

Men's Physical Strength Moderates Conceptualizations of Prospective
Foes In Two Disparate Societies

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Abstract

Purpose: Across taxa, strength and size are elementary determinants of relative fighting capacity; in species with complex behavioral repertoires, numerous additional factors also contribute. When many factors must be considered simultaneously, decision-making in agonistic contexts can be facilitated through the use of a summary representation. Size and strength may constitute the dimensions used to form such a representation, such that tactical advantages or liabilities influence the conceptualized size and muscularity of an antagonist. If so, then, given the continued importance of physical strength in human male-male conflicts, a man's own strength will influence his conceptualization of the absolute size and strength of an opponent.

Methods: Male participants' chest compression strength was compared with their estimates of the size and muscularity of an unfamiliar potential antagonist, presented either as a supporter of a rival sports team (Study 1, conducted in urban California, and Study 2, conducted in rural Fiji), or as a man armed with a handgun (Study 3, conducted in rural Fiji).

Results: Consistent with predictions, composite measures of male participants' estimates of the size/strength of a potential antagonist were inversely correlated with the participant's own strength.

Conclusions: Consonant with a history wherein violent intrasexual selection has acted on human males, a man's own physical strength influences his representations of potential antagonists.

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Key words: relative formidability; fighting capacity; cognitive representation; size; strength

Introduction

Across a wide variety of species, agonistic conflicts with conspecifics are a principal determinant of access to resources, territory, mating opportunities, and other contributors to fitness (Ellis 1995). In any such species, if, for the sake of simplicity, we hold constant the stakes at issue, then, the cost/benefit ratio of engaging in conflict is a function of both the probability of victory and the probable costs (time, energy, and the risk of injury or death) attending a given conflict. These probabilities will be a function of the relative fighting capacities, or formadabilities, of the combatants. While relative formidability is evident post hoc to the investigator by virtue of the outcome of contests, the simplicity of this observation belies the complexity of the cognitive task confronting individuals who must decide whether to fight, flee, appease, or negotiate. In many species, physical strength is a core component of fighting capacity. However, other factors, including body size, health, skill, armaments, and the size and cohesiveness of coalitions also influence the outcome of conflicts. In humans, the richness of our species' behavioral repertoire makes the picture more complex still, as, for example, access to offensive and defensive technologies will frequently be determinative in this regard.

Given the range of factors that contribute to relative formidability, optimal decision-making in situations of potential violent conflict hinges on assessing, tabulating, and comparing diverse features of self and other. Whenever multiple heterogeneous

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factors must be combined in one decision-making process, this process can be simplified by compiling the factors into a single summary representation. Because strength and body size are phylogenetically ancient determinants of fighting capacity – a pattern reinforced by inevitable and redundant experience during development – we should expect many species to be adept at both assessing these attributes and employing representations of such assessments in the decision-making process. In turn, this capacity can be coopted to represent many more factors that contribute to relative formidability. In short, as the complexity of a species' behavioral repertoire increases, the simple representational system that captures assessments of physical size and physical strength can come to serve the aforementioned summary function – size and strength can constitute the dimensions of a cognitive representation that summarizes multiple determinants of relative formidability, such that the greater the actor's formidability compared to that of the prospective opponent, the smaller and weaker the foe is conceptualized as being (Fessler et al. 2012). To be clear, we are concerned here not with the process of visual perception, but rather with the properties of a cognitive representation – conceptualized size and conceptualized strength are hypothesized to be the dimensions of an internal mental representation that summarizes the tactical assets and liabilities that each of the two parties (the self and the target of the assessment) would bring to a violent conflict.

Although still in its early phases, emerging research is consonant with this thesis. In humans, access to weapons is a key determinant of relative formidability, and, consonant with the aforementioned, knowing that a man possesses a weapon leads U.S.

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participants to estimate him to be larger and more muscular (Fessler et al. 2012). Similarly, paralleling the situation in many mammals, coalitional support also contributes to relative formidability in humans, and, correspondingly, the presence of allies leads men in the U.S. to estimate an opponent to be smaller and less muscular (Fessler and Holbrook 2013); likewise, cognizance that an enemy coalition has been degraded has the same effect (Holbrook and Fessler 2013). Risk-proneness is a component of relative formidability, as individuals who are less averse to the possibility of injury or death are more likely to engage an adversary in combat, and less likely to retreat if injured; correspondingly, among participants in both the U.S. and rural Fiji, risk-prone individuals are conceptualized as larger, more muscular, and more violent (Fessler et al., in press). Culture is an important source of information regarding the relative formidability typical of the members of various groups. Correspondingly, in the U.S., racist stereotypes that depict outgroup members as dangerous are accompanied – and mediated – by conceptualizations of increased size and muscularity (Holbrook et al. n.d.). Lastly, addressing an elementary determinant of relative formidability, being physically incapacitated increases U.S. men’s judgments of the size and muscularity of a potential antagonist, and decreases assessments of their own size (Fessler and Holbrook 2013b).

