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Gruesomeness conveys formidability: Perpetrators of gratuitously grisly acts are conceptualized as larger, stronger, and more likely to win

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Abstract

While associated with extreme terrorist organizations in modern times, extensive accounts of grisly acts of violence exist in the archeological, historical, and ethnographic records. Though reasons for this dramatic form of violence are multifaceted and diverse, one possibility is that violence beyond what is required to win a conflict is a method by which violent actors communicate to others that they are formidable opponents. The Formidability Representation Hypothesis predicts that formidability is cognitively represented using the dimensions of envisioned bodily size and strength. We tested the informational ramifications of gruesome acts using two vignette studies depicting individuals who either did or did not grievously damage the corpse of a deceased foe. Participants rated the individual's height, bodily size and strength, as well as his aggressiveness, motivation, and capacity to vanquish opponents in future conflicts. Results indicate that, as predicted, committing gruesome acts of violence enhances perceptions of formidability as measured both by envisioned bodily size and strength and expectations regarding the outcomes of agonistic conflicts. Moreover, the gruesome actor was perceived as more aggressive and more motivated to overcome his enemies, and this mediated the increase in conceptualized size and strength. These results both provide further evidence for the Formidability Representation Hypothesis and support the thesis that overtly grisly violence is tactically employed in part because it conveys information about the perpetrator's formidability.

Keywords: formidability; terrorism; violence; signaling; threat assessment

Introduction

Impaled. Dismembered. Beheaded. The archeological, historical, and ethnographic records are replete with evidence not only of violence, but of violence that is excessive and overtly grisly (Alfsdotter & Kjellström, 2019; Dawes, 2013; Dolce, 2017; Thrasher & Handfield, 2018; Watson & Phelps, 2016; Zamora & Rosaldo, 1981). Today, internet searches readily return photos and videos of the acts of terrorist organizations, crime syndicates, and repressive regimes, all of whom not only kill their victims, but conspicuously damage them in a gruesome fashion. These actions appear to be intended to intimidate opponents. Here, we explore i) the communicative facet of grisly acts, and ii) the thesis that the formidability of a potential antagonist is cognitively represented using the dimensions of bodily size and strength. We examine how observers impute dispositional and motivational attributes on the basis of gruesome acts and demonstrate that representations of relative formidability translate into expectations regarding the outcomes of agonistic conflicts.

When faced with a potential social interaction, accurately assessing the other party is essential for effective decision-making. The ability to quickly and efficiently compute information about potential asymmetries in the event of conflict leads to an evolutionarily stable strategy that optimizes outcomes for both the likely winner and the likely loser of a confrontation. Evolutionary game theory predicts that organisms should be selected to compete aggressively for a resource if the fitness benefit of gaining that resource is greater than the cost of acquiring it (Maynard Smith & Parker, 1976). Acquiring the resource through fighting brings with it the risk of injury or death. Assessing the potential cost of escalating a confrontation requires estimating whether one's opponent is more powerful, or more motivated to fight, and therefore more likely to win a fight if one occurs. Natural selection has shaped organisms to be able to accurately assess asymmetries in power or aggressive motivation, and therefore make accurate predictions about winning or losing fights before deciding whether or not to escalate a contest.

Across the animal kingdom, body size, and strength or power (as estimated through observable muscle mass or weaponry such as fangs, claws, or horns) are reliable predictors of winning physical contests (Archer, 1988; Arnott & Elwood, 2009). Accordingly, size is often used as a

proxy for resource holding potential, or the ability to win an all-out fight (Archer, 1988; Parker, 1974). However, these are not the only factors that can influence the likelihood of winning a contest. For example, the willingness to initiate or escalate a contest (aggressiveness) and the value of the resource to the organism (motivation) can each influence both the expectations and the actual outcome of contests in humans and other animals (Barlow, Rogers, & Fraley, 1986; Hofmann & Schildberger, 2001; Pietraszewski & Shaw, 2015; Westneat, 2010). Moreover, such outcomes in humans also depend on a wide variety of factors, including martial skill, the presence of allies, access to weaponry, and so on.

With multiple variables playing a role in the outcome of a potential contest, decision making becomes complex. To simplify and expedite decision making, relevant information about a conspecific can be summarized in a single heuristic representation, essentially constituting a running tally of relative strengths and weaknesses. As variously articulated by Fessler, Holbrook, and colleagues (see Fessler, Holbrook, & Snyder, 2012 and citations below), the Formidability Representation Hypothesis (FRH) holds that the tactical and motivational assets and liabilities of a potential antagonist (i.e., the determinants of the antagonist's *formidability*) are cognitively represented in terms of the conceptualized size and strength of the opponent. Hence, in the service of rapid and effective decision-making, the human mind is thought to employ a representational system grounded in the physical attributes that reliably predicted the outcome of agonistic conflict both throughout vertebrate evolution and throughout developmental experience.

Consonant with the FRH, multiple variables that influence formidability have been shown to affect the envisioned size and strength of an antagonist in humans, including the antagonist's possession of a weapon (Fessler, Holbrook, & Snyder, 2012), effective group leadership (Holbrook & Fessler, 2013a), the presence of allies (Fessler & Holbrook, 2013a), group synchrony (Fessler & Holbrook, 2014, 2016), and membership in a group stereotyped as dangerous (Holbrook, Fessler, & Navarrete, 2016; Wilson, Hugenberg, & Rule, 2017). Likewise, information about the self that influences formidability has also been shown to affect the envisioned size and strength of an antagonist, including own physical strength (Fessler, Holbrook, & Gervais, 2014), parenthood (Fessler, Holbrook, Pollack, & Hahn-Holbrook, 2014),

physical incapacitation (Fessler & Holbrook, 2013b), perceptions of one's group as capable of victory (Holbrook, López-Rodríguez, Fessler, Vázquez, & Gómez, 2017), and feelings of social power (Duguid & Goncalo, 2012; Yap, Mason, & Ames, 2013). Hence, it appears that humans possess psychological mechanisms that summarize formidability in terms of envisioned size and strength across a wide variety of threat-related variables.

The deployment of signals is frequently advantageous in situations of potential conflict, as the costs of signaling are often lower than the costs of conflict, hence signals that resolve the contest without conflict are profitable (Logue et al., 2010; Maynard Smith & Price, 1973). The FRH has previously been used to show that multiple aspects of behavior can be understood as communicating attributes of the actor relevant to the assessment of formidability. For example, conspicuous voluntary recreational risk-taking indexes an indifference to one's own physical welfare; in turn, this attribute makes one a dangerous opponent and a valuable ally, as those who are willing to place themselves in harm's way are more likely to enter conflicts and more difficult to deter with threats. Correspondingly, individuals who engage in recreational physical risk-taking are envisioned to be larger, stronger, and more prone to violence (Fessler, Tiokhin, Holbrook, Gervais, & Snyder, 2014; Fessler, Holbrook, Tiokhin, & Snyder, 2014). Similarly, overtly displaying markers of coalitional affiliation in situations of potential coalitional conflict not only precludes feigning neutrality, but also advertises to onlookers that the actor invites a contest. Correspondingly, individuals who display such markers are envisioned to be larger, stronger, and more aggressive (Fessler, Holbrook, & Dashoff, 2016).

Here we hypothesize that, whether or not perpetrators are conscious of the communicative consequences, committing gruesome acts of violence enhances observers' assessments of the actor's formidability. If formidability is represented along the dimensions of envisioned bodily size and physical strength, and if grisly acts reveal attributes of the actor that enhance formidability, then perpetrators of such acts should be conceptualized as physically larger and stronger than equivalent actors who do not engage in gruesome behavior.

