"A True Friend with Six Hearts:" Holding a firearm helps gun-owners cope with the threat of electric shock

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Abstract

What does it mean to say that a gun makes a person feel 'safe?' We argue that, for American protective gun owners, this sense of safety extends beyond simple physical protection, covering protection against threats to more fundamental psychological needs. In a preregistered within-subjects laboratory experiment with a convenience sample of American undergraduates, we present evidence that the symbolic protective power of a firearm can help gun owners to cope with anticipated physical pain. We find that, among those from gun-owning households (but, importantly, not among those from non-gun-owning households), holding a non-firing pistol leads to a diminished threat response to anticipated electric shock, compared to both holding a control object and holding the hand of a friend.

"A True Friend with Six Hearts:" Holding a firearm helps gun-owners cope with the threat of electric shock

"If you buy a Colt's rifle or pistol, you feel certain that you have one true friend, with six hearts in his body, and can always be relied on." - Advertisement for Colt's Patent Firearms, 1860

The United States is the world leader in firearms ownership. Americans own over 393 million weapons, 46% of all weapons in civilian hands worldwide (Karp, 2018), and over 40% of American households own at least one gun (Parker, Horowitz, Igielnik, Oliphant, & Brown, 2017). This prevalence of weapons is dangerous: meta-analyses show that having a firearm in the home doubles the likelihood that a member of the household will be violently murdered, and triples the likelihood that a member of the household will die by suicide (Anglemyer et al., 2014). What do gun owners see in their weapons that outweighs the very serious risks that owning a gun brings with it?

When asked, roughly two-thirds of American gun owners report owning their weapons, at least in part, to keep them safe (Parker et al., 2017). On the face of it, this assertion is puzzling, given the vanishingly-small likelihood that any gun owner will actually use their weapon to prevent violent victimization (e.g. Hemenway & Solnick, 2015; Planty & Truman, 2013). 'Safety' is a multifaceted concept however (e.g. Hart, 2014), and these protective gun owners may be using their weapons not just to protect against physical threat; they may additionally be using them to help deal with more psychological threats as well.

The Coping Model of Protective Firearms Ownership (Buttrick, 2020) proposes that this form of ownership helps people to (maladaptively) deal with threats to their fundamental psychological needs (see Leander et al., 2019 for a similar approach). American protective weapons owners are more likely to think that the world is a dangerous place (e.g. Shepperd et al, 2018) and that the institutions of the state are unable or unwilling to keep them safe (e.g. Glaeser & Glendon, 1998; Warner & Thrash, 2020). These perceptions then lead to increased worries about one's safety (e.g. Stroebe et al., 2017), to worries about one's control and self-efficacy (e.g. Freeman & Bentall, 2017), and one's belongingness (e.g. Kohn, 2004). In turning to their guns to help them cope with these concerns, protective owners believe that owning a gun helps them stay safe (e.g. Parker et al., 2017), helps them retain control and efficacy (e.g. Shepherd & Kay, 2018), and helps them to belong to valued social groups (e.g. Carlson, 2015).

A key part of this framework suggests that gun owners use their weapons as a source of coping against generalized psychological threat (Buttrick, 2020). In this study, we test that hypothesis, using a well-validated paradigm designed to measure the buffering effects of felt support within a threatening situation. In this paradigm, participants are hooked up to a shock-generator and repeatedly and randomly shocked. Prior work finds that greater felt social support when holding the hand of a close relational partner, compared to holding the hand of a stranger or holding no hand at all, leads to greater buffering against the threat of shock, indicated by reduced activity in pain-related neural circuits, decreased heartrate, and less self-reported pain (Che, Cash, Fitzgerald, & Fitzgibbon, 2018; Coan, Schaefer, & Davidson, 2006; Coan et al., 2017; López-Solà et al., 2019; see Gross & Medina-Devilliers, 2020 for a review). We adapt this paradigm by adding in a condition asking participants to hold a non-firing pistol, in addition to holding the hand of a friend and holding no hand at all. This allows us to measure the degree to which a gun acts as a 'true friend with six hearts,' helping gun-owners (but not non-owners) to deal with the threat of electric shock.

