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Higher Levels of Psychopathy Predict Poorer Motor Control: Implications for Understanding the Psychopathy Construct

Michael D. Robinson · Konrad Bresin

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Abstract A review of the literature suggests that higher levels of psychopathy may be linked to less effective behavioral control. However, several commentators have urged caution in making statements of this type in the absence of direct evidence. In two studies (total $N=142$), moment-to-moment accuracy in a motor control task was examined as a function of dimensional variations in psychopathy in an undergraduate population. As hypothesized, motor control was distinctively worse at higher levels of psychopathy relative to lower levels, both as a function of primary and secondary psychopathy and particularly their shared variance. These novel findings provide support for the idea that motor control systematically varies by psychopathy, in a basic manner, consistent with views of psychopathy emphasizing lesser control.

Keywords Psychopathy · Behavior · Control · Self-control · Motor · Executive

Introduction

On the basis of his clinical observations, Cleckley (1941) characterized a group of people as intelligent and non-neurotic, but behaviorally somewhat aimless. He further suggested that such psychopathic individuals could be successful, but seemed less capable of modifying their behavior on the basis of feedback or punishment. Also on the basis of clinical observations, Karpman (1941) suggested that there are several features of psychopathy, some of which are likely genetic in

origin (primary psychopathy) and some of which appear to be more due to socialization factors (secondary psychopathy). Hare (1991) created a structured interview for the assessment of psychopathy among prison inmates, one that emphasized overlap among primary and secondary factors, but also linked the former to interpersonal and affective features (e.g., narcissism, callousness) and the latter to an antisocial lifestyle (e.g., earlier criminal offenses, antisocial behaviors). Subsequently, a number of additional assessments of psychopathy have been developed (e.g., Levenson et al. 1995; Lilienfeld and Andrews 1996) and there is now general agreement that psychopathy encompasses several related traits and tendencies such as narcissism, impulsivity, and superficial affect.

The present studies pursue the idea that higher levels of psychopathy may be associated with lesser behavioral control. Several theories of psychopathy emphasize related attributes. For example, Cleckley (1964) characterized the erratic nature of the behavior of psychopaths, Hart and Dempster (1997) suggested that poor behavioral control is a cardinal feature of psychopathy, and Hare (1993) made a similar suggestion. In fact, poor behavioral control is an item on the Psychopathy Checklist-Revised (PCL-R: Hare 2003), a common psychopathy assessment tool. The correlates of psychopathy, moreover, make a case for the idea that higher levels of psychopathy seem to be linked to lesser behavioral control. Individual differences in psychopathy are predictive of criminality (Lee and Salekin 2010), classic behaviors thought to be uncontrolled (Baumeister et al. 1994) such as substance abuse and gambling (Miller and Lynam 2003), personality disorders of an “erratic” type (Miller et al. 2008), violent behaviors (Porter and Woodworth 2006), impulsive or short-term forms of sexuality (Jonason et al. 2009), and susceptibility to temptations such as academic cheating (Nathanson et al. 2006). Moreover, higher levels of psychopathy are marked by lower levels of agreeableness and conscientiousness (Miller et al. 2011), traits theoretically and empirically linked to better “effortful control” in developmental and personality literatures (Rothbart et al. 2011).

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Although it may be intuitive to suggest that higher levels of psychopathy are inversely predictive of behavioral control, several commentators have cautioned against such assertions. For example, Poythress and Hall (2011) examined relations between psychopathy and self-reported impulsivity in a meta-analysis. Such relations were inconsistent and heterogeneous, partly due to the multi-faceted nature of self-report scales of impulsivity (Whiteside and Lynam 2001). Reidy et al. (2011) raised similar cautions concerning aggression. Although psychopathy predicts aggression (Jones and Paulhus 2010), and although aggression is often thought of in terms of uncontrolled behavior (Berkowitz 1993), there are actually two types of aggression—reactive and instrumental—only the former of which can be considered uncontrolled (Wilkowski and Robinson 2010). Data suggest that psychopathy predicts intended or instrumental aggression to a much greater extent than reactive aggression and therefore data are not especially strong in supporting the point that psychopaths engage in uncontrolled aggression to a greater extent than non-psychopaths (Reidy et al. 2011).