Our studies employ a simple design: we ask participants to read a vignette in which a target individual is present when an opponent dies, then either does or does not mutilate the dead

opponent's remains. Examining the psychological characteristics that observers impute on the basis of grisly actions, we query participants regarding dispositional and motivational characteristics of the target individual that are linked to formidability. Addressing the core of the FRH, we also ask participants to estimate the target individual's bodily features. Lastly, to demonstrate that envisioned physical size and strength indeed encapsulate formidability estimates, we ask participants to predict the likelihood that the target individual would win an agonistic conflict, allowing us to compare such predictions with envisioned bodily proportions.

Because we are interested in the communicative component of grisly acts in isolation, our experimental stimuli specify that the perpetrator commits the gruesome behavior after his foe is dead rather than during conflict. Indeed, in both of our studies we are careful to make clear that, despite being enemies, the protagonist is not responsible for his opponent's death. Hence, any differences in participants' assessments of this target individual across conditions cannot owe to direct evidence of his physical attributes, lethality or ability to dominate an opponent. Likewise, we take pains not to present any information that can be used to infer the physical attributes of the protagonist or his martial prowess. Participants' inferences regarding the outcome of a subsequent agonistic conflict involving the target individual therefore constitute a direct application of their assessment of his formidability.

Summarizing the above, we investigated the hypothesized informational value of gruesome acts by testing the following discrete predictions:

H1: Relative to the control condition, the gruesome action will enhance the target individual's perceived formidability, represented in terms of envisioned size and strength.

H2: Relative to the control condition, the gruesome action will enhance the target's perceived trait aggressiveness.

H3: Relative to the control condition, the gruesome action will enhance the target's perceived motivation to overcome adversaries.

H4: Relative to the control condition, the gruesome action will enhance the target's perceived likelihood of winning a future agonistic conflict.

H5: The representation of the target individual's formidability in terms of envisioned size and strength will mediate the effect of condition on perceived likelihood of winning an agonistic conflict.

Study 1

Methods

Participants and vignettes. Institutional Review Board approval was obtained from the University of Chicago prior to data collection. Participants (N= 350) from the United States were recruited from Amazon's Mechanical Turk (MTurk) crowdsourcing platform, with eligibility contingent on being 18 or older, having completed at least 100 tasks, and having a 96% or higher approval rate. Participants were asked two content-based questions to ensure that they carefully read and understood the passages. After excluding individuals who missed either of the content-based questions, a final sample of 335 adults (159 female, M_{age} = 35.99, SD = 11.22) was analyzed.

Because formidability has been shown to be assessed in relation to one's own formidability, we were interested in seeing whether participants with higher self-rated formidability would rate the target relatively lower in formidability. Thus, participants first rated their own martial skills from 1 (not very good) to 10 (extremely good) with the following question: "Relative to the typical person of your gender, how good at physical fighting would you be if you were attacked?" After this, participants were randomly assigned to read one of two versions of a vignette about a man who is attacked while gathering mushrooms in the forest but is spared when his assailant dies in an accident. Mushroom gathering requires neither great strength nor large body size, and, unlike activities such as hunting, does not entail skills that could translate to agonistic conflicts. In addition, the target individual was described as encountering this adversary by chance, to avoid

implicitly suggesting that the protagonist was inherently aggressive and/or welcoming of conflict. The two versions of the vignette varied in that they either did or did not include a grisly mutilation. The mutilation entailed no martial skills, as it was committed postmortem and did not require strength or size to conduct. All participants read the same first two paragraphs, as follows:

> "It is a cool autumn day near a rural mountain range. The area is historically known for violent conflicts between neighboring ethnic groups. However, it has been several years since the last major violent incident. The area has abundant natural resources, including substantial areas of undeveloped forest. People often go into the forests to hunt, fish, and gather wild mushrooms.
>
> One day, a man is gathering mushrooms in the wooded forest near the base of the mountains. Suddenly, he hears the cracking of a branch. He turns to see a hunter from a neighboring group. The hunter quickly realizes that the mushroom gatherer belongs to a different ethnic group. The hunter raises his rifle, aims it directly at the mushroom gatherer, and fires. There is a bright flash and lots of smoke. The hunter drops the rifle, staggering backwards and looking at a red stain spreading across his chest; he falls to the ground. Frightened, the mushroom gatherer crouches behind a rock and watches, but the hunter does not move. Realizing that the rifle must have misfired, he creeps toward the hunter, who lies immobile with his mouth agape and eyes open and unblinking. The mushroom gatherer bends down and puts two fingers to the other man's neck – no pulse. He notices a pocketknife in the man's shirt pocket. He picks it up and flicks open the blade."

Non-gruesome conclusion:

> "He inspects it before tossing it on the ground. Finally, he stands up and heads for home."

Gruesome conclusion:

> "He inspects it and then proceeds to gouge out the man's eyes and cut out his tongue. He then tosses the hunter's eyes and tongue on the ground along with the pocketknife. Finally, he stands up and heads for home."

Measures. After reading the vignette and answering the content-based questions, participants were asked a series of questions about the mushroom gatherer.

Trait Aggression and Motivation. Participants rated the target's trait aggressiveness using a modified version of the physical aggression subscale from Buss and Perry's (1992) Aggression Questionnaire. Statements from the Aggression Questionnaire (AQ) were rephrased to apply to the target instead of the self. For example, "If he had to resort to violence to protect his rights, he would." An aggressiveness score was calculated by averaging and normalizing the scores on the physical aggression subscale of the modified AQ ($\alpha = .94$). While aggressiveness is one psychological factor that contributes to formidability, motivation to dominate opponents is also important. Accordingly, we also asked participants to estimate the mushroom gatherer's motivation, using a scale from 1 (not very much) to 10 (extremely motivated).

Envisioned Physical Traits. Per the FRH, to gauge how participants envisioned the protagonist's physical attributes, we asked them to indicate how tall they thought the mushroom gatherer was in feet and inches, as well as perceived overall size and physical strength on separate 6-point arrays (see Figure 1). Height, size, and strength measures were standardized and averaged to create a composite physical formidability measure ($\alpha = 0.76$).

Predicted Agonistic Success. Participants predicted how likely the protagonist would be to win a fistfight, using a scale from 1 (not very likely) to 10 (extremely likely).

The Aggression Questionnaire was presented first, followed in random order by the height, motivation, and fistfight item; the two visual arrays were presented last, in fixed order.

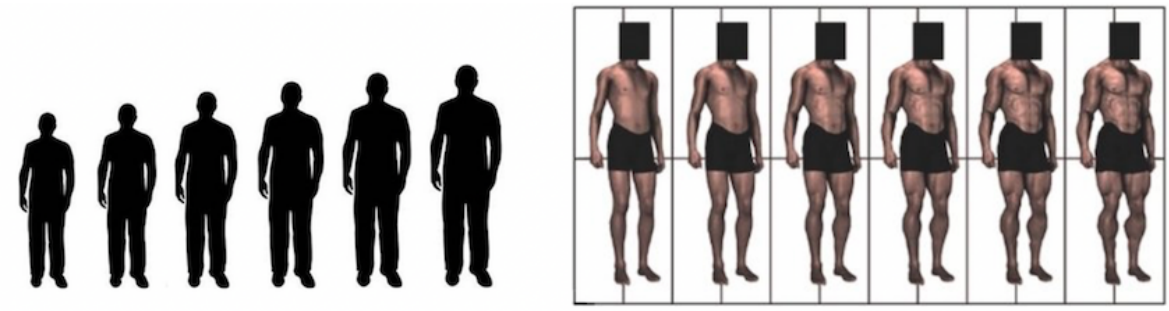

Figure 1. Six-point arrays used by participants to estimate envisioned size (left) and strength (right). From Fessler, Holbrook, & Snyder (2012); modified with permission from Frederick & Peplau (2007).

Results

Statistical analyses for the main variables are reported in Table 1.

Gruesomeness and envisioned physical formidability. As predicted by H1, the target's envisioned physical formidability was greater in the gruesome condition (M = 0.09, SD = 0.83) than in the control condition (M = -0.10, SD = 0.77), $t(330) = 2.21$, $p = .028$.