Method

Disclosures

Preregistration

After data had been collected, but before the end of data-cleaning, we built the analysis script, which automatically blinded the analyst to condition by randomly-shuffling conditions, thus breaking the relationship between IV and DVs. Models were refined on this shuffled data, and then once finalized, we registered the script, which included steps to take in case of model non-convergence. Only after registration were the data unshuffled and analysis completed. The registration can be found at https://osf.io/49hej?view_only=bcbf6f22dcd74975ac59c66fbc58ac39, and the registered analysis script can be found at https://osf.io/f249k/?view_only=bcbf6f22dcd74975ac59c66fbc58ac39

Data and Materials

All data and materials can be found at https://osf.io/fm4sq/?view_only=bcbf6f22dcd74975ac59c66fbc58ac39

Reporting

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. All work was conducted under the supervision of the Institutional Review Board for the Social and Behavioral Sciences of the University of Virginia, protocol #2015-0418.

Participants

We aimed to recruit around 100 participants. We brought 104 undergraduate participants in same-sex friendship pairs, recruited from a psychology department participant pool, into the lab (stopping data collection at the end of an academic year), of which we could extract self-report data from 90 participants (61% from gun-owning households, 62% female, age *M* = 18.84, *SD* = 0.85). Simulation-based power analyses using the statistical model presented in the results (see the analysis script at https://osf.io/pgrv8/?view_only=bcbf6f22dcd74975ac59c66fbc58ac39, which contains the simulation scripts) suggests that this sample provides us 80% power (at an alpha level of 0.05) to detect a within subjects/between-subjects interaction (Block Condition x Gun Ownership) of *partial* eta^2 = 0.063, and 80% power to detect a between-subjects main effect of *partial* eta^2 = 0.093.

We could extract reliable heartrate data from 43 participants (54% from gun-owning households, 63% female, age *M* = 18.79, *SD* = 0.75), with an average of 570.64 beats per condition per person. Simulation-based power analyses suggest that this sample provides us 80% power to detect the hypothesized three-way within-subjects/between-subjects interaction (Block Condition x Trial Threat x Gun Ownership) of *partial* eta^2 = 0.00015, and 80% power to detect a two-way within/between interaction (Block Condition x Gun Ownership) of *partial* eta^2 = 0.00016.

Materials

Pre-Shock Survey

Before undergoing the experimental blocks, participants completed a short survey that began with the single-item, Inclusion of Other in the Self Scale (IOS; Aron, Aron, & Smollan, 1992); the 12-item Multidimensional Scale of Perceived Social Support (MSPSS; Zimet, Dahlem, Zimet & Farley, 1988), alpha = .94 [.93, .96]; and the 24-item Behavioral Inhibition and Activation scales (BIS/BAS; Carver & White, 1994), BIS alpha = .79 [.73, .85], BAS-Drive alpha = .74 [.66, .82], BAS-Fun Seeking alpha = .61 [.49, .73], and BAS-Reward alpha = .64 [.53, .75].

Participants were then presented with a set of sliders to indicate whether they thought that gun laws should be made ‘less strict’ (left anchor), ‘kept as they are now’ (middle anchor), or made ‘more strict’ (right anchor); whether having a gun in the house made it ‘safer’ (left anchor), ‘no difference’ (middle anchor), or ‘more dangerous’ (right anchor); whether the idea of carrying a gun made them ‘more nervous’ (left anchor), ‘no difference’ (middle anchor), or ‘more confident’ (right anchor); whether, if more people carried firearms, the place where they lived would be ‘safer’ (left anchor), ‘no difference’ (middle anchor), or ‘more dangerous’ (right anchor); whether they thought of a gun as an ordinary tool, like a hammer or fishing pole, ‘not at all’ (left anchor) to ‘very much’ (right anchor); and whether they thought of a gun as a symbol or instrument of liberty, ‘not at all’ (left anchor) to ‘very much’ (right anchor).

Participants were asked if they or anyone in their household had ever owned a gun; and were presented with sliders asking how common were guns in their life growing up with ‘never saw one’ (left anchor) to ‘pretty much everyone I knew had one’ (right anchor); and disregarding local gun laws or the price of a firearm, whether they would like to own a gun in the future, with ‘absolutely would not’ (left anchor) to ‘absolutely would’ (right anchor). Participants then reported the postal code in which they grew up, their age, and their gender.

