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Power, Testosterone, and Risk-Taking

RICHARD RONAY* and WILLIAM VON HIPPEL
School of Psychology, University of Queensland Australia

ABSTRACT

Power has been found to increase risk-taking (Anderson & Galinsky, 2006) but this effect appears to be moderated by individual differences in power motivation (Maner, Gailliot, Butz, & Peruche, 2007). Among individuals high in power motivation, the experience of power leads to more conservative decisions. As testosterone is associated with the pursuit of power and status (Dabbs & Dabbs, 2000), we reasoned that high-testosterone individuals primed with power might be similarly risk-avoidant. Conversely, we hypothesized that high-testosterone individuals primed with low power, would see risk-taking as a vehicle for pursuing potential gains to their status and resources. We report findings from two experiments that are consistent with these predictions. In Experiment 1, higher testosterone males (as indicated by second–fourth digit ratio) showed greater risk-taking when primed with low power. Experiment 2 replicated this effect and also showed that when primed with high power, higher testosterone males took fewer risks. Copyright © 2009 John Wiley & Sons, Ltd.

KEY WORDS power; digit ratio; testosterone; risk-taking

The canvas of human history is thickly layered with struggles for power, privilege, and prestige. One such struggle took place in 50BC when the Roman Senate, led by Pompey, attempted to subjugate Julius Caesar by accusing him of treason and ordering him to return to Rome and disband his army. In response, with a single legion of men, Caesar re-entered Rome, crossing the Rubicon River and uttering the words, ‘‘Let the die be cast!’’. Thus began a civil war that set in motion the fall of the Republic and the emergence of the Roman Empire.

Why would Pompey, comfortably seated within the powerful echelons of the Roman elite, risk Caesar's wrath with such a challenge and then flee when the challenge was met? Why would a vastly outnumbered Caesar risk his life in response to such a challenge? One possible explanation can be found in research that suggests that the experience of power can lead individuals to assume unduly optimistic appraisals of the possible consequences of their actions, and subsequently take risks they would otherwise avoid (Anderson & Galinsky, 2006).

* Correspondence to: Richard Ronay, School of Psychology, University of Queensland, St Lucia, QLD, 4072, Australia.
E-mail: r.ronay@psy.uq.edu.au

POWER AND RISK-TAKING

Power refers to the capacity to influence others via the control of resources and the ability to administer rewards and punishments (Emerson, 1962; French & Raven, 1959; Anderson & Galinsky, 2006). This capacity appears to influence individuals in a number of ways that are relevant to risky decision-making. Power inspires action (Galinsky, 2003) and approach-orientations (Keltner, Gruenfeld, & Anderson, 2003), it shifts attention away from punishments and toward rewards (Keltner et al., 2003), and it leads to optimism and subsequent risk-taking (Anderson & Galinsky, 2006).

Despite the consistency of these findings, there is reason to suspect that the story might be more complicated than this. The quest for power is an ongoing tournament, with the winnings from one round subject to the outcome of the next. As a consequence, the powerful and the powerless enter each new contest from very different perspectives, with powerful individuals having much more to lose and powerless individuals having much more to gain. The fact that the balance of potential gains and losses is asymmetrically experienced by the powerful and powerless suggests that the two should be differentially disposed to risk. That is, the benefits of power should cause the powerful to avoid risks that place their privileges in jeopardy, and this effect should be stronger for those who value power more.

Support for this possibility is provided by the recent demonstration that the effect of power on risk-taking is moderated by individual differences in power motivation (Maner et al., 2007). Despite prior demonstrations that power increases risk-taking on average (Anderson & Galinsky, 2006; Galinsky, 2003), Maner and colleagues found that powerful participants who were high in power-motivation (defined as a high-motivation to achieve and maintain positions of power) took *fewer* risks than controls. Powerful participants with relatively low-power motivation on the other hand acted in a manner consistent with Anderson and Galinsky's (2006) findings, and took more risks. Furthermore, Maner et al. found that these results only emerged when participants perceived their power to be unstable. When the power structure was perceived as stable, both high- and low-power motivated participants responded with riskier decisions. Thus, for those high in power motivation, the possibility of losing their valued status was enough to avert them from the risk-taking that they freely pursued under more stable conditions.