There is a more basic issue here, however. Baumeister et al. (1994) considered the possibility that several of the correlates of psychopathy—such as aggression, gambling, and substance abuse—reflect lesser control over one's behaviors. Contrary to this idea, they concluded that such behaviors *could* be controlled if the individual was motivated enough to do so. For example, substance abuse often appears partially or fully willed by the individual (West 2006). What is needed to circumvent such ambiguities is a method of assessing control in a more basic and unambiguous manner. Fortunately, such paradigms exist in the kinesiology literature. When assessed in terms of moment-to-moment performance, it is clear that motor control is imperfect at best (Slifkin and Newell 1998). Furthermore, moment-to-moment assessments of motor control are sensitive to factors implicated in self-control. For example, people exhibit better motor control to the extent that they receive more frequent visual feedback (Ranganathan and Newell 2009), consistent with an executive attention perspective of how self-control should operate (Shallice 1988). Additionally, it has been shown that groups of people who are thought to have difficulties controlling their behavior perform more poorly in motor control tasks, including young children (Getchell 2006), old-aged adults (Kovacs 2005), and brain-damaged individuals (Winstein et al. 1999). Such basic tasks can additionally be used to examine dimensional, rather than group-based, variations in controlled performance (Bresin et al. 2012), the focus of the present studies.

Motor control tasks may assess the extent to which one can control one's behaviors in a manner that is ambiguous when people self-report on outcomes such as aggression or substance abuse (Baumeister et al. 2007). Nonetheless, we have and will use the phrase “behavioral control” to characterize the outcomes typically examined in the psychopathy literature

and the phrase “motor control” to characterize what we assess. It is our hypothesis that these two different levels of analysis can be linked—i.e., that people self-reporting higher levels of psychopathy should exhibit lesser motor control in a task designed to assess it.

Overview of Investigation

Based on several theoretical perspectives of psychopathy (Cleckley 1964; Hare 1993; Hart and Dempster 1997) and its correlates (Lee and Salekin 2010; Lynam et al. 2011; Miller and Lynam 2003), a basic deficit in motor control was hypothesized to characterize higher levels of psychopathy relative to lower levels of it. A basis for this idea is that motor control difficulties may contribute to, or at least serve as a marker of (Shallice 1988), less effective behavioral control in more general terms (Getchell 2006; Winstein et al. 1999). To ensure replicability, two studies were conducted. They focus on dimensional perspectives of psychopathy rather than diagnostic groups. Such studies have been recommended in that psychopathy is dimensional (Walters et al. 2008) and a full range of psychopathy scores can result in a better understanding of how this trait functions relative to a restricted range (Sadeh and Verona 2008). Non-forensic samples are also useful in guarding against factors such as extensive drug use or a history of incarceration (Lilienfeld 1994) that, we suggest, could quite likely affect motor control. Given the design, further work would be necessary to extend the present work to diagnostic levels of psychopathy or forensic populations.

There are two agreed-upon types of psychopathy and we sought to assess both. Primary psychopathy (sometimes termed Factor 1) taps emotional and interpersonal features of psychopathy such as narcissism, callousness, and deficient empathy. Secondary psychopathy (sometimes termed Factor 2) focuses more on behavioral aspects of psychopathy such as impulsivity, irresponsibility, and conduct problems. Primary and secondary psychopathy are moderately correlated (Hare 1991), both predict antisocial behavior (Lee and Salekin 2010), and both are equally marked by low levels of agreeableness (Lynam and Derefinko 2006). In addition, Lynam et al. (1999) found both forms of psychopathy to predict commission errors in a go/no go task, results at least suggestive of the idea that motor control may be poorer for both forms of psychopathy (also see Zeier et al. 2012). Secondary psychopathy, however, is a better predictor of seemingly uncontrolled behaviors such as substance abuse, aggression, and criminality (Benning et al. 2003; Falkenbach et al. 2007), results at least suggestive of the idea that secondary psychopathy may be the better predictor of motor control difficulties. These alternative perspectives will be tested using basic probes of motor control.

We also deemed it potentially informative to manipulate aversive experiences in examining the psychopathy/motor

control relationship. Possible interactions involving this manipulated factor were uncertain, however. On the one hand, there are data to suggest that psychopathic individuals are less reactive to aversive experiences in physiological terms (Patrick 1994). On the other hand, some have suggested that links between psychopathy and controlled performance might be more evident under high stress conditions (e.g., Zeier et al. 2012). Given such discrepant ideas and findings, we could not make a directional prediction. Nonetheless, potential moderating effects seemed useful to consider, at the very least in establishing a (motor control) phenomenon that is apparent in both aversive and non-aversive contexts.

Study 1

Study 1 assessed primary and secondary psychopathy using the well-validated Levenson Self-Report Psychopathy Scale (Levenson et al. 1995). Aversive experiences were manipulated in a trial-specific manner in terms of anticipated noise blasts. Motor control was assessed using the joystick task developed by Bresin et al. (2012), as described below.