Post-Block Survey

After each within-subjects block (i.e. three times in total), participants filled out the Self-Assessment Manikin (SAM) Scales (Bradley and Lang, 1994). The SAM Scales are non-verbal measures used by participants to rate their current subjective feelings of valence and arousal. The valence scale shows pictures ranging from a smiling, happy figure to a frowning, unhappy figure, and the arousal scale shows pictures ranging from an excited, wide-eyed figure to a relaxed, sleepy figure. Participants additionally self-reported the amount of pain that they felt during the block.

Procedure

Participants were informed about the shock and informed consent was collected from both the participant and the same-sex friend that they brought to the study session. Participants and friends were seated at separate computers to complete a series of questionnaires assessing multiple personality and relationship characteristics. Upon completion of questionnaires, participants were fitted with ECG electrodes on their left wrist and right below their right clavicle and shoulder. Ankle shock electrodes were placed on the ankle (counterbalanced for side) and calibrated to a level of shock (0.2-4.0 milliamps) that was uncomfortable but not painful.

Participants were then taken into a small room, behind a curtain, and completed three within-subjects blocks in a randomized order. During each block, participants were placed in front of a computer screen that presented 48 trials. Before each trial, the screen presented a fixation cross. In 'safety' trials, the screen presented an O, indicating that there would be no shock in that trial. In 'threat' trials, the screen presented an X, indicating that there was a 20% chance that they would be shocked during the next 10 seconds. There were an equal number of threat and safety trials in each block, and trial order was counterbalanced across blocks and participants. In the Object condition, participants completed the block while continuously holding a small metal weight. In the Handholding condition, participants completed the block while continuously holding the hand of the same-sex friend that they brought to the study with them, who was sitting on the other side of the curtain, and therefore could only interact through touch. In the Gun condition, participants completed the block while continuously holding a non-firing handgun. The handgun looked and felt like a Beretta M9 pistol (the standard sidearm for the US military from 1985-2017), but had no internal firing mechanism. At the end of each block, valence, arousal, and pain measures were recorded using a 9-point computerized version of the SAM Scales. After one participant had completed all three blocks, their partner was then set up with the electrodes, and roles were reversed. Upon completion of the task, participants were debriefed.

ECG Recording and Data Reduction

The electrocardiogram (ECG) was recorded using the SynAmps2 amplifier system within the Curry8 program (Compumedics) and exported in Neuroscan's CNT format. We attached Ag-AgCl electrodes to the lower left forearm and right inner clavicle with electrode conductive cream. The ECG was acquired continuously and digitised at a sampling rate of 1 kHz. Raw signal was offline filter (bandpass filter 5-35 Hz) and hand-corrected for artifacts, such as missed, erroneous, or ectopic beats.

Continuous ECG data was exported to QRSTool and CMetX software programs (Allen et al., 2007). Inter-beat interval (IBI) series were first derived from the raw ECG by identifying heartbeats by hand and using QRStool to extract the IBI series, and Cardiac Metric X software (CMetX) to derive the resulting metrics. IBIs were epoched in 5 second segments (at the start of the safe/threat cue and throughout the fixation cue). IBIs were then exported as TXT files and analyzed using R.

Analytic Strategy

We built a set of separate multilevel models to investigate the effect of condition on both heartrate and on self-reported feelings, with *p*-values based on Satterthwaite approximations. For testing the effect of heartate, we first excluded any inter-beat interval less than or greater than 3x the interquartile range within each participant's heartrate data. We then predicted the inter-beat interval of every heartrate in the session from the fixed-effect three-way interaction of block condition (i.e. handholding, gun, or control object), of whether the trial was a threat or a safety trial, and whether or not the participant came from a gun-owning household. For the random effects, we registered that we would estimate both a random slope of the condition by threat interaction, and a random intercept for participant nested within their dyad. If that model did not converge, we registered that we would simplify it by iteratively simplifying the random slopes. Based on convergence and singular-fit issues, we ultimately ended with a random-effects term containing just the random intercept for participant nested within dyad.