Additional support for the above representational thesis derives from recent work by other investigators who work outside of an evolutionary framework, and employ different measures. Yap, Mason, and Ames (2013) report that manipulating participants’ sense of power influences participants’ estimates of a target individual’s size and weight, where those induced to feel powerful underestimated these features of a target, while

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those induced to feel powerless overestimated them. Likewise, Duguid and Goncalo (2012) show that participants induced to feel powerful overestimate their own height and, secondarily, underestimate the height of a target individual.

While humans possess the most complex behavioral repertoire known, in face-to-face violent conflicts, physical strength nevertheless contributes to human fighting capacity just as it does in other species. This is most clearly evidenced by a) the value of strength/power conditioning in contemporary training for combat sports (Amtmann and Berry 2003; La Bounty et al. 2011), b) the ubiquitous use of weight categories in combat sports as a means to minimize strength differences between contestants, and c) the equally ubiquitous practice among combat sports athletes of dramatically reducing body weight just prior to contests in an attempt to obtain a strength advantage over opponents (Horswill 2009). Human males exhibit a wide variety of morphological attributes consistent with a history of intrasexual selection through agonistic competition (Archer 2009; Puts, 2010, Sell et al. 2012; Morgan & Carrier 2013). Correspondingly, by attending to such features, observers appear able to accurately judge a man's strength and fighting ability (Sell et al. 2009a; Sell et al. 2010; Třebický et al. 2013). Moreover, male morphology appears to be adaptively complemented by a corresponding psychology, as men who are stronger / better fighters report greater feelings of entitlement, lower tolerance for imposed costs, and greater use of and endorsement of violent or coercive tactics, with physical strength being a determinant of each (Gallup et al. 2007; Archer and Thanzami 2009; Sell et al. 2009b; Hess et al. 2010; Sell et al. 2012; Muñoz-Reyes et al. 2012; Petersen et al. 2013; but see also Price et al. 2012 for caveats). These sentiments

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reveal a motivational architecture attuned to the likelihood of victory in violent conflict, one that must necessarily be based on assessments of relative formidability. Moreover, the aforementioned representational thesis provides an avenue for exploring the inner workings of such assessments, as, if relative formidability is represented in terms of size and strength, then a man's own strength should inversely predict his conceptualization of a prospective foe's size and strength.

Importantly, if we are to explore the thesis that a man's own strength contributes to his representation of the relative formidability of an opponent (where that representation uses the dimensions of size and strength), then we must employ absolute rather than relative judgments. We would learn little about the relevant psychological mechanisms were we to ask, "Relative to you, how strong is a generic opponent?" as the participant could accurately answer the question simply by consulting past experience. For example, if, as the literature cited above strongly suggests, men know with reasonable certainty where they lie on the distribution of strength in the local population, then producing relative judgments of a generic opponent would involve nothing more than verbalizing this knowledge. In contrast, if we frame the question in absolute terms, then individual differences in responses potentially reveal the workings of the postulated representational system. Were responses to this query not influenced by said representations, they would consist merely of reports of the modal characteristics in the local population, with any deviations simply reflecting random variation in the accuracy of participants' knowledge in this regard. In contrast, if responses to this query are indeed influenced by the individual's representation of his own formidability, and if

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strength is a determinant of such formidability, then responses to questions posed in absolute terms should be systematically patterned with regard to attributes of the participants' own bodies.

Following the above logic, we predicted that stronger individuals would estimate a prospective foe to be smaller and weaker in absolute terms than would weaker individuals. We tested this prediction in three studies. Additionally, in light of the hypothesized use of size as one of the two dimensions with which relative formidability is represented, we also conducted exploratory tests of the effect of participants' own height on conceptualizations of prospective foes, although we did not have firm predictions in this regard.

To conduct the clearest test of our hypothesis, we limited our investigations to men. Although the same representational system exists in women (Fessler et al. 2012), and although strength undoubtedly plays a role in women's decision-making in agonistic contexts (Felson 1996), as noted above, morphological, behavioral, and psychological evidence indicates that selection for success in violent conflict has operated more strongly on human males, and hence we expect the predicted effect to be most pronounced in men.