Method

Participants and Procedures

Sixty-four (37 female; 95 % Caucasian) undergraduates from an upper Midwest University received psychology course credit upon completion of the study. They reported to the laboratory in groups of 6 or less and were generally told that they would complete several tasks on computer. Individuals were then seated at personal computers with dividers. The motor control task was programmed with E-Prime software and the psychopathy questionnaire was programmed with Medialab software. The motor control task occurred first to preclude possible influences of thinking about one's personality tendencies on implicit performance (Robinson and Neighbors 2006). For conceptual reasons, though, the psychopathy assessment is described first.

Psychopathy Assessment

To ensure a degree of comparability across forensic and non-forensic samples, it may be useful to administer a psychopathy test modeled after the PCL-R (Hare 2003), often considered the gold standard of psychopathy assessment (Lee and Salekin 2010). Levenson et al. (1995) created such an instrument, one that is now termed the Levenson Self-Report Psychopathy (LSRP) scale. Items were modeled after the PCL-R, evidence was found for correlated yet distinct primary and secondary factors, and convergent and predictive validity for the scales

was further established (Levenson et al. 1995). Subsequent investigations have provided support for the LSRP in relation to model-based cluster analyses (Falkenbach et al. 2008), convergence with other self-report scales of psychopathy (Lynam et al. 2011), the ability to predict personality disorder symptoms and traits (Miller et al. 2008), and sensitivity to dimensional rather than taxonomic features of psychopathy (Walters et al. 2008).

In specific terms, participants indicated the extent to which (1 = disagree strongly; 4 = agree strongly) 26 statements encompassing psychopathic attitudes and behaviors were true of the self (Levenson et al. 1995). Sixteen of these statements were designed to assess primary psychopathy (e.g., "People that are stupid enough to get ripped off usually deserve it") and 10 were designed to assess secondary psychopathy (e.g., "I find myself in the same kinds of trouble time after time"). Means were computed by averaging across the relevant items and descriptive statistics for the scales were practically identical to those reported by Levenson et al. (1995) for both primary ($M=1.99$; $SD=0.44$; $\alpha=.86$) and secondary ($M=2.06$; $SD=0.40$; $\alpha=.63$) psychopathy. We further note that there was a good range of scores for psychopathy in both its primary (1.00–3.12) and secondary (1.40–2.90) forms and that the scales correlated with each other to a moderate degree, $r=.41$, $p<.01$.

Motor Control Task

Equipment The E-prime program used a 32-bit distribution of Windows XP and monitors had a screen height of 13.64 in.. The screen resolution was set to 1,280×1,024 pixels. During the task, participants wore headphones that allowed us to present sounds of equal strength to both headphone speakers. Computers were equipped with Saitek Aviator-01 Dual Throttle joysticks connected to a USB port.

Task To examine potential relations between psychopathy and motor control, we programmed the following task (also see Bresin et al. 2012). On each of 60 trials, a spatial target (a white + sign) was presented on the computer screen. Its position was randomly varied across trials, but excluded centered presentations along either the x- or y-axis, which would have rendered a trial easier than desired. The joystick cursor was initially presented at center screen and it was also a white + sign. Participants were told to move the joystick cursor to the presented target and hold it steadily on the stationary target thereafter. When the joystick cursor was within 5 pixels of the target, both horizontally and vertically, the target turned yellow, indicating that the motor control portion of the trial had begun. For each trial, we then sampled joystick position every 50 ms for 2,000 ms (i.e., there were 40 samples collected per trial). After this 2,000 ms interval, participants were instructed to return to center screen. After they had done so, and after the

manipulation described next, there was a 250 ms delay until the next trial began.

A Trial-Specific Manipulation of Aversive Experience At the beginning of each trial, participants were informed that they would (“you will receive noise”; 80 dB of white noise for 4,500 ms) or would not (“you will receive silence”; 0 dB of white noise for 4,500 ms) encounter a noise blast over headphones at the end of the trial, a message presented for 2,000 ms to ensure its registration. Anticipating an aversive experience is very stressful according to the results of Monat et al. (1972). In addition, a pilot study established that people find white noise blasts to be quite a bit more (1 = not at all; 5 = extremely) “irritating” ($M=3.13$) than silence ($M=1.32$), $F(1, 84)=192.73$, $p<.01$. An equal number of noise and silence trials occurred, randomized by trial number.