TESTOSTERONE AND RISK-TAKING

Testosterone is one of several androgenic hormones that function to biologically differentiate the sexes in utero, and at puberty contribute to the emergence of secondary sexual characteristics. Testosterone is not only instrumental in the development of sexually dimorphic physical characteristics, but also contributes to psychological differences between the sexes. Higher levels of testosterone are associated with the pursuit of status seeking, dominance, competition, and violence (for a review see Mazur & Booth, 1998). For instance, lawyers with higher levels of testosterone are more likely to work within the adversarial field of trial law (Dabbs, Alford & Fielden, 1998) and prisoners with higher levels of testosterone are more likely to have a history of violent crime, to be rated as tougher by fellow inmates, and to violate prison rules in displays of overt confrontation (Dabbs, Carr, Frady, & Riad, 1995). Aside from competition, status seeking and dominance appear to be the two traits most reliably associated with testosterone (Booth, Granger, Mazur, & Kivlighana, 2006; Dabbs & Dabbs, 2000). Indeed, testosterone is so strongly associated with the pursuit of status that when this desire is not fulfilled, physiological arousal increases and cognitive functioning declines (Josephs, Sellers, Newman, & Mehta, 2006).

The fact that power motivation (measured via self reports of status seeking and dominance) has been shown to moderate the effect of power on risk-taking (Maner et al., 2007) suggests that the relationship between power and risk-taking might also be moderated by individual differences in testosterone. Maner and colleagues reasoned that when primed with power, individuals high in power motivation sought to avoid risks

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in the interest of maintaining the status quo. Based on this logic, we predicted that high-testosterone individuals would be similarly motivated to preserve their status by avoiding risk when in the possession of power.

EXPERIMENT 1

The goal of experiment 1 was to test whether the effect of power on men's risk-taking would be moderated by individual differences in testosterone. We specifically wished to target males as they characteristically engage in greater risk-taking (Byrnes, Miller, & Schaefer, 1999), particularly in situations that can be construed as a challenge to their masculinity (Ronay & Kim, 2006). Based on the findings of Maner et al. (2007), and consistent with the main effect found by Anderson et al. (2006), we predicted that men with lower levels of testosterone would show greater risk-taking when feeling powerful than when feeling powerless. In contrast, for men with higher levels of testosterone, we predicted greater risk-taking when primed with low as opposed to high power. To test these possibilities, we measured participants' digit ratios as a proxy indicator of testosterone.

One marker of exposure to testosterone in utero is the second–fourth digit ratio (2D:4D) on a person's right hand, with higher testosterone exposure resulting in a lower 2D:4D ratio (Manning, 2002). Thus, 2D:4D is frequently used in studies seeking to explore the effects of pre-natal exposure to testosterone, and as a proxy for individual differences in testosterone. 2D:4D has been shown to correlate with higher levels of circulating testosterone (Manning, Scutt, Wilson, & Lewis, 1998) as well as a range of sexually dimorphic traits; including sensation seeking (Fink, Neave, Laughton, & Manning, 2006), aggression (Millet & Dewitte, 2007), and dominance (Neave, Laing, Fink, & Manning, 2003).

Method

Participants

Fifty-nine 1st year male psychology students participated in exchange for course credit.

Materials and procedure

Participants were randomly assigned to either a high-power or low-power condition. To manipulate power, we followed the priming procedure used by Anderson and Galinsky (2006). Participants in the high-power condition were given the following instructions:

> Please recall an incident in which you had power over another individual or individuals. By power, we mean a situation in which you controlled the ability of another person or persons to get something they wanted or were in a position to evaluate those individuals. Please describe this situation in which you had power -what happened, how you felt, etc.

Participants in the low-power condition read the following instructions:

> Please recall a particular incident in which someone else had power over you. By power, we mean a situation in which someone had control over your ability to get something you wanted or was in a position to evaluate you. Please describe this situation in which you did not have power - what happened, how you felt, etc.