Men readily employ a variety of phenotypic cues to assess other men's physical formidability (Sell et al. 2009a, 2010; Třebický et al. 2013). Given that violent male-male competition is relatively rare in many of the contemporary groups from which existing results derive, these patterns suggest that such competition was a sufficiently powerful source of selective pressure in the past as to shape male minds so as to be ever

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alert to this possibility. By the same token, even when interactions among men are friendly or potentially friendly, men may assess one another's physical formidability as part of an evaluation of their respective affordances as allies in combat. However, regardless of the truth of these conjectures, it is plausible to expect that mechanisms responsible for assessing relative formidability will be most active in contexts containing cues of the potential for agonistic interaction. Accordingly, the studies reported here were designed to lead participants to infer the possibility of such events.

The popularity of team sports arguably reflects the extent to which these activities engage evolved motives active in coalitional violence (Fessler and Haley 2003); correspondingly, violent altercations between fans of rival teams are not uncommon. In studies of many contemporary populations, sports rivalries thus provide an avenue for implicitly framing a target individual as a prospective foe. Because we expect the predicted patterns to be most evident in contexts containing cues of the potential for agonistic interaction, sports rivalries thus provide a useful context for testing our predictions. Study 1 employed this tactic among a sample of University of California, Los Angeles (UCLA) male undergraduate students, examining the effects of participants' own strength on their estimates of a target man's size and strength. While both useful and convenient, Western university samples nevertheless often provide only limited evidence in tests of postulated human universals. Study 2 therefore employed the same tactic among rural Fijian men, a culturally and technologically disparate sample compared to that of Study 1. Lastly, because the postulated mechanism is expected to operate in both coalitional and non-coalitional agonistic interactions, Study 3, also

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conducted in rural Fiji, removed the implicit framing of coalitional violent conflict, replacing it with indications that the target individual was armed, and thus would pose a danger if hostile.

All studies reported in this paper were approved by the UCLA Office of Human Research Protection Program. Informed consent was obtained from all participants.

Study 1

Participants

Thirty-nine adult male undergraduates were recruited while walking alone on the UCLA campus and invited to participate in exchange for \$3 compensation. Four visiting foreign students who did not speak fluent English were dropped, leaving a final sample of 35 males ranging in age from 18 to 28 years ($M = 20.9$; $SD = 2.18$).

Materials and Procedure

In order to minimize the likelihood that participants would use the researcher as a reference point in making assessments, data were collected by a single female research assistant. Using sports rivalries as an avenue for implicitly framing a target individual as a foe, we recruited participants during the highly-publicized March Madness national basketball tournament, asking them to evaluate a target man described as a student at the University of Southern California (USC), our university's principal rival; UCLA's basketball team was competing in the tournament during data collection. The study was framed as relating physical strength to various aspects of visual perception.

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On the first page of the survey packet, participants were informed that the study was being conducted by researchers at UCLA and USC to explore the ability to discern various types of information from visual imagery; the page prominently featured both “UCLA Bruins” and “USC Trojans” logos. Following several filler / distracter measures involving visual judgment (e.g., estimating how many colors were originally present in a photograph of jellybeans that had been converted to grayscale), participants were shown a facial photograph of target male depicted in a grayscale image cropped to mask his bodily characteristics (see Figure 1). The caption read: “This face photo was taken from a pool of photographs taken of USC students. The researchers measured the USC students’ bodily characteristics. Now, your task is to estimate the student’s bodily characteristics using only the face photo.” In actuality, the face image was taken from the Radboud Faces Database (Langner et al. 2010). Participants estimated the target individual’s height in feet and inches, to the nearest half-inch, and used 6-item pictorial arrays (see Figure 1) to estimate his overall body size and muscularity. Demographic items followed, including self-reported height (to the nearest half-inch).

Chest compression strength is a representative measure of male upper-body strength, a key component of fighting capacity; correspondingly, this measure predicts conflictual self-interested attitudes (Sell et al. 2009a; Hess et al. 2010; Sell et al. 2012). Following Sell et al. (2009a), using a hydraulic dynamometer (manufacturer: Baseline) with its handles inverted, we next measured chest compression strength as follows: After grasping the handles, participants were instructed to hold the device at mid-chest height with elbows extended and feet spaced shoulder-width apart. Participants were

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encouraged to press inward as hard as possible. Participants repeated the strength measure three times each; the highest score was used.

Upon completion, participants were debriefed, thanked, and questioned for suspicion about the purpose of the study. None evinced suspicion that the study involved competition with USC or links between one's own physical strength and one's estimations of attributes of the target USC student.

Results

All analyses reported in this paper are two-tailed, $\alpha = .05$.

Estimated height/size was computed by averaging standardized height estimates and size array ratings. Composite physical formidability scores were created by averaging the height/size and standardized muscularity scores. As predicted, participant strength significantly correlated with estimations of the target's composite formidability (see Table 1). Follow-up tests assessing separate estimations of height/size and muscularity revealed a significant negative correlation between strength and the envisioned muscularity of the target. Strength was also negatively correlated with the envisioned height/size of the target, but did not reach significance (see Table 1).