Gruesomeness and perceived aggressiveness. As predicted by H2, the target's perceived aggressiveness was greater in the gruesome condition (M = 0.63, SD = 0.69) than in the control condition (M = -0.66, SD = 0.88), $t(311) = 14.82$, $p < .001$.

Gruesomeness and perceived motivation. As predicted by H3, the target was perceived to be more motivated in the gruesome condition (M = 7.86, SD = 1.65) than in the control condition (M = 7.13, SD = 1.68), $t(332) = 3.99$, $p < .001$.

Perceived aggressiveness mediates the effect of condition on formidability. Using the 'psych' package in R (Revelle, 2017) we conducted bias-corrected, nonparametric bootstrapping analysis (based on 5000 resamples) to test if aggressiveness mediated the relationship between condition (gruesome or non-gruesome) and envisioned formidability. The dependent variable was envisioned formidability, the independent variable was condition, and

the mediating variable was perceived aggressiveness. The total effect of scenario on formidability was significant (*TE* = 0.12, *SE* = 0.05, *p* = .028) and the direct effect without aggressiveness was not (*DE* = -0.11, *SE* = 0.07, *p* = .10). Consistent with the FRH, aggressiveness mediated the relationship between condition and envisioned formidability (*IE* = 0.23, *SE* = 0.05, 95% CI = [0.13, 0.33], *p* < .001, r^2 = .10; Figure 2).

Table 1.

Mean Estimated Formidability, Aggressiveness, and Motivation (Study 1)

	Gruesome		Control			Confidence Interval		
Measure	*M*	*SD*	*M*	*SD*	*p*	Lower	Upper	Cohen's *d*
Formidability (Z-score)	0.09	0.77	-0.10	0.83	.028	0.02	0.37	0.24
Win Fistfight	6.92	1.95	5.38	1.96	<.001	1.12	1.96	0.79
Aggressiveness (Z-score)	0.63	0.69	-0.66	0.88	<.001	1.11	1.45	1.63
Motivation	7.86	1.65	7.13	1.68	<.001	0.37	1.08	0.44

Perceived motivation mediates the effect of condition on formidability. Motivation is another factor that could influence assessments of formidability. Therefore, we tested if motivation mediated the relationship between condition and envisioned formidability. The dependent variable was envisioned formidability, the independent variable was condition, and the mediating variable was perceived motivation. The total effect of scenario on formidability was significant (*TE* = 0.12, *SE* = 0.05, *p* = .028) and the direct effect without motivation was not (*DE* = 0.08, *SE* = 0.05, *p* = .13). Consistent with the FRH, motivation mediated the relationship between condition and formidability (*IE* = 0.04, *SE* = 0.02, 95% CI = [0.01, 0.07], *p* < .001, r^2 = .10).

Aggressiveness versus motivation as a mediator of the effect of condition on formidability. In a mediation model including both perceived aggressiveness and motivation as mediators, aggressiveness (*DE* = 0.21, 95% CI = [0.11, 0.31]), but not motivation (*DE* = 0.02, 95% CI = [-0.01, 0.05]), mediated the relationship between condition and envisioned formidability, and the

bootstrapped indirect effect remained significant (*IE* = 0.22, *SE* = 0.05, 95% CI = [0.13, 0.32], $p < .001$, $r^2 = .10$).

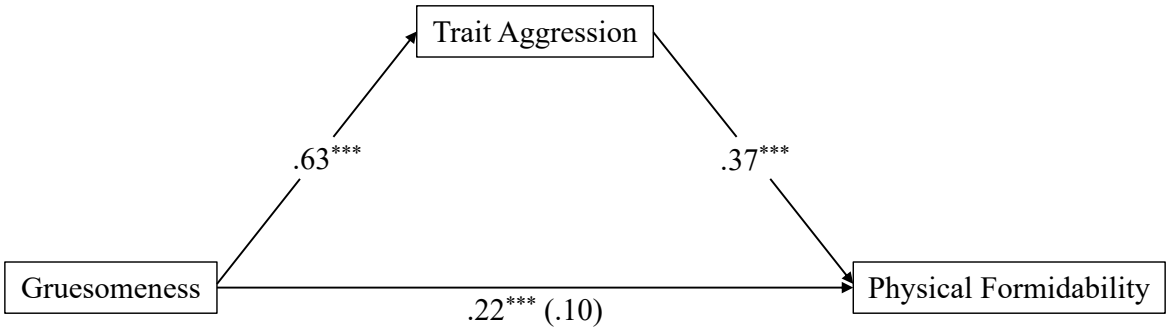

Figure 2. Standardized regression coefficients for the relationship between the gruesomeness manipulation and envisioned physical formidability as mediated by perceived aggressiveness. The standardized regression coefficient between gruesomeness condition and estimated physical formidability, with the mediator included in the model, is given in parentheses. Perceived aggressiveness appears to fully mediate the effect of the gruesomeness manipulation.

Gruesomeness and winning a fistfight. Consistent with the FRH and as predicted by H4, the target was rated as more likely to win a fistfight in the gruesome condition (*M* = 6.92, *SD* = 1.95) than in the control condition (*M* = 5.38, *SD* = 1.96), $t(333) = 7.21$, $p < .001$.

Envisioned formidability mediates the effect of condition on winning a fistfight. We tested whether envisioned formidability mediated the relationship between condition (gruesome or non-gruesome) and likelihood of winning a fistfight. The DV was likelihood of winning a fistfight, the IV was condition, and the mediating variable was formidability. The total effect of scenario on winning a fistfight was significant (*TE* = 0.37, *SE* = 0.05, $p < .001$) as was the direct effect (*DE* = 0.31, *SE* = 0.04, $p < .001$). As predicted in H5, envisioned formidability mediated the relationship between condition and perceived likelihood of winning a fistfight (*IE* = 0.05, *SE* = 0.03, 95% CI = [0.01, 0.11], $p < .001$, $r^2 = .34$).

Self-rated fighting ability and envisioned physical formidability. Across conditions, self-rated fighting ability did not predict lower ratings of target formidability (β = -0.015, *SE* = 0.019, $F(1,333) = 0.602$, $p = .439$). [i]

Discussion

Consistent with our predictions, a hypothetical protagonist who was described as committing a gruesome act was perceived to be larger, stronger, more aggressive, more motivated, and more likely to win a fistfight than an otherwise identical protagonist who did not perform such acts. Importantly, this difference occurs despite the complete absence of cues in the vignette of strength, size, or of initiating the conflict intentionally. Rather, these differences appear to derive entirely from the gruesome treatment of the corpse. As entailed by the notion that grisly acts reveal aspects of the perpetrator's character relevant to formidability assessment, our exploratory mediational analysis showed that perceived aggressiveness mediated the relationship between condition and envisioned formidability (for similar findings, see Holbrook, Fessler, & Navarrete, 2016). While the protagonist's inferred motivation to overcome opponents was not significant when included in a model alongside trait aggression, it did show mediation when considered in a model by itself, suggesting that our measure of motivation was treated by participants as a proxy for aggressiveness. However, the wording we used to assess impressions of the protagonist's motivation was imprecise with regard to what sort of motivation was under consideration, a potential limitation addressed in Study 2.

The core prediction of this study was that a gruesome actor would be perceived as more formidable. The FRH predicts that formidability is represented using a mind's-eye image of the target individual varying along the dimensions of size and strength, and that this representation is used in forecasting the target individual's future performance in agonistic interactions. Supporting this, we found that envisioned formidability mediated the relationship between gruesomeness and perceived likelihood of winning a future fistfight – a direct measure of formidability. This finding lends further support to the FRH and reifies our core hypothesis about the relationship between gruesomeness and formidability.