Following the power manipulation, participants completed the computer-based risk task from Maner et al. (2007), known as the Balloon Analogue Risk Task (BART; Lejuez et al., 2002). The BART presents an

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onscreen balloon and pump, as well as a temporary and permanent bank. Participants are instructed to use the pump to expand the balloon, and with each pump they earn one cent in a temporary bank. However, with each pump the risk increases that the balloon will explode, and if this happens all money in the temporary bank is lost. To avoid this outcome, participants can choose to safeguard their winnings at any point by transferring the money earned from the temporary bank to their permanent bank, at which point they move on to the next balloon. In total, participants were presented with 10 balloons, and they moved from one to the next either as a result of the balloon exploding, or their decision to stop pumping the balloon and transfer the money accrued thus far. This task measures risk-taking, as the desire to continue pumping up the balloon to earn more money is offset by the fear that the balloon will pop and all money on that balloon will be lost.

The probability of a balloon exploding on the first pump is 1/128, for the second it is 1/127 and so on, until a probability of 1/1 is reached on the 128th pump. The task is designed to mirror the contingencies of many real-life risk activities, with proportional gains diminishing and the chance of all gains being lost increasing with each additional pump. Willingness to tolerate these increments is taken as a measure of participants' risk-taking propensity. The BART has demonstrated convergent validity with Zuckerman's (1994) sensation seeking scale, as well as self-reported impulsiveness, smoking, alcohol and other drug use, gambling, and theft (Lejuez et al., 2002). To enhance the possibility that participants would perceive their actions on the BART as reflecting genuine risk, participants were promised their winnings would be paid at the conclusion of the experiment (average winnings were $2.40 AUD [~$2 USD], *SD* = $0.81).

At the conclusion of the experiment participants positioned their hands palm down on a flatbed scanner and images of both hands were captured. Lengths of the second–fourth digits were then measured from the ventral proximal crease of the digit to the tip of the finger using the "Measure" tool in Adobe Photoshop. Measurements were computed in the absence of any other information about the participant.

Results

As a manipulation check, two independent coders (Cohen's $\kappa = .73$) rated 50% of the autobiographical recounts on a 7-point scale for the amount of power the participant had in each recount (1 = very little, 7 = a lot). As expected, participants in the high-power condition described themselves as possessing more power ($M = 5.00$, $SD = .69$) than those in the low-power condition ($M = 2.25$, $SD = .71$), $F(1,28) = 92.02$, $p < .001$.

Digit ratio was computed by dividing the length of the 4th digit on the right hand by the length of the second digit on the right hand. It is standard practice to use the right hand in 2D:4D research (Manning, 2002), as sexually dimorphic traits in general, and particularly 2D:4D ratios, tend to be more strongly expressed in the "male form" on the right side of the body than the left (Tanner, 1990). The mean 2D:4D of the right hand was 0.95 ($SD = .03$) with lower ratios reflecting exposure to higher levels of testosterone in utero.

Risk-taking on the BART was computed as the average number of pumps on unexploded balloons (as in Maner et al., 2007). We opted to use this adjusted average, as the variance in pumps on the exploded balloons is restricted, thereby reducing between subject variability (Lejuez et al., 2002). To examine the effect of the power manipulation and digit ratio on the BART, the BART score was regressed simultaneously on a dummy-coded condition variable and participants' digit ratios in the first step of the model, and on their interaction term in the second step of the model. This analysis revealed no main effect for condition, $\beta = .02$, $t(56) = .11$, $p = .91$, or digit ratio, $\beta = -.11$, $t(56) = -.80$, $p = .43$. However, the analysis revealed the predicted interaction between these variables, $\beta = .31$, $t(55) = 2.21$, $p = .03$, *r-squared change* = .08. As can be seen in Figure 1, this interaction was composed of a significant negative relationship between digit ratio and the BART for participants in the low-power condition, $\beta = -.36$, $t(27) = -2.01$, $p = .05$, and a non-significant positive relationship for those in the high-power condition, $\beta = .24$, $t(28) = 1.31$, $p = .20$. Thus, lower digit ratios (associated with higher testosterone) predicted increased risk-taking on the BART in the low-power condition, but not in the high-power condition.