In a marginally significant trend, participant height predicted the target's estimated composite formidability, $r(35) = -.32, p = .062$. Follow-up tests revealed a significant negative correlation between participant height and the envisioned height/size of the target, $r(35) = -.34, p = .046$. Participant height was negatively correlated with envisioned muscularity of the target, but not significantly, $r(35) = -.19, p > .25$.

Discussion

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The thesis at issue addresses a postulated species-typical psychological adaptation. Accordingly, the predicted inverse relationship between own strength and conceptualizations of an antagonist's absolute size and strength documented in Study 1 should obtain universally. Western undergraduates are outliers on many psychological dimensions (Henrich et al. 2010), and are awash in media portrayals of culturally schematized male-male interactions. Because it is unclear how a wide variety of attributes unique to populations such as that which we sampled in Study 1 might have shaped our participants' responses, it is therefore critical that the thesis at issue be tested in a population that differs along many conceivably relevant dimensions. Rural Fiji affords such testing, as the population is culturally and experientially disparate from that of a Western university.

Studies 2 and 3 recruited men from small villages on Yasawa Island, Fiji, individuals who have far less exposure to formal education and global media than is typical in the West. On average, Yasawan villagers complete eight years of primary school within their villages but do not go on to secondary school. At the time of these investigations, there was no reliable electricity in the villages, nor were there any satellite dishes – although televisions were common as household ornaments. Moreover, in contrast to life at an urban Western university, subsistence activities allow Yasawan men to frequently directly assess one another's strength. Subsistence activities produce 75% of calories consumed in Yasawan villages, with men's activities involving daily tending of household gardens and spear or line fishing. Village life also includes frequent collective fishing, farming, house building, and village cleaning events. Pick-up rugby games and

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inter-village rugby tournaments are also common, affording additional opportunities for physical assessment. In light of norms governing male-female interactions, both studies were administered by male researchers. The studies reported here were conducted as part of a larger long-term project encompassing multiple features of life in a number of villages on Yasawa, hence participants were familiar with participation in structured scientific research. For a fuller ethnographic description of life in the region, see Henrich and Henrich (in press) and Gervais (2013).

Study 2

Participants

All 43 adult male residents (age 18-79; $M = 42.67$.N; $SD = 15.70$) present in two Yasawan villages were recruited. No compensation was offered for this study; rather, the larger study of social life on Yasawa Island within which this study was embedded periodically provides cash and assistance to villagers.

Materials and Procedure

Rugby – a sport happily described by many practitioners as a form of coalitional violence – is the principal athletic activity in rural Fiji. Participants were shown a facial photograph of an unfamiliar target Fijian man, cropped to mask bodily characteristics (see Figure 1), and truthfully described as a supporter of the rival rugby club based on a neighboring island. Participants then used the visual arrays employed in Study 1 to estimate the target's overall body size and muscularity; height was not estimated in formal units (e.g., inches or centimeters) in this study, as participants were not

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accustomed to reckoning size in this manner. In the weeks prior to this study, as part of broader anthropometric data collection procedures for the larger study of Yasawa Islanders in which this study was embedded, participant height, chest compression, and handgrip strength were measured.

Results

As predicted, participant chest compression strength significantly correlated with estimations of the target's composite formidability (see Table 1). Follow-up tests revealed a significant negative correlation between chest strength and the envisioned muscularity of the target. The correlation between chest strength and the envisioned size of the target was also negative, but did not reach significance (see Table 1). Handgrip strength did not correlate with the target's composite formidability, or with separate estimations of the target's size or muscularity, $ps > .18$. Participant height was also not correlated with estimations of the target's composite formidability, or with separate estimations of the target's size or muscularity, $ps > .44$.

Discussion

By presenting the target individual as a supporter of a rival sports team, Studies 1 and 2 implicitly framed him as a foe. However, encounters with conspecifics are frequently more ambiguous than this, as coalitional affiliation may not be advertised at the time of interaction. Under conditions of greater ambiguity, the other party's affordances for aggression should dictate the extent to which the actor infers that an agonistic context exists. This is because the costs of erroneously presuming peaceful

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intent scale with the other party's ability to do harm, creating a problem of error management (Galperin and Haselton in press) – if the other is capable of inflicting substantial harm, then erroneously assuming that the other is not hostile when the converse is true will be far more costly than erroneously presuming that the other is hostile when, in fact, he is not. Accordingly, in addition to overt cues of hostility, features of the target that enhance his formidability should preferentially activate this representational system. To explore this, we compared Fijian men's own strength with their estimates of the size and muscularity of men depicted holding either innocuous tools or a handgun.