The lack of an effect across conditions of self-rated fighting ability on envisioned formidability suggests that features of the self may contribute less to third-party than to second-party formidability assessments. Indeed, prior work exploring the effects of features of the self on assessments of formidability were designed such that the participant is confronted with a threatening stimulus or is asked to imagine being in such a situation (e.g., Fessler, Holbrook, & Gervais, 2014). In contrast, participants in this study play the role of a distant observer of events in which they are not involved. Thus, this study may not have been optimally designed to address questions about the role of features of the self in assessments of formidability. Another possibility is that sex influences the relationship between self-rated formidability and envisioned formidability (see the Supplementary Material for an analysis of sex differences). Because it was ancillary to our main interest and our study design was not optimized for it, the item concerning self-reported fighting ability was not included in Study 2.

Not all forms of aggression involve direct confrontation. If we are correct that observers interpret grisly acts as indexing dispositional and motivational features that contribute to overall formidability, and that formidability is represented using envisioned size and strength, then the deployment of a representation of enhanced formidability should occur regardless of whether the behavior being forecasted involves direct or indirect confrontation. Importantly, the FRH predicts that, ceteris paribus, proficiency in modes of attack which are entirely unrelated to physical size and strength should be conceptualized in terms of physical formidability. Accordingly, in Study 2 we added a measure concerning the use of poison to kill an enemy, while also retaining the fistfight item to allow for direct replication of Study 1. Many wild mushrooms are poisonous, and hence a mushroom-gatherer would presumably be well positioned to poison others. To avoid the possibility of this mushroom-gathering confound, and to rule out the possibility that the results of Study 1 were somehow contingent on stereotypes of mushroom gatherers, we describe the protagonist in Study 2 as a fisherman. Both mushroom gathering and fishing can take place in the same setting, and neither connotes exceptional physical size or strength, allowing us to use the same vignette and test the direct effect of gruesome actions.

Study 2

Methods

Following the same recruitment procedures employed in Study 1, new participants (N = 350) were recruited for Study 2. After excluding individuals who missed either of the content questions, 321 participants (175 female, M_{age} = 36.88; SD = 11.81) were included in the analysis. As in Study 1, height, size, and strength measures were standardized and averaged to create the physical formidability measure (α = .70), and an aggressiveness score was calculated by averaging and normalizing the scores on the physical aggression subscale of the modified AQ (α = .93). Participants answered how likely it is that the fisherman would be capable of successfully poisoning his enemies without their knowledge. The motivation question was modified to specifically refer to the target individual's motivation "to overcome his enemies." The Aggression Questionnaire was presented first, followed in random order by height, motivation, fistfight item, and poison item; the two visual arrays were presented last, in fixed order.

Results

Statistical analyses for the main variables are reported in Table 2.

Gruesomeness and envisioned physical formidability. As predicted by H1 and in line with Study 1, the target's envisioned physical formidability was greater in the gruesome condition (M = 0.12, SD = 0.77) than in the control condition (M = -0.14, SD = 0.77), $t(318) = 3.07$, $p = .002$.

Gruesomeness and perceived aggressiveness. Consistent with H2 and Study 1, the target's perceived aggression was greater in the gruesome condition (M = 0.57 SD = 0.75) than in the control condition (M = -0.61, SD = 0.89), $t(304) = 12.77$, $p < .001$.

Gruesomeness and perceived motivation. As predicted by H3, the target was perceived to be more motivated to overcome his enemies in the gruesome condition (M = 8.49, SD = 1.95) than in the control condition (M = 6.29, SD = 2.24), $t(308) = 9.38$, $p < .001$.

Perceived aggressiveness mediates the effect of condition on formidability. As in Study 1, we found that aggressiveness mediated the effect of gruesomeness on envisioned formidability. The total effect of scenario on formidability was significant (TE = 0.17, SE = 0.06, p = .002) and the direct effect without aggressiveness was not (DE = -0.04, SE = 0.06, p = .49). As predicted by the FRH, aggressiveness mediated the relationship between condition and formidability (IE = 0.22, SE = 0.04, 95% CI = [0.14, 0.30], $p < .001$, $r^2 = .12$).

Table 2.

Mean Estimated Formidability, Aggressiveness, Motivation, and Poison (Study 2)

	Gruesome		Control			Confidence Interval		
Measure	*M*	*SD*	*M*	*SD*	*p*	Lower	Upper	Cohen's *d*
Formidability (Z-score)	0.12	0.77	-0.14	0.77	.002	0.10	0.43	0.34
Win Fistfight	7.30	1.68	5.87	1.90	<.001	1.04	1.83	0.8
Aggressiveness (Z-score)	0.57	0.75	-0.61	0.89	<.001	0.99	1.40	1.43
Motivation	8.49	1.95	6.29	2.24	<.001	1.74	2.66	1.05
Poison Enemies	7.50	2.04	5.91	2.30	<.001	1.11	2.07	0.73

Perceived motivation mediates the effect of condition on formidability. Using the more specific question about motivation, we found that motivation to overcome enemies mediated the effect of gruesomeness on envisioned formidability. The total effect of scenario on formidability was significant (TE = 0.17, SE = 0.06, p = 0.002) and the direct effect without motivation was not (DE = 0.01, SE = 0.06, p = 0.89). As would be predicted by the FRH, motivation mediated the relationship between condition and formidability (IE = 0.16, SE = 0.04, 95% CI = [0.09, 0.24], $p < .001$, $r^2 = .12$).

Aggressiveness vs motivation as a mediator of the effect of condition on formidability. In a mediation model including both perceived aggressiveness and motivation to overcome enemies as mediators, both aggressiveness (*DE* = 0.15, 95% CI = [0.06, 0.23]) and motivation to overcome enemies (*DE* = 0.11, 95% CI = [0.04, 0.19]) mediated the relationship between condition and envisioned formidability, and the bootstrapped indirect effect was significant (*IE* = 0.26, *SE* = 0.04, 95% CI = [0.18, 0.35], $p < .001$, $r^2 = .16$; Figure 3).

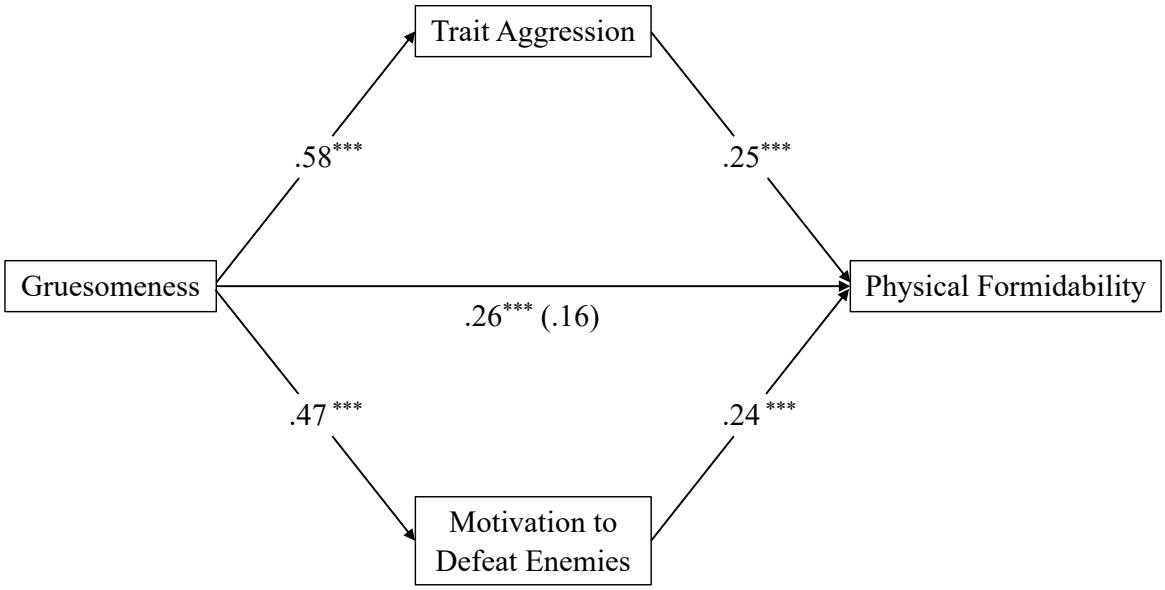

Figure 3. Standardized regression coefficients for the relationship between the gruesomeness manipulation and envisioned physical formidability as mediated by perceived aggressiveness and motivation to defeat enemies. The standardized regression coefficient between gruesomeness condition and estimated physical formidability, with the mediators included in the model, is given in parentheses. Perceived aggressiveness and motivation to defeat enemies appear to fully mediate the effect of the gruesomeness manipulation.

