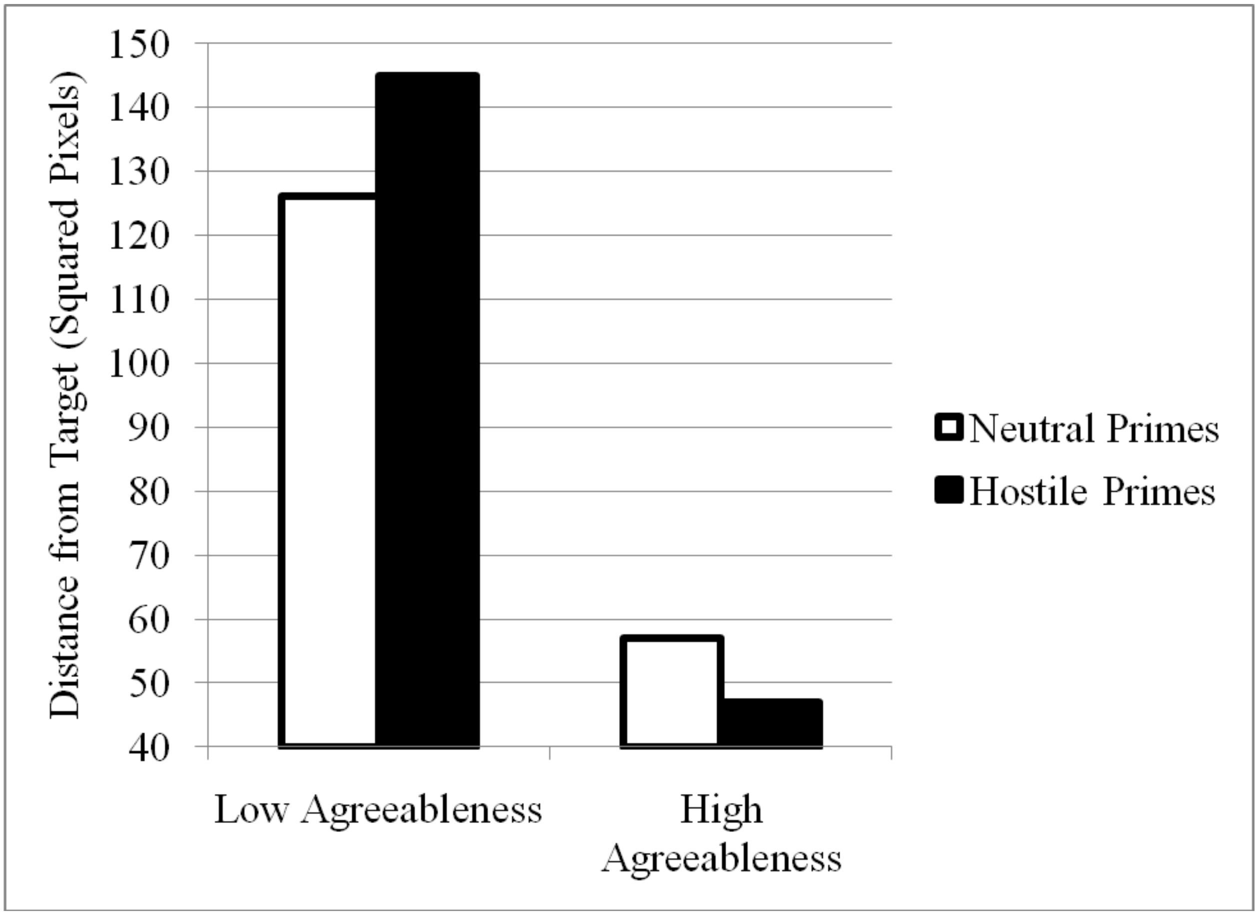
Figure Caption

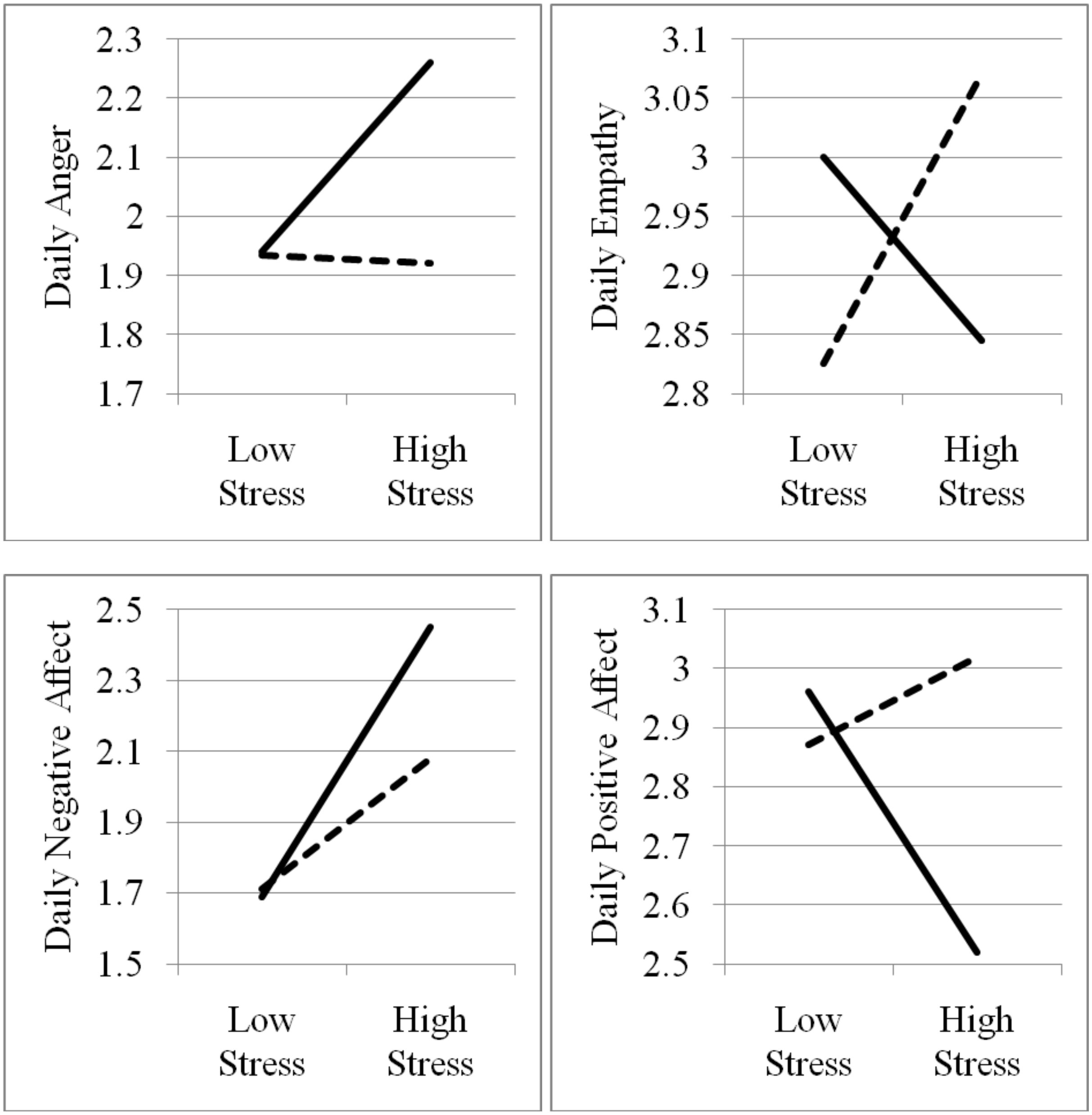
Figure 1

Mean Target Distance as a Function of Prime Type and Agreeableness, Study 1

Figure 2

Stress-Outcome Relations as a Function of the Hostile Priming Variable, Study 2; Dashed Lines = Better Motor Control Following Hostile Primes (-1 SD); Solid Lines = Worse Motor Control Following Hostile Primes (+1 SD)


150
140
130
120
110
100
90
80
70
60
50
40
Distance from Target (Squared Pixels)
Low Agreeableness
High Agreeableness
Neutral Primes
Hostile Primes



Daily Anger
2.3
2.2
2.1
2
1.9
1.8
1.7
Low Stress
High Stress
Daily Empathy
3.1
3.05
3
2.95
2.9
2.85
2.8
Low Stress
High Stress
Daily Negative Affect
2.5
2.3
2.1
1.9
1.7
1.5
Low Stress
High Stress
Daily Positive Affect
3.1
3
2.9
2.8
2.7
2.6
2.5
Low Stress
High Stress