Study 3

Participants

This sample was identical to that of Study 2, save one individual who was absent; the age range was 18-79 ($M = 43.6$; $N = 15$; $SD = 15.91$). The modal timespan separating participation in the two studies was 14 days.

Materials and Procedure

The study was framed to participants as an investigation of whether hand characteristics can reveal bodily traits. In a within-subjects design, participants viewed five photographs purportedly depicting the right hands of five men (in reality, only one man's hand was portrayed). Each hand held either one of four construction tools, or a handgun (see Figure 2); participants were told that these items were included in order to provide scale. The five photographs were presented in randomized order. Participants

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estimated the size and muscularity of the five targets using the same measures as in Study 2.¹

Results

Preliminary analyses revealed no effects of order on formidability ratings. A repeated measures ANOVA found no effect of the item held in a given photograph on estimations of physical formidability, $p > .41$.² As predicted, participant chest strength correlated with the gun-holding man's estimated composite formidability (see Table 1). There were no significant correlations between participant chest strength and estimations of the formidability of any of the tool-holders, $ps > .10$. Follow-up tests assessing the individual estimations of size and muscularity revealed a significant negative correlation between chest strength and the envisioned muscularity of the gun-holding man. The correlation between participant chest strength and the envisioned size of the gun-holding

¹ For this test to be meaningful, the stimulus items must be recognizable to participants. Although we did not systematically measure such familiarity, on the basis of extensive immersion in the local culture, M.G. estimates participants' ranked degree of familiarity with these items as (1) saw; (2) gun; (3) drill; (4) stapler; (5) caulking gun. Handsaws are common in Fijian villages and are integral to all house building. Guns are rare in Fiji, and absent from villages, but they are common in the few action movies that villagers have seen on DVD (such a movie might be played once or twice a month on a weekend night when a generator is running at the house of one of the few villagers with a TV and DVD player). Drills are occasionally used by government workers constructing schools and similar buildings in the villages, and are used at the lone tourist resort on the island (1.5 hours away from the villages) where village men are sometimes employed; the latter is also true of staplers and caulking guns.

² The stimuli used in Study 3 were taken from Fessler, Holbrook, and Snyder (2012). Consistent with the thesis that relative formidability is represented using the dimensions of size and strength, Fessler et al. found that, among U.S. Internet users, men holding either guns or a knife were conceptualized as larger and more muscular than men holding tools. The departure of our results in this regard from those of Fessler et al. likely stems from the marked difference in sample sizes between the two investigations, as all of the Fessler et al.'s samples were more than 10 times larger than our sample.

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man was also negative, but nonsignificant (see Table 1). Handgrip strength did not correlate with the gun holding target's composite formidability, $p > .29$, with separate estimations of the gun holding target's size or muscularity, $ps > .24$, or with the composite formidability of any of the tool-holders, $ps > .08$. Participants' height did not correlate with estimations of the gun-holding target's composite formidability, $p > .55$.

Discussion

The uniqueness of the effects of a man's own strength on his conceptualizations of a gun-wielding target relative to his assessments of possessors of tools is consonant with the thesis that assessments of one's own strength are primarily salient in potentially agonistic contexts. Although tools can be employed as weapons, because their use need not connote a combative stance, judgments of tool possessors appear not to activate assessments of one's own formidability to the same extent as judgments of those possessing weapons.

General Discussion

With some variation in the particulars, across three studies conducted in two disparate societies, we found that, consonant with both the importance of physical strength in human aggression and the notion that relative formidability is represented using the dimensions of size and strength, a man's own physical strength was inversely related to his estimates of the composite size and strength of an unfamiliar man when the latter either was presented as a likely adversary (Studies 1 and 2), or was depicted holding a weapon affording hostile action (Study 3).

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Being preliminary in nature, our explorations of this topic are subject to a number of limitations. First, in contrast to some studies of aggression (e.g., Cohen et al. 1996), we did not present participants with an actual antagonist in person, but instead used photographs that depicted only the face or hand of the target being evaluated. It is important to understand that our studies are intended to explore a representational system, not a perceptual system. It would be maladaptive indeed were it the case that one's own formidability influenced one's ability to accurately perceive the actual dimensions of an antagonist, as this would lead to ineffective combat maneuvers (i.e., blows that miss the target, etc.).³ Given our goals, we intentionally presented our participants with stimuli that provided only limited information regarding the bodily features of the target, thereby affording an opportunity for the participant's representational system to surface via his estimates of the attributes of the target. Nevertheless, while the rationale for our choice of methods is sound, it is likely that photographs, especially those depicting only portions of an individual, activate the postulated mechanisms more weakly than would the presence of an actual antagonist.