Gruesomeness and winning a fistfight. Consistent with the FRH and the results of Study 1, the target was rated as more likely to win a fistfight in the gruesome condition (*M* = 7.30, *SD* = 1.68) than in the control condition (*M* = 5.87, *SD* = 1.90), $t(310) = 7.14$, $p < .001$.

Envisioned formidability mediates the effect of condition on winning a fistfight. As in Study 1, we tested if envisioned formidability mediated the relationship between condition and

likelihood of winning a fistfight. The total effect of scenario on winning a fistfight was significant (*TE* = 0.37, *SE* = 0.05, $p < .001$) as was the direct effect (*DE* = 0.29, *SE* = 0.05, $p < .001$). As predicted by H4, envisioned formidability mediated the relationship between condition and perceived likelihood of winning a fistfight (*IE* = 0.08, *SE* = 0.03, 95% CI = [0.03, 0.14], $p < .001$, $r^2 = .36$).

Gruesomeness and successfully poisoning enemies. Consistent with H4, the target was rated as more likely to successfully poison his enemies without their knowledge in the gruesome condition (*M* = 7.50, *SD* = 2.04) than in the control condition (*M* = 5.91, *SD* = 2.30), $t(310) = 6.54$, $p < .001$.

Formidability mediates relationship between gruesomeness and poisoning. We evaluated the mediating effect of envisioned formidability on the relationship between condition and likelihood of the fisherman successfully poisoning his enemies – a non-physical and non-confrontational form of lethality. The total effect of scenario on poisoning was significant (*TE* = 0.34, *SE* = 0.05, $p < .001$) as was the direct effect (*DE* = 0.31, *SE* = 0.05, $p < .001$). As predicted, the envisioned formidability of the fisherman mediated the relationship between condition and the likelihood of him successfully poisoning his enemies (*IE* = 0.04, *SE* = 0.02, 95% CI = [0.01, 0.07], $p < .001$, $r^2 = .16$).

Discussion

Study 2 replicated the findings of Study 1 and provided additional support for our hypothesis that gruesome actions enhance cognitive representations of the perpetrator's formidability as conceptualized according to bodily size and strength. Consistent with the FRH, we found that perceptions of trait aggressiveness and motivation to overcome enemies each mediated the effects of the gruesomeness manipulation on estimations of formidability as measured by envisioned size and strength. Note that the significant mediation effect of motivation in a model controlling for covarying aggressive tendencies departs from the nonsignificant effect of motivation observed when controlling for aggressiveness in Study 1, a difference which most likely owes to our rewording of the question in Study 2 to more clearly specify individual motivation to overcome one's enemies. Supporting this, we found that

motivation also mediated the effects of gruesomeness on estimation of formidability in a supplementary study (see Supplementary Materials). Finally, in Study 2 we also tested the FRH prediction that, ceteris paribus, physical formidability can be utilized to conceptualize modes of lethality that are unrelated to physical size or strength. We observed that the target individual in the gruesome condition was seen as more likely to successfully poison his enemies, and envisioned physical formidability mediated the relationship between condition and ability to successfully poison an enemy.

General Discussion

Formidability is the product of physical, social, technological, and psychological factors – a strong fighter dominates a weak fighter; a fighter with many allies dominates a lone antagonist; a well-armed individual dominates a poorly armed opponent; and, critically, an aggressive, motivated fighter dominates a meeker or less motivated foe. Across two studies, we found that knowing that an individual engaged in gruesome acts enhances people's estimation of that individual's formidability, and that this perceived ability to triumph in agonistic conflict was conceptualized using mental representations of physical size and strength which were in turn closely linked with psychological assessments of the target character's aggressiveness and degree of motivation. Together, these findings bolster the growing body of evidence indicating that determinants of formidability are summarized into a heuristic representation of the physical attributes of the target individual. Likewise, our results support the conclusion that grisly acts may be committed in part because they serve a strategic communicative function. Gruesome violence indicates dispositional and motivational features of the perpetrator that enhance others' estimates of the actor's formidability, thereby decreasing the frequency, and thus the costs, required by the actor to achieve dominance through conflict.

The present studies are only a first step toward understanding the potential functional aspects of gruesomeness. While our studies affirm that gruesome violence promotes assessments of formidability, they do not describe the pathway(s) by which this occurs. For example, excessive physical damage to an opponent can indicate either an inability to regulate aggression or an insensitivity to the added costs (energy, time, etc.) of egregious violence. Either of these attributes should increase others' assessments of an actor's formidability, as both make it

difficult to deter or negotiate with such a foe. Alternatively, grievous violations of the body envelope are an inherently powerful stimulus, as they unambiguously indicate death or mortal wounds (Barrett & Behne, 2005; White, Fessler, & Gomez, 2016). As such, observers of a corpse that suffers such damage can be expected to experience more powerful emotional responses, including emotionally driven perceptions of the perpetrator as a threat. Perpetrators might directly leverage this effect as a cue to enhance assessments of their formidability—which may or may not be objectively accurate. It may also be the case that perpetrators of grisly acts take advantage of recursive theory-of-mind reasoning, in that observers can infer that perpetrators know that observers may react with outrage, hence engaging in such provocatively gruesome action constitutes an active challenge to observers – and an actor who challenges foes is likely to be more dangerous than an actor who avoids conflict. Moreover, norm violations can inherently enhance assessed formidability, as norms render behavior predictable, and an unpredictable foe is more dangerous than a predictable one. The above possibilities are not mutually exclusive, and gruesome violence may enhance perceived formidability via multiple pathways simultaneously.

In addition to the need to adjudicate among the possible ways in which gruesomeness conveys formidability, future work could also examine the role of communicative intent, as some of these pathways involve signals while others involve cues. In evolutionary biology, a signal is a method of communication shaped by natural selection that is built to send specific information; in contrast, a cue transmits information purely as a by-product of some other attribute (Laidre & Johnstone, 2013). Cues can evolve into signals if the evolutionary fitness benefits to the sender of conveying the information, or to the recipient of understanding what the information indicates, are great enough. Many of the signals of formidability mentioned in the introduction may have first arisen as cues that happen to transmit particularly valuable information relevant to the survival of the sender, the recipient, or both. One way to disentangle whether gruesome violence serves as a signal or a cue would be to manipulate the presence of an audience and the identity of the audience. Because the advantages of communicating information are enhanced when a larger number of individuals receives that information, the presence of an audience will often enhance behaviors that serve as signals; in contrast, because cues convey information only incidentally, an audience will have no effect on behaviors that are merely cues. Another key factor that was

not addressed by our studies is the identity of the victim. In our studies, the victim was a member of a hostile group who accidentally died while trying to kill the target individual. Gruesome acts of violence committed against an enemy warrior might communicate a different message about the perpetrator's formidability than gruesome acts of violence against a civilian or an animal. For example, committing a grisly act against a member of a powerful enemy coalition, knowing it could incite fierce retaliation, might cause the perpetrator to be perceived as more formidable than if the act was committed against a neutral bystander. In short, despite the antiquity and broad distribution of grisly acts, much remains to be understood about the psychology of gruesomeness.