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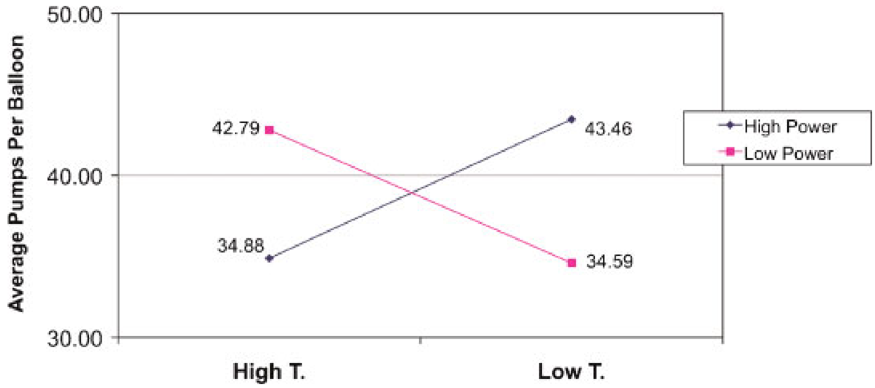

Figure 1. Mean pumps per unexploded balloon on BART task by condition and testosterone at 1 SD above and below the mean

Discussion

The results of Experiment 1 suggest that the effect of power on risk-taking is moderated by individual differences in testosterone. When feeling low power, males whose digit ratios suggested higher levels of testosterone were more risk-seeking than lower testosterone participants. Although the interaction between power and testosterone on risk-taking was partially driven by the reverse pattern in the high-power condition, here the simple effect was non-significant.

This interaction between power and testosterone on risk-taking is conceptually consistent with the findings reported by Maner et al. (2007) concerning power motivation. In their research, individuals with low-power motivation moved toward risk-seeking when assigned to positions of power, while individuals with high-power motivation moved away from risk-seeking when assigned to positions of power. As higher testosterone levels are associated with behaviors intended to gain and maintain power and status (Mazur & Booth, 1998), the findings reported here are consistent with predictions derived from Maner et al. (2007).

The current data also extend Maner et al.'s (2007) findings, which focussed solely on the experience of high power, by revealing effects of low power. The present data show that under conditions of low power, higher levels of testosterone predict enhanced risk-taking. Although this finding is consistent with Maner et al.'s (2007) conceptual framework, it does not follow directly from their findings as they did not include a low-power condition. Nonetheless, existing biosocial approaches to the study of testosterone and its effects on behavior suggest that it is during such threats to status that testosterone should be most predictive of behaviors such as risk-taking (see Booth et al., 2006).

EXPERIMENT 2

Experiment 1 provided evidence that the effect of power on risk-taking is moderated by individual differences in testosterone. Nevertheless, the relationship between digit ratio and risk-taking was not significant in both low- and high-power conditions, suggesting that perhaps the measure of risk-taking was insufficiently compelling. Experiment 2 sought to address this issue by creating a risk-taking measure that mirrored the parameters of the BART regarding future gains and losses, but also introduced the possibility of immediate punishment.

The consequences of unsuccessful risk-taking on the BART task were delivered in the form of lost temporary gains, as all accumulated winnings for that particular balloon were lost. This threat of losing accumulated gains should move participants toward risk-aversion as their temporary bank grows in size. In this instance, however, participants' fear of losing relatively meager gains (accrued at 1 cent per pump) may

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have been insufficient to induce a motivation toward risk-aversion, even in people otherwise inclined toward such a conservative approach. We therefore replaced the BART in Experiment 2 with a new measure that introduced a punishment in the form of an unpleasant tactile response.

Method

Participants

Sixty-five 1st year male psychology students participated in exchange for course credit.