For testing the self-reported effects, after each block, of arousal, pain, and valence, we fit three separate models, predicting each of the DVs from the fixed-effect interaction of block condition and gun-ownership, with a random slope for condition and a random intercept for participant nested within dyad. If that model did not converge, we registered that we would simplify it by iteratively dropping the random slopes, ultimately ending with just the random intercept for participant nested within dyad.

We predicted that, if the gun was acting as a metaphorical security blanket, that we would see longer IBIs (i.e. a slower heartrate), along with lower self-reported arousal, less pain, and a more positive valence, for gun owners when threatened with shock in the gun-holding condition than in the object-holding condition; while seeing the reverse for non-gun-owners: shorter IBIs, higher arousal, more pain, and more negative valence in the gun-holding condition when threatened than in the object-holding condition when threatened. We expected that holding a gun would look like holding a hand for gun-owners across all DVs, but not for non-gun-owners, where holding the object was expected to look more like holding the hand.

Alternately, if holding a gun simply oriented participants towards threat, we would expect to see shorter IBIs in the gun-holding condition when threatened than in the object-holding condition, regardless of gun-ownership status, and would expect to see higher arousal, less pain, and more positive valence after the gun-holding condition, relative to after the object-holding condition among gun owners; while seeing higher arousal, higher pain, and more negative valence for guns than objects for non-gun owners.

Owing to the size of our anticipated sample, we made no predictions about main-effect comparisons between gun owners and non-gun owners.

Results

Deviations from registered analyses

While we originally brought 104 participants into the lab, due to recording errors or datafile corruption, we were only able to extract usable heartrate data from 43 participants across 27 dyads. We iteratively simplified the random-effects terms of our models to deal with singular fit in the random effects (as per our registration), with a final model that contained the full fixed-effect three-way-interaction between block-condition, trial-threat, and gun-ownership, but with only a random intercept for participant nested within their dyad. See the Supplemental Materials for the principal components analyses of the variance-covariance matrices for the random-effects terms in all models, which explain the nature of the singular fit involved.

Confirmatory Models

Effects of Condition on Inter-beat Intervals

For our primary analyses, using data from 43 participants (23 from gun-owning households and 20 from non-gun owning households), we did not find evidence for the expected three-way interaction between block condition, threat trial, and gun ownership, $F(2, 73560) = 0.32$, $p = .73$, *partial* $eta^2 = 0.0000086$ [0.00, 0.000076]. We did however, find evidence for an interaction between block condition and gun ownership, $F(2, 73568) = 59.20$, $p < .001$, *partial* $eta^2 = 0.0016$ [0.0011, 0.0022] collapsing across threat type. We decomposed the interaction using all pairwise tests, Holm-corrected. For those from gun-owning households, inter-beat intervals were longer when holding a gun ($M = 772.01$ ms between heartbeats, $se = 25.16$ ms) than when holding either a metal weight ($M = 763.07$ ms, $se = 25.17$), $z = 9.54$, $p < .001$, $d = 0.12$ [0.10, 0.15]; or when holding a partner's hand ($M = 752.32$ ms, 25.17 ms), $z = 20.81$, $p < .001$, $d = 0.26$ [0.24, 0.29]. Holding a metal weight also led to longer inter-beat intervals than when holding a partner's hand, $z = 11.07$, $p < .001$, $d = 0.14$ [0.12, .17].

By contrast, those from non-gun-owning households showed a different pattern of results, where holding on to the metal object ($M = 798.18$ ms, $se = 26.97$ ms) led to longer inter-beat intervals than holding on to a gun ($M = 791.63$ ms, $se = 26.97$ ms), contrast = 6.46, $z = 6.04$, $p < .001$ $d = 0.086$ [0.058, 0.11]; holding on to a gun led to longer inter-beat intervals than holding on to a partner's hand ($M = 777.78$ ms, $se = 26.97$ ms) , $z = 13.22$, $p < .001$, $d = 0.19$ [0.16, 0.21]; and holding on to an object led to longer inter-beat interval than holding on to a partner's hand, contrast = 20.29, $z = 18.20$, $p < .001$, $d = 0.27$ [0.24, 0.30].