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Data Availability: All pre-registrations, materials, data, and code used to generate the analyses are available on the Open Science Framework https://osf.io/2ghav/?view_only=fd49b9a70cad42929076d524a57c3941.

References

Alfsdotter, C., & Kjellström, A. (2019). The Sandby borg massacre: Interpersonal violence and the demography of the dead. *European Journal of Archaeology*, *22*(2), 210-231.

Archer, J. (1988). *The behavioural biology of aggression* (Vol. 1). Cambridge, England: Cambridge University Press.

Arnott, G., & Elwood, R. W. (2009). Assessment of fighting ability in animal contests. *Animal Behaviour*, *77*(5), 991-1004.

Barlow, G. W., Rogers, W., & Fraley, N. (1986). Do Midas cichlids win through prowess or daring? It depends. *Behavioral Ecology and Sociobiology*, *19*(1), 1-8.

Barrett, H. C., & Behne, T. (2005). Children's understanding of death as the cessation of agency: A test using sleep versus death. *Cognition*, *96*(2), 93-108.

Buss, A. H., & Perry, M. (1992). The aggression questionnaire. *Journal of Personality and Social Psychology*, *63*(3), 452-459.

Dawes, J. (2013). *Evil men*. Cambridge, USA: Harvard University Press.

Dolce, R. (2017). *Losing one's head in the ancient Near East: Interpretation and meaning of decapitation*. Routledge.

Duguid, M. M., & Goncalo, J. A. (2012). Living large: The powerful overestimate their own height. *Psychological Science*, *23*(1), 36-40.

Fessler, D. M., & Holbrook, C. (2013). Bound to lose: Physical incapacitation increases the conceptualized size of an antagonist in men. *PloS One*, *8*(8), e71306.

Fessler, D. M., & Holbrook, C. (2013). Friends shrink foes: The presence of comrades decreases the envisioned physical formidability of an opponent. *Psychological Science*, *24*(5), 797-802.

Fessler, D. M., & Holbrook, C. (2014). Marching into battle: Synchronized walking diminishes the conceptualized formidability of an antagonist in men. *Biology Letters*, *10*(8), 20140592.

Fessler, D. M., & Holbrook, C. (2016). Synchronized behavior increases assessments of the formidability and cohesion of coalitions. *Evolution and Human Behavior*, *37*(6), 502-509.

Fessler, D. M., Holbrook, C., & Dashoff, D. (2016). Dressed to kill? Visible markers of coalitional affiliation enhance conceptualized formidability. *Aggressive Behavior*, *42*(3), 299-309.

Fessler, D. M., Holbrook, C., & Gervais, M. M. (2014). Men's physical strength moderates conceptualizations of prospective foes in two disparate societies. *Human Nature*, *25*(3), 393-409.

Fessler, D. M., Holbrook, C., Pollack, J. S., & Hahn-Holbrook, J. (2014). Stranger danger: Parenthood increases the envisioned bodily formidability of menacing men. *Evolution and Human Behavior*, *35*(2), 109-117.

Fessler, D. M., Holbrook, C., & Snyder, J. K. (2012). Weapons make the man (larger): Formidability is represented as size and strength in humans. *PloS One*, *7*(4), e32751.

Fessler, D., Holbrook, C., Tiokhin, L., & Snyder, J. (2014). Sizing up Helen: Nonviolent physical risk-taking enhances the envisioned bodily formidability of women. *Journal of Evolutionary Psychology*, *12*(2-4), 67-80.

Fessler, D. M., Tiokhin, L. B., Holbrook, C., Gervais, M. M., & Snyder, J. K. (2014).

Foundations of the Crazy Bastard Hypothesis: Nonviolent physical risk-taking enhances conceptualized formidability. *Evolution and Human Behavior*, *35*(1), 26-33.

Hofmann, H. A., & Schildberger, K. (2001). Assessment of strength and willingness to fight during aggressive encounters in crickets. *Animal Behaviour*, *62*(2), 337-348.

Holbrook, C., & Fessler, D. M. (2013). Sizing up the threat: The envisioned physical formidability of terrorists tracks their leaders' failures and successes. *Cognition*, *127*(1), 46-56.

Holbrook, C., Fessler, D. M., & Navarrete, C. D. (2016). Looming large in others' eyes: Racial stereotypes illuminate dual adaptations for representing threat versus prestige as physical size. *Evolution and Human Behavior*, *37*(1), 67-78.

Holbrook, C., López-Rodríguez, L., Fessler, D. M., Vázquez, A., & Gomez, A. (2017). Gulliver's politics: Conservatives envision potential enemies as readily vanquished and physically small. *Social Psychological and Personality Science*, *8*(6), 670-678.

Laidre, M. E., & Johnstone, R. A. (2013). Animal signals. *Current Biology*, *23*(18), R829-R833.

Logue, D. M., Abiola, I. O., Rains, D., Bailey, N. W., Zuk, M., & Cade, W. H. (2010). Does signalling mitigate the cost of agonistic interactions? A test in a cricket that has lost its song. *Proceedings of the Royal Society B: Biological Sciences*, *277*(1693), 2571-2575.

Maynard Smith, J., & Parker, G. A. (1976). The logic of asymmetric contests. *Animal Behaviour*, *24*(1), 159-175.

Maynard Smith, J, & Price, G. R. (1973). The logic of animal conflict. *Nature*, *246*(5427), 15.

Parker, G. A. (1974). Assessment strategy and the evolution of fighting behaviour. *Journal of Theoretical Biology*, *47*(1), 223-243.

Pietraszewski, D., & Shaw, A. (2015). Not by strength alone. *Human Nature*, *26*(1), 44-72.

Revelle, W. (2016). *psych: Procedures for personality and psychological research*. (R package version 1.6.12) Evanston, IL: Northwestern University, http://CRAN.R-project.org/package = psych

Rosaldo, R. (1980). *Ilongot headhunting, 1883-1974: A study in society and history*. Stanford University Press.

Thrasher, J., & Handfield, T. (2018). Honor and violence. *Human Nature*, *29*(4), 371-389.

Watson, J. T., Phelps, D. O., Aspöck, E., Goldstein, L., Gordón, F., Lambert, P. M., ... & Phelps,

D. (2016). Violence and perimortem signaling among early irrigation communities in the Sonoran Desert. *Current Anthropology*, *57*(5), 586-609.

Westneat, D., & Fox, C. W. (Eds.). (2010). *Evolutionary behavioral ecology*. Oxford, England: Oxford University Press.

White, C., Fessler, D. M., & Gomez, P. S. (2016). The effects of corpse viewing and corpse condition on vigilance for deceased loved ones. *Evolution and Human Behavior*, *37*(6), 517-522.

Wilson, J. P., Hugenberg, K., & Rule, N. O. (2017). Racial bias in judgments of physical size and formidability: From size to threat. *Journal of Personality and Social Psychology*, *113*(1), 59.

Yap, A. J., Mason, M. F., & Ames, D. R. (2013). The powerful size others down: The link between power and estimates of others' size. *Journal of Experimental Social Psychology*, *49*(3), 591-594.

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[i] Using a one-tailed t-test, we found a significant interaction between condition and self-rated fighting ability ($\beta = 0.063$, $SE = 0.038$, $F(3,331) = 1.684$, $p = .047$, $r^2 = 0.02$). Because previous studies on this topic involved threats to the self, the observed effect in the gruesome condition may suggest that the gruesome actor is being perceived as more threatening to the observer.

Supplementary Material: Gruesomeness conveys formidability: Perpetrators of gratuitously grisly acts are conceptualized as larger, stronger, and more likely to win

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Analysis of Sex Differences

In addition to our main analyses, we explored whether or not any sex differences existed in the variables we measured.