Materials and procedure

Participants were randomly assigned to either a high-power or low-power condition, which was manipulated as in Experiment 1. Following the power manipulation, participants were invited to play a risk-taking game that used a commercially available electronic device known as the ''shock ball''. The ball holds a small electric charge and delivers a mild electro-tactile response at randomly determined intervals. Participants were told they could win money by holding the ball for as long as they dared, with every additional second they chose to do so resulting in an additional point being earned. However, if the ball was held past a randomly determined point, the timer would cause the ball to flash red and deliver a shock to the participant's hand. In addition to the shock, participants were informed that all points accrued for that ball would then be lost. Thus, our version of the shock ball game was modeled after the BART as designed by Lejeuz et al. (2002), but with the addition of an immediate mild punishment in cases of failed risk-taking. Participants were given 10 turns at this game, and were informed that the person who managed to accrue the most points across 10 trials would win a cash prize of $50 (similar to Maner et al., 2007). After having the game described to them, participants were reminded that they could choose to decline to participate in this component of the study.

Additionally, it should be noted that the decision to include the shock ball as a measure of risk-taking was not entered lightly. Although the shocks represented no real physical risk to participants, the experience of being shocked is an unpleasant one. Thus, we also considered alternatives such as the possibility of increasing the number of cents per pump and thereby increasing the potential for loss and subsequent risk-aversion. Ultimately however we felt that in many instances of real-world risk-taking, particularly in the world of young adult males, the negative consequences associated with unsuccessful risk-taking tend to be both more immediate and more visceral in nature than the potential loss of money. The inclusion of the electric shock associated with failure was meant to mirror this reality.

Results

The effectiveness of the power prime was checked by randomly selecting half of the power recall tasks and having two independent coders (Cohen's $\kappa = .77$) rate the amount of power possessed by participants in the descriptions on a 7-point scale (1 = very little, 7 = a lot). Those in the high-power condition described themselves as possessing more power $M = 5.60$, $SD = .70$ than those in the low-power condition, $M = 2.50$, $SD = 1.40$, $F(1,28) = 43.33$, $p < .01$. Digit ratio was calculated in the same manner as in Experiment 1.

Seven of the 65 participants declined to participate in the shock ball game. Analysis revealed that these decisions varied as a function of experimental group, $\chi^2 = 8.09$, $p < .01$, with all seven abstainers belonging to the low-power group. In addition, logistic regression revealed that this decision to decline was predicted by higher digit ratios (indicative of lower levels of testosterone), *Wald = 5.50, p < .02*. Although self-selection is undesirable (if necessary for ethical reasons), this particular self-selection effect is unlikely to have caused the predicted interaction. The participants who declined to play were predicted to be risk-averse (low power/low testosterone), and it seems relatively safe to assume that had they been forced to play,and they would have

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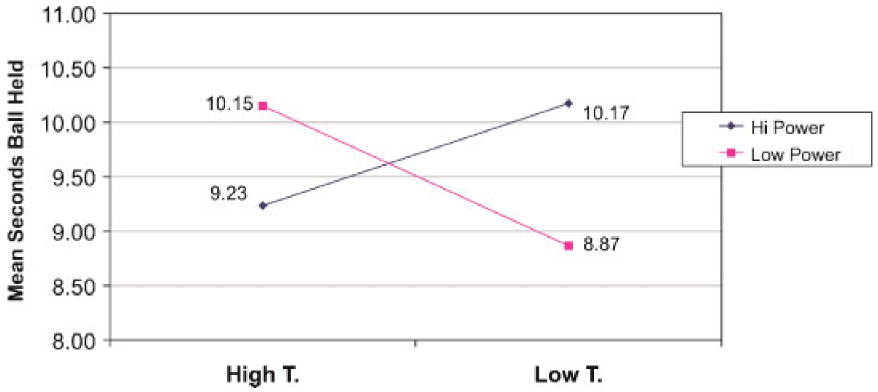

Figure 2. Mean time Shock Ball held by condition and testosterone at 1 SD above and below the mean

been quick to drop the shock ball. Indeed, this self-selection effect was consistent with predictions that low-testosterone males primed with low power would be relatively risk-averse. And, of course, their lack of participation would have no bearing on the predicted simple effect in the high-power condition.