Quantification of Motor Control Difficulties The task required participants to keep their joystick cursor as close to the target position as possible. We quantified success in maintaining this proximity in Euclidean pixel-based terms. For each sample of each trial, the Pythagorean Theorem ($c^2 = a^2 + b^2$, with a & b being position discrepancies along the x- and y-axes of the computer screen) was used to calculate the shortest distance from the sampled joystick position to the stationary target. These squared distance estimates were then averaged across samples for a given trial. Subsequently, trial scores were averaged by participant and condition such that each participant had one mean distance score for the aversive condition and one for the silence condition. As is true of many performance-based measures (Sanders 1998), these target distance means were positively skewed. We therefore log-transformed them to reduce skew (Robinson 2007), though results are reported in terms of non-transformed means for ease of interpretation.

Results

Overview

To simultaneously examine possible effects involving condition and psychopathy, General Linear Model (GLM) procedures were used. The GLM is a parent to both analysis of variance and multiple regression procedures, but is more flexible in handling mixed designs of the present type (Robinson 2007). In the present case, condition was a discrete, within-subject predictor of motor control and psychopathy was a continuous, z-scored (Robinson 2007) between-subjects predictor. Initial GLMs focus on each form of psychopathy separately, omitting sex for the sake of parsimony. Subsequently, potential

interactions by sex will be examined and regressions will be performed to refine our understanding of the findings.^{1, 2}

It should be emphasized that variations in primary and secondary psychopathy were treated as continuous predictors in all analyses. No analysis, that is, dichotomized people into low and high psychopathy groups. When we refer to people low and high in psychopathy, we do so on the basis of estimated (rather than actual) means (± 1 SD) along the relevant psychopathy continuum, following the procedures advocated by Aiken and West (1991).

Primary Psychopathy Findings

Motor control performance was first examined in a GLM crossing variations in primary psychopathy with the condition manipulation. As hypothesized, there was a main effect for Primary Psychopathy, $F(1, 62)=5.55$, $p<.05$. To understand this effect, estimated means were calculated for prototypically low (-1 SD) versus high ($+1$ SD) levels of primary psychopathy and these estimated means are reported in the top panel of Fig. 1. As shown there, motor control was 183 % worse at the high relative to low level of primary psychopathy. We had thought it possible that motor control would be worse when anticipating noise, but there was no main effect for Condition, $F<1$. Of potential interest, there was a Primary Psychopathy by Condition interaction, $F(1, 62)=4.93$, $p<.05$. The interaction was subtle, however, in that estimated means as well as simple regressions indicated a marked effect for primary psychopathy in both the control (estimated $M_s=62.18$ versus 190.57), $t=2.51$, $p<.05$, and anticipated noise (estimated $M_s=66.69$ versus 177.69), $t=2.20$, $p<.05$, conditions, with perhaps a slightly larger effect in the control condition. Given the subtle nature of the interaction, we emphasize the main effect for primary psychopathy that occurred, though Study 2 will allow us to reexamine the possibility of an interaction with another manipulation of aversive experience.

¹ Aiken and West (1991) advocate standardizing continuous predictors in multiple regression analyses and Robinson (2007) extends such considerations to the GLM. Using non-standardized personality scores can result in erroneous findings involving the repeated-measures variable (here, anticipated noise condition), though will not alter the main effects for psychopathy that are reported (Maxwell and Delaney 2004). This is because z-scoring does not alter the shape of the distribution for a continuous predictor (Maxwell and Delaney 2004). Thus, for example, participants' untransformed primary psychopathy scores correlated at $r=1$ with their z-scored primary psychopathy scores.

² Separate GLMs for primary and secondary psychopathy were performed to examine whether each form of psychopathy, as an independent entity, predicted motor control. Entering both forms of psychopathy simultaneously would eliminate their common variance and the consequences of doing so are saved for a subsequently reported multiple regression.

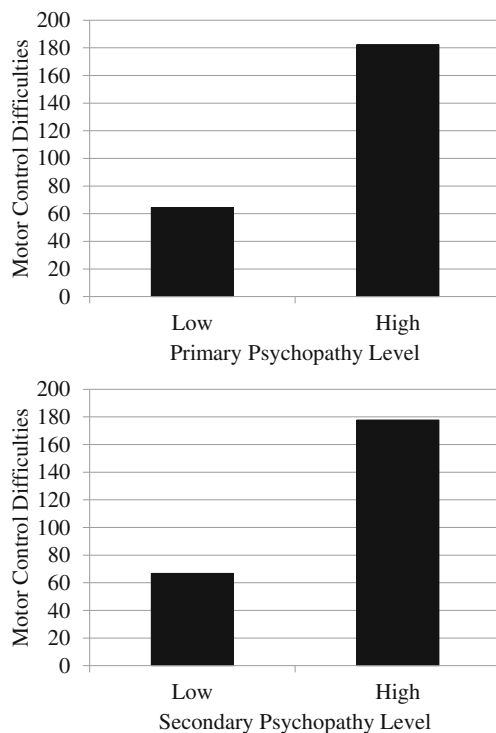


Fig. 1 Motor control difficulty estimated means as a function of primary psychopathy (*top panel*) and secondary psychopathy (*bottom panel*), Study 1