Study 1

Two-way analyses of variance were conducted on each of the main outcome variables to test for any interactions between scenario (gruesome vs non-gruesome action) and sex. Results are reported in Supplementary Table 1. Across all studies and main dependent variables, there were no significant interactions between scenario and sex. However, in 2 cases, sex did have a significant relationship to the dependent variable. In Study 2, females rated the fisherman more likely to successfully poison his enemies overall than males. However, this was independent of whether or not the fisherman committed a gruesome action. Likewise, females in the supplemental study rated the mushroom gatherer as more formidable than males independent of whether or not the mushroom gatherer committed a gruesome action. It could be the case that females simply rate males as more lethal than males do in some cases. However, neither of these relationships were particularly strong, and there was no interaction with gruesomeness, hence we urge caution in interpreting these results.

Supplementary Table 1.
Analysis for each measured variable by sex

Study	Variable		*Df*	*SS*	*MS*	*F*	*p*
Study 1	Formidability	scenario	1	3.13	3.13	4.90	**.028**
		sex	1	1.20	1.20	1.87	.173
		scenario*sex	1	0.01	0.01	0.01	.922
	Aggressiveness	scenario	1	137.88	137.88	220.20	**< .001**
		sex	1	0.19	0.19	0.31	.579
		scenario*sex	1	0.03	0.03	0.05	.818
	Motivation	scenario	1	44.10	44.10	15.95	**< .001**
		sex	1	4.90	4.90	1.77	.184
		scenario*sex	1	2.20	2.20	0.80	.372
	Win Fistfight	scenario	1	199.10	199.10	52.19	**< .001**
		sex	1	13.00	13.00	3.42	.065
		scenario*sex	1	0.00	0.00	0.01	.934
Study 2	Formidability	scenario	1	5.61	5.61	9.40	**.002**
		sex	1	0.25	0.25	0.42	.520
		scenario*sex	1	0.25	0.25	0.43	.515
	Aggressiveness	scenario	1	110.60	110.60	164.27	**< .001**
		sex	1	0.58	0.58	0.86	.355
		scenario*sex	1	0.73	0.73	1.09	.298
	Motivation	scenario	1	388.50	388.50	87.93	**< .001**
		sex	1	0.20	0.20	0.05	.816
		scenario*sex	1	0.50	0.50	0.12	.731
	Win Fistfight	scenario	1	164.60	164.60	51.07	**< .001**
		sex	1	0.70	0.70	0.22	.641
		scenario*sex	1	2.00	2.00	0.62	.432
	Poison Enemies	scenario	1	202.60	202.60	43.42	**< .001**
		sex	1	22.80	22.80	4.88	**.028**
		scenario*sex	1	0.10	0.10	0.03	.858
Supplementary Study	Formidability	scenario	1	1.88	1.88	2.85	.092*
		sex	1	3.20	3.20	4.85	**.028**
		scenario*sex	1	0.15	0.15	0.22	.638
	Aggressiveness	scenario	1	155.44	155.44	282.18	**< .001**
		sex	1	0.83	0.83	1.51	.220
		scenario*sex	1	0.30	0.30	0.55	.458
	Motivation	scenario	1	596.10	596.10	128.35	**< .001**
		sex	1	0.50	0.50	0.11	.746
		scenario*sex	1	6.30	6.30	1.35	.246
	Win Fistfight	scenario	1	331.60	331.60	72.21	**< .001**
		sex	1	11.10	11.10	2.42	.121
		scenario*sex	1	0.90	0.90	0.21	.651
	Win Gunfight	scenario	1	190.50	190.50	28.74	**< .001**
		sex	1	11.70	11.70	1.76	.186
		scenario*sex	1	6.50	6.50	0.99	.322

* This *p* value is for a 2-tailed test. We preregistered and conducted a one-tailed test for formidability in the supplemental study. The one-tailed test is significant ($p = .047$).

Supplemental Study

Rationale

Physically large and strong people are, on average, more likely to be aggressive (Felson, 1996; Sell, Tooby, & Cosmides, 2009). Despite our crafting the vignettes employed in Studies 1 and 2 such that they contained no cues of actual bodily properties, knowledge derived from experience may have influenced participants' inferences that the perpetrator of grisly acts was larger and stronger. In an attempt to reduce the influence of such prior beliefs, in an additional study reported here, we described the events as occurring in Tibet, on the assumption that, to the extent that our American participants have prior expectations concerning Tibetans, these will include relatively small stature and peaceability, rendering this study a stringent test of the Formidability Representation Hypothesis (FRH). The FRH holds that the tactical and motivational assets and liabilities of a potential antagonist (i.e., the determinants of the antagonist's *formidability*) are cognitively represented in terms of the conceptualized size and strength of the opponent.

Methods

After obtaining Institutional Review Board approval from the University of Chicago, participants (N= 350) from the United States were recruited from Amazon's Mechanical Turk (MTurk) crowdsourcing platform. Eligibility was contingent upon being 18 or older, having completed at least 100 tasks, and having a 96% or higher approval rate. After excluding individuals who missed either of the content questions, 335 participants (172 female, M_{age} = 38.04; SD = 12.46) were included in the analysis. Following collection of informed consent, participants read the vignette and answered questions about the protagonist. The vignettes were the same as those employed in Study 1 except for the first sentence, which sets the story in Tibet. As in Study 1,

height, size, and strength measures were standardized and averaged to create the physical formidability measure ($\alpha = 0.79$), and an aggressiveness score was calculated by averaging and normalizing the scores on the physical aggression subscale of the modified Buss and Perry AQ ($\alpha = 0.94$). Participants also answered how likely the mushroom gatherer would be to win a gunfight, from 1 (not very likely) to 10 (extremely likely)[i]. The motivation question was worded as in Study 2, i.e., the target individual's motivation "to overcome his enemies." The Aggression Questionnaire was presented first, followed in random order by height, motivation, fistfight item, and gunfight item; the two visual arrays were presented last, in fixed order.

Results

Statistical analyses for the main variables are reported in Supplementary Table 2.

Gruesomeness and envisioned physical formidability. Because we expected a smaller effect in this vignette due to prior beliefs about peaceability, etc., and because we had evidence of a directional effect (more gruesome = more formidable), we pre-registered a one-tailed test of the effect of scenario on envisioned formidability. As predicted, the target's envisioned physical formidability was greater in the gruesome condition ($M = 0.05$, $SD = 0.89$) than in the control condition ($M = -0.10$, $SD = 0.73$), $t(321) = 1.685$, $p = .047$.

Gruesomeness and perceived aggressiveness. As predicted, the target's perceived aggressiveness was greater in the gruesome condition ($M = 0.68$, $SD = 0.65$) than in the control condition ($M = -0.6$, $SD = 0.83$, $t(311) = 16.76$, $p < .001$.

Supplementary Table 2.

Mean Estimated Formidability, Aggressiveness, Motivation, and Gunfight.

	Gruesome		Control			Confidence Interval		
Measure	*M*	*SD*	*M*	*SD*	*p*	Lower	Upper	Cohen's *d*
Formidability (Z-score)	0.05	0.89	-1.0	0.73	.047	0.00	∞	0.18
Win Fistfight	6.89	2.05	4.90	2.23	<.001	1.53	2.45	0.93
Aggressiveness (Z-score)	0.68	0.65	-0.68	0.83	<.001	1.20	1.52	1.84
Motivation	8.37	1.78	5.70	2.48	<.001	2.20	3.13	1.24
Win Gunfight	6.21	2.46	4.70	2.69	<.001	0.95	2.06	0.59

Gruesomeness and perceived motivation. Consistent with our main studies, the target was perceived to be more motivated in the gruesome condition ($M = 8.37$, $SD = 1.78$) than in the control condition ($M = 5.70$, $SD = 2.48$), $t(299) = 11.31$, $p < .001$.