Second, we were faced with the problem of possible sex-of-experimenter effects. On the one hand, given that targets were male, the use of male researchers carried the liability that participants might employ the researcher as a reference point in making

³ By the same token, we are not proposing that strategic self-deception occurs – we do not suggest that strong men harbor illusions (whether adaptive or otherwise) regarding the real physical properties of other men. Rather, we argue, conceptualized muscularity and conceptualized bodily size are the dimensions of a mental image that captures many properties, be they somatic, social, or technological, of the antagonist relative to the self. Strong men do not conceptualize the target differently than do weak men because the former are deluded; rather, they do so because they possess a tactical asset – their strength – that the latter do not.

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judgments about the target, thereby introducing noise into the results. Although Fijian norms of inter-gender behavior led us to use male researchers in Studies 2 and 3, in light of the above considerations, we opted for a female researcher in Study 1. However, this too carries liabilities, as young men plausibly seek to impress young women, particularly on strength measures that involve a degree of discomfort (cf. Levine and De Simone, 1991); such behavior may be especially pronounced in more aggressive men. That we obtained similar results across Studies 1 and 2 provides some reassurance in this regard, but future investigators should nonetheless attend carefully to this issue.

As the above illustrates, cross-cultural variation in norms can complicate research. Nonetheless, when investigating putatively universal features of the mind, there is significant advantage in employing samples from societies differing widely in scale, value systems, modes of subsistence, and immersion in global mass media, as this reduces the likelihood that positive results reflect parochial features of one society. The latter constitutes a notable risk whenever the sole society sampled is the investigators' own, as the nature of mechanisms that process and use cultural information is such that culture is often transparent to the user, making it easy to mistake local psychologies for universal features of mind (Fessler 2011).

A third limitation to which our studies are subject concerns additional factors likely to play a role in decision-making in situations of potential agonistic conflict. In introducing the theoretical framework employed here, we noted that the cost/benefit ratio of engaging in combat is a function of both the probability of victory and the probable costs of combat *provided that one holds constant the stakes at issue*. Like the prior

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research summarized in the Introduction, the research reported here examines only the tactical assets and liabilities that the two parties bring to a fight; left unaddressed are questions of the rewards of victory or the costs of defeat. It is possible that, consonant with the dimensions employed, the representational system at issue operates exclusively on information relevant to relative formidability, and hence does not capture considerations of stake size. However, given that the postulated function of this system is to compile diverse pieces of information into a single summary representation that can readily be consulted when making a decision, we might expect that, despite being conceptually divorced from the dimensions of size and strength, factors determining stake size are nevertheless summarized by the same representation. We hope to explore such questions in the future.

Study 3 employed photographs of a handgun and construction tools, items that are clearly modern in nature. Some readers may be puzzled by our use of such stimuli in a study designed to probe postulated evolved mechanisms. Evidence from speed-of-detection studies indicates that modern threats (guns) are noticed as quickly as ancestral threats (snakes) (Fox et al. 2007), while detection of each can be enhanced by priming with congruent environments (Young et al. 2012). Importantly, such findings do not argue against the notion that evolved mental mechanisms play a critical role in processing and responding to stimuli of high fitness relevance. Ancestral humans occupied a wide variety of ecosystems, each entailing unique hazards. Many of these hazards did not have overlapping cue features, precluding the evolution of panhuman templates for detecting such threats. At the same time, culture acts as a repository of locally-relevant

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information. As a result, we can expect evolved mechanisms to be both open to, and dependent on, socially-transmitted information (Barrett, 2005; Fessler and Machery, 2012). Hence, while guns and power drills were not part of our species' ancestral environment, other weapons and tools were, and we can expect the mind to readily acquire, retain, and use information about the properties of modern exemplars of these two categories, including their affordances in combat. Accordingly, in the present context, a man depicted holding a drawn handgun should readily be categorized as a potential assailant, while a man depicted holding a power drill should not; calculations of relative formidability plausibly then occur downstream of these categorization events.

In all three of the studies reported here, a man's own strength is significantly negatively correlated with conceptualizations of a prospective foe postulated to reflect assessments of relative formidability; however, in two of the three studies, a man's own height is not correlated thusly. The apparent absence of an effect of own height is further underscored by the fact that the positive results obtained in this regard in Study 1 rely on self-reported height, whereas the null results in Studies 2 and 3 derive from actual anthropometric measurements. As noted in the Introduction, existing evidence indicates that factors affecting relative formidability shape perceptions of own height (Duguid and Goncalo 2012; Fessler and Holbrook 2013b), hence it is possible that the positive effects found in Study 1 simply reflect an indirect pathway whereby own strength influences conceptualizations of relative formidability by influencing descriptions of one's own height – in the context of Study 1, self-reported height may well reflect psychological rather than anthropometric properties.