Secondary Psychopathy Findings

To determine whether motor control varies by secondary psychopathy, a parallel GLM analysis replaced primary psychopathy scores with secondary psychopathy scores. In this analysis, there was a main effect for Secondary Psychopathy, $F(1, 62) = 4.67, p < .05$, no main effect for Condition, $F < 1$, and no Secondary Psychopathy by Condition interaction, $F < 1$. In other words, a basic, condition-invariant, relationship between secondary psychopathy and motor control was evident. Estimated means for the main effect are reported in the bottom panel of Fig. 1. Motor control performance was 166 % worse at the prototypically high (+1 *SD*) relative to low (-1 *SD*) level of the secondary psychopathy continuum.

Potential Interactions by Participant Sex

Men often score moderately higher than women on dimensional assessments of psychopathy (Paulhus and Williams 2002). Nonetheless, the correlates of both primary and secondary psychopathy—in terms of personality facets and personality disorder symptoms—are highly similar for men and women (Miller et al. 2008). Accordingly, there were reasons for thinking that relations between psychopathy and motor control might be invariant across participant sex. To formally examine this possibility, we added participant sex as a factor to the GLM analyses reported above. More specifically, one GLM included

the factors of primary psychopathy, sex, condition, and all two-way and three-way interactions involving these predictors; the other replaced primary psychopathy with secondary psychopathy. No effect involving sex was significant, all p 's $> .25$. Thus, higher levels of psychopathy predicted poorer motor control equally so for males and females.

Poorer Motor Control as a General Feature of Psychopathy

Irrespective of the instrument used, primary and secondary psychopathy assessments are highly correlated (Hare 2003; Miller et al. 2008). Additionally, given that both primary and secondary psychopathy predicted motor control, it seemed likely that poorer motor control characterizes psychopathy in general terms. This point was substantiated in a multiple regression. When removing overlapping variance, neither Primary Psychopathy, $t = 1.61, p > .10$, nor Secondary Psychopathy, $t = 1.33, p > .15$, predicted motor control performance. By contrast, when averaging across primary and secondary psychopathy scores, overall levels of psychopathy *did* predict motor control difficulties in a simple regression, $t = 2.73, p < .01$, Beta = .33. At least with respect to the data collected in Study 1, then, poorer motor control appears to reflect what is common to primary and secondary psychopathy.

Study 2

Given the novel nature of the findings, a more or less direct replication effort seemed desirable. In addition, though, Study 2 sought to instantiate a stronger manipulation of aversive experience in that aversive or neutral sound clips were played over headphones *while* participants attempted motor control. Such procedures will allow us to more directly determine the relevance of emotional factors to relations between psychopathy and motor control.

Method

Participants, Procedures, and Psychopathy Assessment

A different sample of 78 (40 female; 75 % Caucasian) undergraduates from an upper Midwest University received course credit. They completed the study in groups of 6 or less on personal computers, with an order of assessment parallel to Study 1. Individual differences in psychopathy were again assessed by the LSRP (Levenson et al. 1995). Descriptive statistics for primary ($M = 2.05$; $SD = 0.47$; $\alpha = .86$) and secondary ($M = 2.15$; $SD = 0.41$; $\alpha = .63$) psychopathy were very similar to Study 1. In addition, the range of scores was substantial for both primary (1.06–3.18) and secondary

(1.20–3.40) psychopathy. The correlation between these two forms of psychopathy was $r = .29$, $p < .01$.