To create a dependent variable from the shock ball that was parallel to the measure derived from the BART, risk-taking on the shock Ball was scored as the average time the ball was held on all trials that did not culminate in the delivery of a shock. This score was then simultaneously regressed on a dummy-coded condition variable and participants' digit ratios in the first step of the model, and on their interaction term in the second step of the model. This analysis revealed no main effect for condition, $\beta = -.01$ $t(54) = -.07$, $p = .95$, or digit ratio, $\beta = .07$, $t(54) = .47$, $p = .64$. As in Experiment 1, an interaction emerged in the second step of this model, $\beta = .42$, $t(53) = 3.12$, $p < .01$, *r-squared change* = .16. As can be seen in Figure 2, this interaction was composed of a significant positive relationship between digit ratio and risk-taking in the high-power condition, $\beta = .37$, $t(31) = 2.22$, $p = .03$, and a significant negative relationship in the low-power condition, $\beta = -.44$, $t(22) = -2.27$, $p = .03$. Thus, lower digit ratios (associated with higher testosterone) predicted increased risk-taking on the shock ball in the low-power condition, but decreased risk-taking in the high-power condition.

Discussion

Experiment 2 replicated the interaction between testosterone and power on risk-taking found in Experiment 1, and as predicted, the effect was slightly stronger with a physical analogue of the risk-taking task that included the possibility of immediate punishment. Consistent with predictions, higher testosterone males were inspired to greater risk-seeking when primed with low power, whereas lower testosterone males were more risk-seeking when primed with high power.

GENERAL DISCUSSION

Taken together, these studies suggest that power does not universally inspire risk-taking among men. Rather the effect appears to be subject to individual differences in pre-natal exposure to testosterone. Experiment 1 demonstrated that under conditions of low power, higher levels of testosterone (as indexed by digit ratio) are predictive of greater risk-taking. Experiment 2 replicated this effect with an alternative measure of risk-taking that offered a more salient potential punishment as a consequence for unsuccessful risk-taking. Experiment 2 also revealed that under conditions of high power, lower levels of testosterone are predictive of greater risk-taking. Higher testosterone males therefore appear to take more risks under conditions of low power, while lower testosterone males take more risks under conditions of high power.

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The greater risk-taking displayed by our lower testosterone participants when primed with high power is consistent with the findings of Anderson and Galinsky (2006). In their paper they reasoned that the experience of power leads to risk-taking via the promotion of an optimistic frame of mind and lowering of one's risk-perception, and the current data with low-testosterone individuals present no challenge to this explanation.

In contrast to these findings with low-testosterone individuals, the behavior of the high-testosterone participants appears inconsistent with the overall pattern of findings from Anderson and Galinsky (2006). As noted above, this inconsistency might be best understood by considering testosterone's links with power motivation. Higher levels of testosterone are associated with the pursuit of status, dominance, and competition (Booth & Osgood, 1993; Dabbs & Dabbs, 2000; Josephs et al., 2006; Mazur & Booth, 1998), qualities that have been shown to moderate the effect of power on risk-taking (Maner et al., 2007). Maner and colleagues argue that for those high in power motivation, the experience of power acts as a signal that their wish for power is being fulfilled, thus prompting a desire for the status quo. It may well be that the risk-aversion displayed by high-testosterone participants in the present studies is similarly facilitated by a desire for stability when their power needs are met. As such, the manner in which the perceived stability of dominance hierarchies might moderate the interaction reported here represents a possible avenue for future research. It seems likely that the experience of irrevocable, as opposed to unstable power would overcome the proposed motivation thought to underlie the risk-averse pattern of responding observed among high power, high-testosterone males. Whether irrevocable low power would similarly quell the risk-seeking behaviors observed among high-testosterone males is also an interesting question. Additionally, the role of optimism and approach orientation in the current findings is untested, but inclusion of such measures might clarify the relationship between the current findings and those of Anderson and Galinsky (2006), which at the moment remains an open question.