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Evidence from professional mixed martial arts contests – often called ‘reality fighting’ because of the close similarity to street brawls – indicates that height contributes to fighting ability (Collier et al. 2012). Likewise, observers perceive a man’s height as contributing to his fighting ability (Sell et al. 2009a) and, correspondingly, take relative size into consideration when deciding whether to escalate hypothetical confrontations (Archer and Benson 2008; but see also Archer 2007). Consistent with their being less vulnerable to assault, taller men are less sensitive to cues of dominance than are shorter men (Watkins et al. 2010). However, while some studies find that height correlates with reported history of aggression and violence (Archer and Thanzami 2007; see also Felson, 1996), others find no such effects, particularly after controlling for muscular strength (Archer and Thanzami 2009; Sell et al. 2009b; Hess et al. 2010); likewise, the effects of height on perceived fighting ability are substantially smaller than the effects of strength (Sell et al. 2009a). Taken together, these results suggest that strength is a more important determinant of relative formidability than is height; correspondingly, if one’s own height contributes at all to assessments of one’s relative formidability, it likely does so to a far lesser degree than does one’s strength.

The above discussion raises the question of why size is a dimension with which relative formidability is represented.⁴ First, this pattern may reflect the nature of the ancestral trait: if body size was a key determinant of relative formidability throughout

⁴ Although in the present studies only nonsignificant trends linked the independent variable of interest (own strength) with the conceptualized height / size of the target individual, much of the prior work reviewed in the Introduction reports expected correlations between relative formidability and the conceptualized height / size of the target.

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much of vertebrate evolution, then, if the mechanism for representing this attribute was subsequently co-opted for use in summarizing many contributors to relative formidability, this dimension would have been retained as a key feature of the representation. Second, this pattern may reflect developmental experience: gross differences in body size between children and adults, and between younger and older children, are necessarily highly predictive of the outcome of violent conflicts. As a consequence, drawing on experience, mechanisms for representing relative formidability may seize on this dimension. Lastly, it is possible that both the phylogenetic and the ontogenetic explanations apply.

Regardless of which of the above explanations accounts for the phenomenon, many of the prior investigations described in the Introduction have found that the conceptualized size of a potential foe is one of the two dimensions using which relative formidability is represented. In all three of the studies reported here, a participant's own physical strength correlates more strongly with his conceptualization of the target's muscularity than with his conceptualization of the target's size. This raises the possibility that, perhaps reflecting the isomorphism between the relevant aspect of the self and the feature of the other being envisioned, own physical strength shapes conceptualization of the foe's muscularity via a more direct pathway than is true of other determinants of relative formidability.

Some prior investigations have found that handgrip strength correlates with an individual's self-reported history of aggression (Archer and Thanzami 2007; Gallup et al. 2007; see also Muñoz-Reyes et al. 2012); however, other studies have found no such

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correlation (Archer and Thanzami 2009; Gallup et al. 2010). We did not measure handgrip strength in Study 1; in Studies 2 and 3, participants' handgrip strength did not correlate with their conceptualizations of the muscularity or size of the target individual. While handgrip strength is undoubtedly relevant to fighting ability – particularly when weapons are employed (see Young 2003) – it is probably far less important than chest strength, a determinant of both the force of punches and grappling capacity. Consonant with this reasoning, male expert judo practitioners do not differ from non-practitioners in handgrip strength despite the importance of grasping in this combat sport (Ache Dias et al., 2012). Indeed, underscoring the importance of forceful blows, there are indications that the human hand exhibits derived features that enhance its effectiveness as a striking weapon when the fist is closed (Morgan & Carrier 2013). In light of these considerations, of the two measurements, it is plausible to expect that chest strength will contribute more to self-assessed relative formidability than will handgrip strength; this may explain why the former, but not the latter, was consistently negatively correlated with participants' conceptualizations of the prospective foe in Studies 2 and 3.

With the above caveats and considerations in mind, our results can be understood as adding to the growing body of literature documenting that, consistent with a history of violent intrasexual competition, a man's own strength and fighting ability play a prominent role in both his thinking about others and his behavior toward them. Specifically, by conceptualizing their opponents as smaller and weaker in absolute terms, stronger men represent their superior relative formidability, thus setting the stage for self-interested expectations and coercive actions toward others.

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Table 1.