Motor Control Task

Equipment and programming for the motor control task were identical to Study 1, as was the number of trials (60). There were two key differences, however. Motor control had been assessed for 2,000 ms in Study 1. To obtain more extensive data, each trial of Study 2 consisted of 6,000 ms of motor control efforts. The sampling rate was 50 ms, resulting in 120 samples per trial. The other major change was the emotion-related manipulation. In Study 2, it was decided to manipulate aversive experiences during motor control efforts. Instructions stated that we were interested in abilities to perform two tasks simultaneously, one involving listening to sounds for a later memory test (which was not administered) and the other involving motor control. These instructions provided a rationale for the manipulation that occurred.³

Sound clips (6,000 ms each) from the well-validated database of Bradley and Lang (1999) were used. Fifteen (e.g., screaming, vomiting) were aversive (IAD-2 #s 115, 242, 255, 260, 261, 276, 277, 279, 282, 284, 292, 296, 422, 712, & 719) and 15 (e.g., cattle sounds, yawning) were neutral (IAD-2 #s 114, 130, 246, 262, 358, 364, 368, 373, 382, 425, 627, 701, 708, 722, & 723). Along the 1–9 rating scales of Bradley and Lang (1999), the aversive sounds were more unpleasant ($M = 2.24$) than the neutral sounds ($M = 4.84$), $F(1, 28) = 370.14$, $p < .01$, and also more arousing ($M = 7.06$) than the neutral sounds ($M = 4.68$), $F(1, 28) = 75.66$, $p < .01$. Sound clips of this type have been effectively used in other psychopathy studies (e.g., Verona et al. 2004), though in relation to different dependent measures than ours.

Trial procedures consisted of the following. A white + sign appeared in a random location on the computer screen, with the constraint that it could not be centered. A white + sign, representing the joystick cursor, appeared at center screen. Participants were to move the cursor to the target and hold it as steadily as possible on the target for 6,000 ms. When the cursor was within 5 pixels of the target, both horizontally and vertically, two events occurred. First, the cursor turned yellow, indicating that the motor control portion of the trial had begun. Second, a sound clip was selected and played over headphones at a loud, but reasonable volume (~80 dB). Sounds were chosen randomly without replacement, such that each

sound was played twice and there were 30 trials of each type—neutral and aversive. At the end of 6,000 ms, the sound stopped and participants were instructed to return the cursor to center screen. After they had done so, there was a 250 ms blank delay until the next trial started.

Motor control performance was quantified as in Study 1, but in the context of 120 samples per trial. After scoring each trial, means were then calculated across the 30 trials of each condition, separately so by participant. The latter means were log-transformed for analysis purposes because this transformation normalizes the skew typical of cognitive measures (Robinson 2007), but results are reported in terms of original (non-transformed) units because such units are more intuitive in appreciating a pattern of findings (Robinson 2007).

Results

Motor control performance was examined in two GLMs, with condition (unpleasant versus neutral) as a within-subject predictor and z-scored variations in a type of psychopathy as a continuous, between-subjects predictor. In the GLM involving primary psychopathy, there was a main effect for Primary Psychopathy, $F(1, 76) = 4.28$, $p < .05$, no effect for Condition, $F(1, 76) = 1.38$, $p > .20$, and no Primary Psychopathy by Condition interaction, $F < 1$. Estimated means for the primary psychopathy main effect are reported in the top panel of Fig. 2. Motor control was 200 % worse at the high relative to low level of primary psychopathy. Note that the subtle interaction of Study 1 was not replicated and is therefore not robust.

Results were similar for secondary psychopathy. In this analysis, there was a main effect for Secondary Psychopathy, $F(1, 76) = 5.02$, $p < .05$, no main effect for Condition, $F(1, 76) = 1.38$, $p > .20$, and no Secondary Psychopathy by Condition interaction, $F < 1$. Estimated means for the secondary psychopathy main effect are reported in the bottom panel of Fig. 2. Motor control was 254 % worse at the high relative to low level of secondary psychopathy.

As in Study 1, follow-up GLMs were performed in which sex was added to the more streamlined GLMs reported above. One, for example, examined the effects of primary psychopathy, sex, condition, and all two-way and three-way interactions among these predictors. No effect involving sex—whether main effect or interaction—was significant, all $ps > .25$.

Study 1 established that motor control varies by what is common to primary and secondary psychopathy rather than what is unique to one type of psychopathy relative to the other. We performed two regression-based analyses to determine whether the same was true in Study 2. We first conducted a multiple regression in which the common variance between primary and secondary psychopathy was controlled for. When removing this common variance, neither Primary Psychopathy, $t = 1.40$, $p > .15$, nor Secondary Psychopathy, $t = 1.82$, $p > .05$,

³ Participants were not probed for awareness of the possible influence of the manipulation on motor control. When we have probed for awareness using similar “dual task” instructions in the past, people have not spontaneously mentioned that one task involved some sort of condition difference (i.e., a manipulation) that might affect what they were subsequently asked to do.