Perceived aggressiveness mediates the effect of condition on formidability. As in Studies 1 and 2, we found that aggressiveness mediated the effect of gruesomeness on envisioned formidability. The total effect of scenario on formidability was significant ($TE = 0.09$, $SE = 0.05$, $p = .047$) as was the direct effect without aggressiveness ($DE = -0.17$, $SE = 0.07$, $p = .018$), though in the opposite direction. As predicted by the FRH, aggressiveness mediated the relationship between condition and formidability ($IE = 0.26$, $SE = 0.04$, 95% CI = [0.18, 0.35], $p < .001$, $r^2 = .09$).

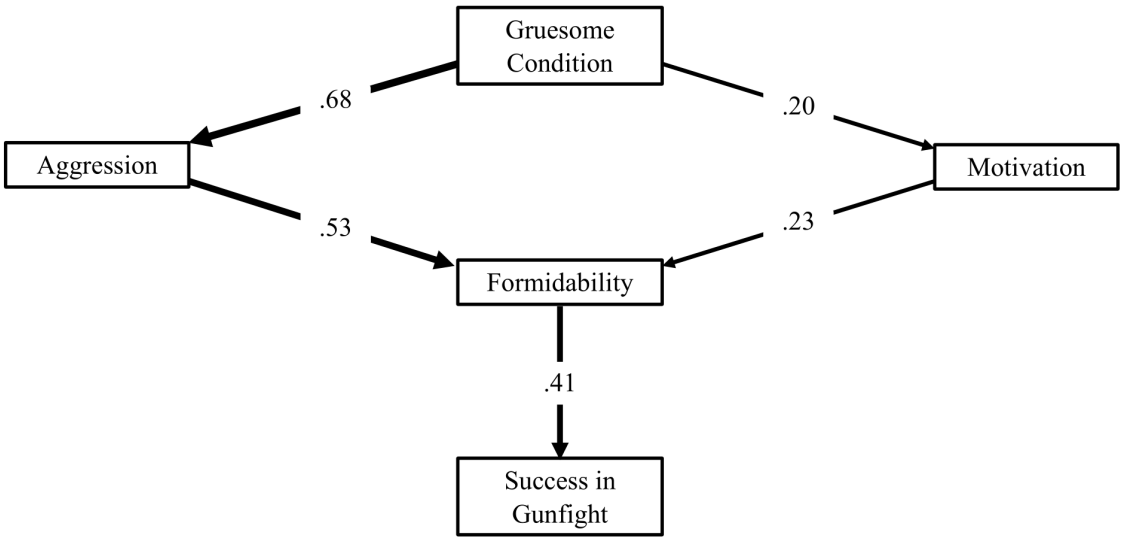
Perceived motivation mediates the effect of condition on formidability. Using the more specific question about motivation employed in Study 2, we again found that motivation to overcome enemies mediated the effect of gruesomeness on envisioned formidability. The total effect of scenario on formidability was significant (*TE* = 0.09, *SE* = 0.05, *p* = .047) and the direct effect without motivation was not (*DE* = -0.09, *SE* = 0.06, *p* = 0.120). As would be predicted by the FRH, motivation mediated the relationship between condition and formidability (*IE* = 0.19, *SE* = 0.03, 95% CI = [0.12, 0.26], *p* < .001, r^2 = .10).

Aggressiveness vs motivation as a mediator of the effect of condition on formidability. In a mediation model including both perceived aggressiveness and motivation to overcome enemies as mediators, both aggressiveness (*DE* = 0.14, 95% CI = [0.02, 0.26]) and motivation to overcome enemies (*DE* = 0.12, 95% CI = [0.03, 0.22]) mediated the relationship between condition and envisioned formidability, and the bootstrapped indirect effect was significant (*IE* = 0.26, *SE* = 0.05, 95% CI = [0.18, 0.35], *p* < .001, r^2 = .11).

Gruesomeness and winning a fistfight. Consistent with our prediction, the target was rated as more likely to win a fistfight in the gruesome condition (*M* = 6.89, *SD* = 2.05) than in the control condition (*M* = 4.90, *SD* = 2.23), *t*(329) = 8.48, *p* < .001.

Envisioned formidability mediates the effect of condition on winning a fistfight. As in Studies 1 and 2, we tested if envisioned formidability mediated the relationship between condition and likelihood of winning a fistfight. The total effect of scenario on winning a fistfight

was significant (TE = 0.42, SE = 0.05, p < .001) as was the direct effect (DE = 0.38, SE = 0.04, p < .001). As predicted, envisioned formidability mediated the relationship between condition and perceived likelihood of winning a fistfight (IE = 0.04, SE = 0.02, 95% CI = [0.00, 0.09], p < .001, r^2 = .36).



Supplementary Figure 1. Path analysis figure with standardized regression coefficients for the relationship between the measured variables. Perceived aggressiveness and motivation to overcome enemies predict envisioned formidability, which in turn predicts perceived success in a gunfight.

Gruesomeness and winning a gunfight. Consistent with our predictions, the target was rated as more likely to win a gunfight in the gruesome condition (M = 6.21, SD = 2.46) than in the control condition (M = 4.70, SD = 2.69), t(329) = 5.35, p < .001.

Envisioned formidability mediates the effect of condition on winning a gunfight. We also tested if envisioned formidability mediated the relationship between condition and likelihood of winning a gunfight. The total effect of scenario on winning a gunfight was significant ($TE = 0.28$, $SE = 0.05$, $p < .001$) as was the direct effect ($DE = 0.24$, $SE = 0.05$, $p < .001$). As predicted, envisioned formidability mediated the relationship between condition and perceived likelihood of winning a gunfight ($IE = 0.04$, $SE = 0.02$, 95% CI = [-0.01, 0.08], $p < .001$, $r^2 = .24$).

Discussion

As in Studies 1 and 2, the protagonist in the gruesome condition was perceived as more formidable, more aggressive, more motivated to overcome his enemies, and more likely to win a fistfight or a gunfight. Though imagining a stereotypically small group of people appears to have reduced the effect size, this study provides additional support for our hypothesis that gruesome actions enhance cognitive representations of the perpetrator's formidability as measured through envisioned size and strength. Moreover, the individual who committed gruesome acts was estimated to be more likely to win a fistfight than the individual who did not. Our mediational analysis in this supplementary study provides further support for the FRH by demonstrating that both perceived trait aggression and motivation to overcome enemies (as measured using our improved item) mediate the relationship between condition and envisioned formidability. Moreover, envisioned formidability mediated the relationship between condition and estimated ability to win an agonistic conflict, providing further evidence for the FRH.

Participants' judgments as to the likelihood of the protagonist winning a gunfight – a contest in which size and strength play no role – parallel their responses regarding a fistfight, with the composite of envisioned physical dimensions mediating the effect of condition on both. Paralleling our reasoning with regard to responses to the poisoning question in Study 2, given that bodily dimensions play no part in success in a gunfight, this suggests that participants' responses to the fistfight item reflect the deployment of their representation of the protagonist's assessed formidability and are not merely byproducts of their use of size and strength as dimensions in a representation that summarizes multiple characteristics of the protagonist. Further supporting this interpretation, envisioned formidability mediated the relationship between condition and estimated ability to win a gunfight.

Data Availability: All pre-registrations, materials, data, and code used to generate the analyses are available on the Open Science Framework https://osf.io/2ghav/?view_only=fd49b9a70cad42929076d524a57c3941

Supplementary Study References

Felson, R. B. (1996). Big People Hit Little People: Sex differences in physical power and interpersonal violence. *Criminology*, *34*, 433-452.

Sell, A., Tooby, J., & Cosmides, L. (2009). Formidability and the logic of human anger. *Proceedings of the National Academy of Sciences*, *106*, 15073-15078.

[i] There was a typo in the pre-registration for this hypothesis such that it reads "will not enhance." However, H5 as we intended and as it is written here is directly predicted from the FRH (e.g., Fessler, Holbrook, & Snyder, 2012).