Correlations of Chest Compression Strength and Envisioned Formidability of a Coalitional Rival (Studies 1-2) or Armed Man (Study 3) in Los Angeles and Yasawa, Fiji

	<i>r</i>	<i>p</i>
<i>Study 1 UCLA: Sports Rival</i>		
Composite Formidability	-.45	.007
Muscularity	-.44	.009
Height / Size	-.29	.098
<i>Study 2 Yasawa: Sports Rival</i>		
Composite Formidability	-.34	.027
Muscularity	-.36	.017
Height / Size	-.22	.166
<i>Study 3 Yasawa: Man with Gun</i>		
Composite Formidability	-.42	.005
Muscularity	-.57	< .001
Height / Size	-.15	.354

Note. In Study 1, height was estimated both in numerical inches and according to the size array. Height was estimated using only the size array in Studies 2 and 3.

Figure Captions

Fig. 1 Stimuli used in Studies 1 and 2, and dependent measures used in Studies 1, 2, and 3^a

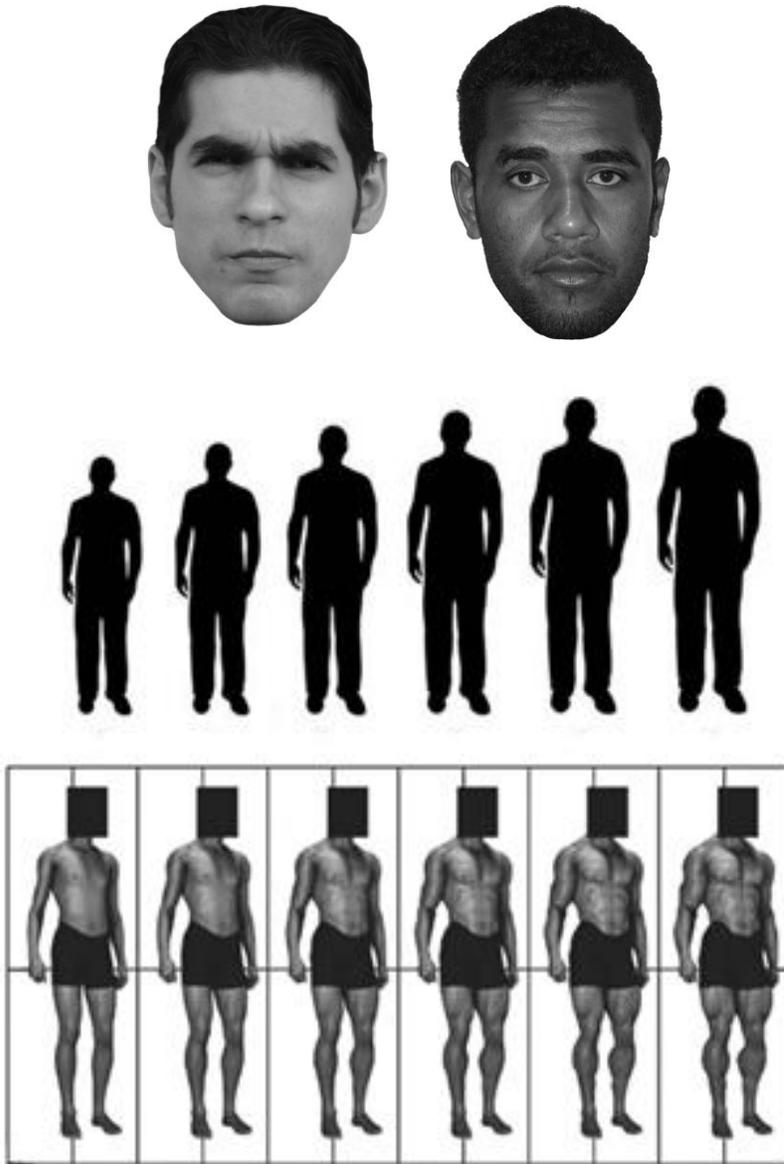
^aParticipants in Studies 1 and 2 viewed the facial photograph of a purported fan of a rival sports team and estimated his physical traits. In Study 1, conducted at the University of California, Los Angeles, the target (top left; modified from the Radboud Faces Database – Langner et al. 2010) was framed as a student at the University of Southern California; in Study 2, conducted on Yasawa Island, Fiji, the target was framed as a supporter of the Suva rugby club. Image arrays were used to estimate size (middle) and muscularity (bottom) in all three studies. In Study 1, height was also estimated in terms of feet and inches. The muscularity array was modified from Frederick and Peplau (2007).

Fig. 2 Stimuli used in Study 3^b

^bIn Study 3, participants rated the size and muscularity of men holding a .357 caliber handgun, a drill, a handsaw, a caulking gun, and a stapler. The photographs, presented on laminated cards, were sized so that the objective dimensions of each hand remained constant across all images.

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Fig. 1



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Fig. 2