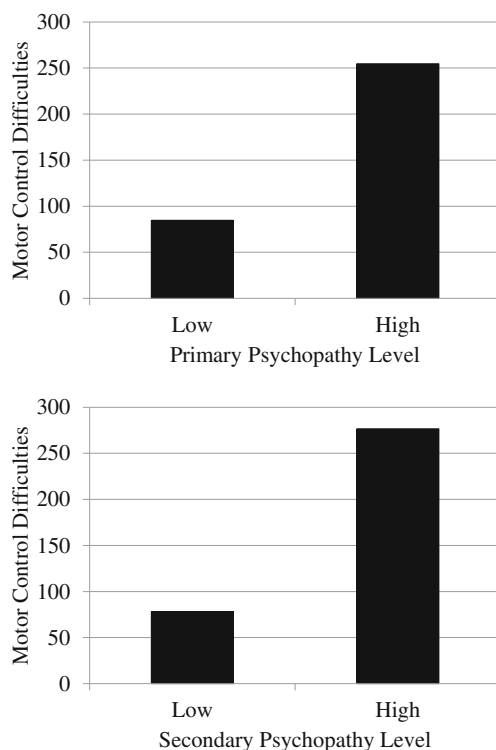


Fig. 2 Motor control difficulty estimated means as a function of primary psychopathy (*top panel*) and secondary psychopathy (*bottom panel*), Study 2

predicted motor control deficits. When averaging primary and secondary psychopathy, the overall psychopathy score was a robust predictor of motor control, $t=2.72$, $p<.01$, $Beta=.30$. The Study 2 results therefore closely replicate those of Study 1 in suggesting that people higher in psychopathy, regardless of its form, have poorer motor control.

General Discussion

Two studies pursued the idea that higher levels of psychopathy can be linked to less effective motor control. To circumvent concerns about self-reports (Baumeister et al. 2007), an objective performance task was used. The task was one in which control cannot be perfect, rendering it sensitive to individual differences in the executive control of the motoric system (Newell et al. 2009). Both studies found inverse relations between psychopathy and motor control. Estimated means differed greatly by psychopathy and motor control deficits were common to its primary and secondary forms. The relationships were general in nature in that they were not exacerbated by manipulations of aversive experience. The findings are discussed in terms of their implications for understanding individual differences in psychopathy and future research directions are also presented.

Executive Functions and Motor Control in Psychopathy

Individual differences in “executive functions”—i.e., those mediated by the frontal cortex (Goldberg 2009)—have primarily been investigated in tasks that might be viewed as inhibition-related in nature. For example, the classic Stroop task (MacLeod 1991) requires people to inhibit distracting sources of information present on some trials relative to other trials. The motor control tasks administered in the present studies were quite different. First, motor output rather than cognition was to be controlled. Second, there were no congruent or incongruent conditions. Rather, every trial assessed the extent to which control was effectively administered. Third, we could quantify moment-to-moment variations in control on individual trials in a manner consistent with the kinesiology literature (Slifkin and Newell 1998) relative to quantifications in which there is only one data-point per trial (Sanders 1998).

Such considerations aside, it is useful to discuss the present findings in relation to work on psychopathy and executive processing deficits owing to this work’s similar focus on deficits in control. Two studies (Blair et al. 2006; Lapierre et al. 1995) have linked psychopathy to poorer performance in tasks thought to be mediated by the orbitofrontal cortex (OFC), but not to poorer performance on other tasks thought to be mediated by the dorsolateral prefrontal cortex (dlPFC). The OFC plays a role in reversing previously reinforced associations (Rolls 2005), but it also plays a role in mitigating impulsive responding (Lapierre et al. 1995), including in tasks such as the go/no go task (Roussy and Toupin 2000). Along the latter lines, Lynam et al. (1999) found that both primary and secondary psychopathy were predictive of commission errors in go/no go tasks. Our findings, we think, should be viewed as compatible with the Lynam et al. (1999) findings and with this OFC perspective of psychopathy.

By contrast, predictions for more traditional interference-related dlPFC tasks such as the flanker effect (Kerns et al. 2004) are more complicated (Zeier et al. 2012). There are sources of data to suggest that psychopaths may “gate out” irrelevant perceptual inputs at an early level of processing (e.g., Hiatt et al. 2004). Accordingly, it may not be surprising that links of psychopathy to such traditional executive processing tasks are not particularly consistent across studies (Ogilvie et al. 2011). Our task was not of this dlPFC type in that cognitive sources of interference were not manipulated. It is likely in part for this reason that robust links of psychopathy to motor control deficits were found.