The current data contribute to research suggesting that testosterone is most likely to predict behaviors when situational pressures interact with baseline levels of the hormone (Josephs et al., 2006; Kemper, 1990; Newman, Sellers, & Josephs, 2005). Testosterone was not a unidirectional predictor of behavior in the current studies, as it interacted with feelings of power to determine risk-taking. Future research might expand on this interactionist approach by identifying other situations that determine when testosterone leads to greater versus less risk taking. Future research might also explore the psychological states that mediate these behavioral propensities induced by testosterone. Although the current results follow from the findings of Maner et al. (2007) regarding power motivation, and the known effects of testosterone on power motivation (Booth & Osgood, 1993; Dabbs & Dabbs, 2000; Josephs et al., 2006; Mazur & Booth, 1998), there was no direct test of this relationship in the current experiments. Thus, future research might assess whether the moderating effect of testosterone is itself mediated by explicit or implicit indicators of desire for power. Such a cognitive mediator of a hormonal effect on a behavioral outcome would provide compelling evidence for proximal mechanisms whereby hormones exert their effect on behavior.

The present research also has practical implications for those wishing to understand how power is won and how it is lost. Data from the two studies reported here suggest that higher testosterone might be associated with high status in dominance hierarchies because high-testosterone individuals are willing to take risks in the pursuit of power but then are risk-averse once they have secured power. The finding that lower testosterone males finding themselves in positions of power are more likely to take subsequent risks suggests that such individuals may be unlikely to remain in power for long. Subsequent studies might seek to explore whether the effects reported here replicate within different populations and using more domain-specific measures of risk-taking. Would high-testosterone financial traders for instance take greater financial risks when primed with a low-power threat?

Finally, we expect that the relative weighting of potential gains to losses is likely to be critical to shape the interaction reported here. Future research might seek to determine how sensitivity to potential rewards and losses is affected by the interaction between power, individual differences in testosterone, and power motivation''.

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Caveats and limitations

The studies reported here have used digit ratio as a proxy measure for individual differences in testosterone. The relationship between 2D:4D and testosterone is a complex one as 2D:4D correlates with circulating testosterone (Manning et al., 1998), pre-natal testosterone exposure (Manning, 2002), and sensitivity to testosterone (Manning, 2003). Despite these various relationships, digit ratio is probably most reliably used as a marker of pre-natal testosterone exposure (Manning, 2002) rather than circulating testosterone (Honekopp, Bartholdt, Beier, & Liebert, 2007). Nevertheless, it is not completely clear what the effects of 2D:4D reflect. To the extent that 2D:4D implicates a range of biological processes that shape the brain during development (Dabbs & Dabbs, 2000; De Vries & Simerly, 2002; Manning, 2002), a variety of testosterone-relevant processes might be responsible for the moderating influence observed in the current studies. Nevertheless, some aspect of the relationship between 2D:4D and testosterone is likely to underpin the current findings, as these results follow from our understanding of testosterone and seem unlikely to be related to other aspects of finger length.

Conclusion

If we return to Caesar's risky decision to defy the Roman Republic by crossing the Rubicon and committing himself to civil war, we can interpret his behavior as consistent with the findings of the current experiments. For individuals high in testosterone, and thus high in power motivation, the denial of power appears to motivate them toward risk-seeking behaviors, presumably in an effort to gain or regain power. The current research suggests that inducing high-testosterone individuals to feel powerless may remove a subjective state with which they are generally accustomed, or to which they orient (Cashdan, 1995; Dabbs et al., 1998; Dabbs, de la Rue, & Williams, 1990; Josephs et al., 2006; Mazur & Booth, 1998), thereby causing them to adopt a risky frame of mind. In contrast, when high-testosterone individuals are in positions of power, they tend to be risk-averse, apparently in an effort to avoid disrupting the status quo.

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Authors' biographies:

Richard Ronay received his BA and BPSYCH from Macquarie University in Sydney, Australia. He is currently a doctoral candidate in Social Psychology at the University of Queensland. His research interests include biosocial influences on decision-making, self-regulation, and evolutionary psychology.

William von Hippel is Professor of Psychology at the University of Queensland. He received his BA from Yale University and his PhD in Social Psychology from the University of Michigan. His interests include executive functioning, social cognitive aging, evolutionary psychology, and stereotyping and prejudice.

Authors' Addresses:

Richard Ronay and **William von Hippel**, School of Psychology, University of Queensland, St Lucia, Queensland, 4072, Australia

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