Secondary psychopathy, relative to primary psychopathy, is often the better predictor of seemingly dysregulated outcomes such as substance abuse, aggression, and criminality (Benning et al. 2003; Falkenbach et al. 2007). Yet, both forms of psychopathy have been linked to traits thought to reflect lower effortful control (Miller et al. 2011), personality disorder

symptoms of an “erratic” type (Miller et al. 2008), and antisocial behaviors and aggression (Sadeh and Verona 2008). In addition, there are theories (e.g., Moffitt 1993) and sources of data (e.g., Morgan and Lilienfeld 2000) indicating that antisocial behavior, which is common to primary and secondary psychopathy (Sadeh and Verona 2008), is predictive of deficits in executive functioning. On the basis of our findings, something like poorer effortful control, which is common to both primary and secondary psychopathy (Miller et al. 2008), appears to underlie problems with motor control. This would explain why controlling for overlapping variance among primary and secondary psychopathy resulted in a non-significant prediction of motor control deficits.

Even so, the psychopathy inventory administered may have a limitation in that the primary psychopathy scale of the LSRP (Levenson et al. 1995) appears more closely aligned with its secondary psychopathy scale than is the case when using the revised Psychopathic Personality Inventory, in which the primary factor has been termed fearless-dominance (PPI-R: Poythress et al. 2010). It is therefore possible that dissociations involving primary and secondary psychopathy could be found with the PPI-R scales, though it should also be mentioned that there are concerns related to the operationalization of primary psychopathy in the PPI-R (Miller and Lynam 2012) and the LSRP scales continue to have broad support (Falkenbach et al. 2007; Miller et al. 2008). Nonetheless, we suggest that motor control could be revisited in the context of alternative assessments of the various factors of psychopathy.

Aversive experiences did not interact with psychopathy to predict motor control. The results are therefore consistent with the idea that the psychopathy/control interface can be a basic one (e.g., Morgan and Lilienfeld 2000) that is independent of the emotional processing features that have sometimes been emphasized in this literature (e.g., Lykken 1995). It should be recognized, though, that the manipulations of aversive experience did not affect motor control in main effect terms, despite the within-subject power and strength (e.g., concurrent audio clips: Study 2) of this feature of the design. It is possible that affective manipulations that are more self-relevant (e.g., error feedback: Moeller and Robinson 2010) might have a larger influence on motor control. Alternatively, motor control may primarily vary by factors that are chronic and trait-related rather than temporary and state-related. Future research using other manipulations will be necessary to decide among these two possibilities.

Potential Clinical Significance and Future Research Directions

Our focus was on basic processes, but the findings possess potential clinical significance. Meyer and Kurtz (2006) have highlighted the limitations of self-reports in the clinical realm. Implicit assessments such as ours can bypass some such

limitations. For example, it is doubtful that one could “fake” higher levels of motor control when one lacks it. With appropriate norms, motor control performance may aid case conceptualization much as intelligence tests currently do (Kazdin 2008). Further, difficulties in motor control may alert the client and the assessor or therapist to targets of intervention (Shedler and Westen 2007). In turn, changes in motor control might inform treatment progress, in that successful treatment may be expected to improve motor control (Wiers and Stacy 2006). Finally, it is conceivable that training motor control might have some therapeutic benefit. This suggestion is plausible given current theories of self-regulation (Carver and Scheier 1998; Muraven and Baumeister 2000) and it is also consistent with cognitive retraining results in the mood disorder literature (Yiend 2004). At the very least, our findings highlight a robust correlate of psychopathy that deserves applied research attention.

There are further limitations to the present results and therefore several additional directions of research that can be advocated. It would be useful to conceptually replicate the present results using other tasks in which motor control can be assessed such as pinch grip force tasks or circle tracing tasks (see Slifkin and Newell 1998, for an overview of some of these tasks). Especially high levels of psychopathy, or at least its criminal manifestations, might not be especially prevalent among college undergraduates and replication with other—e.g., forensic (Hare 1993)—samples would be desirable. We focused on the dimension of psychopathy rather than its correlates and it would therefore be useful to investigate whether motor control difficulties can predict psychopathy-linked outcomes such as aggression (Reidy et al. 2011) and/or substance use (Miller and Lynam 2003). In this connection, we suspect that poorer motor control may be a robust predictor of externalizing behaviors of multiple types (e.g., those reviewed by Krueger et al. 2009) though establishing this point requires additional research. The predictive value of motor control might be further established by using longitudinal designs as the prediction of future externalizing problems may be of more clinical value than the prediction of problematic behaviors that have already occurred. Altogether, research of the type outlined would be useful in further validating the idea that people who display poorer motor control in basic tasks are likely to display self-control problems more generally considered.

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