We additionally found evidence for an interaction between block condition and threat, $F(2, 73560) = 4.50$, $p = .011$, *partial* $eta^2 = 0.00012$ [0.0000065, 0.00032]. Collapsing across gun-ownership status, participants in the object-holding condition showed longer inter-beat intervals in safety trials ($M = 780.07$ ms, $se = 18.54$ ms) than in threat trials ($M = 777.54$ ms, $se = 18.54$ ms), $z = 2.54$, $p = .011$, $d = 0.034$ [0.0077, 0.060]. No such difference was detected for gun-holding safety trials ($M = 780.39$ ms, $se = 18.53$ ms) vs. threat trials ($M = 781.33$ ms, $se =$

18.53 ms), z = -1.07, p = .29, d = -0.013 [-0.038, 0.011]; or for handholding safety trials (M = 763.29 ms, se = 18.53 ms) vs. threat trials (M = 764.31 ms, se = 18.54 ms), z = -1.19, p = .23, d = -0.015 [-0.04, 0.0098]. See Figure 1 for a plot of all inter-beat interval data.

We did not design or power the study to detect fully-between differences in gun owners versus non-gun owners, and we did not detect differences in our heartrate analyses between non-gun-owners and gun-owners when holding objects, z = 0.96, p = 1.00, d = 0.47 [-0.49, 1.43]; hands, z = 0.70, p = 1.00, d = 0.34 [-0.62, 1.30], or guns, z = 0.54, p = 1.00, d = 0.26 [-0.70, 1.22].

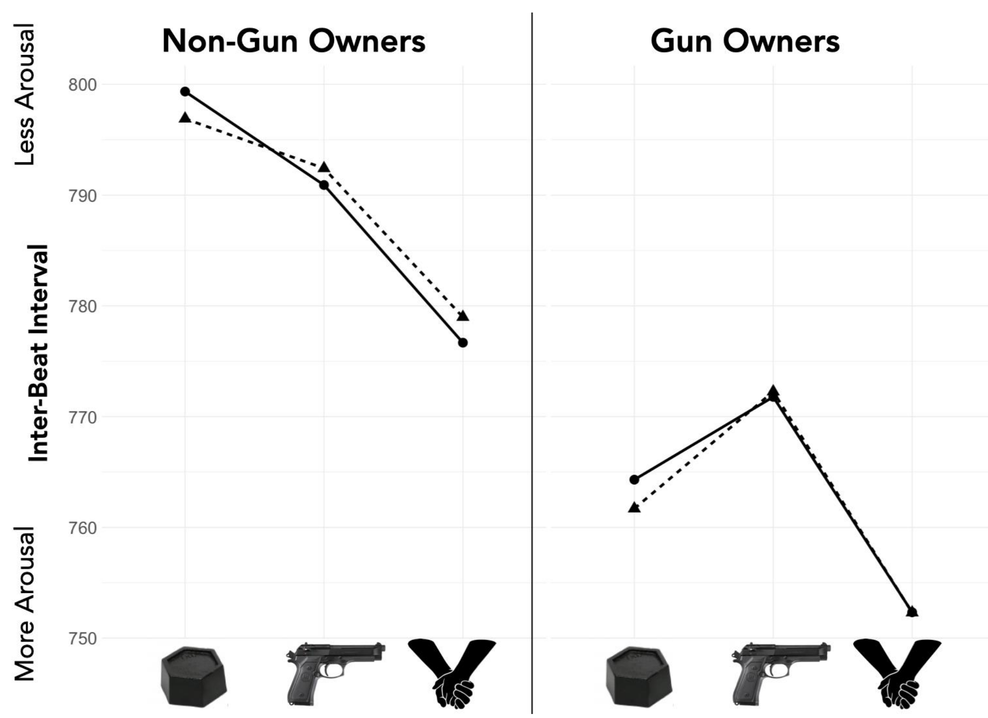


Figure 1. Inter-beat intervals, by condition and gun ownership. Solid lines (with circles) indicate safety trials while dotted lines (with triangles) indicate threat trials. Conditions, left to right, are the *object* condition, the *gun* condition, and the *handholding* condition.

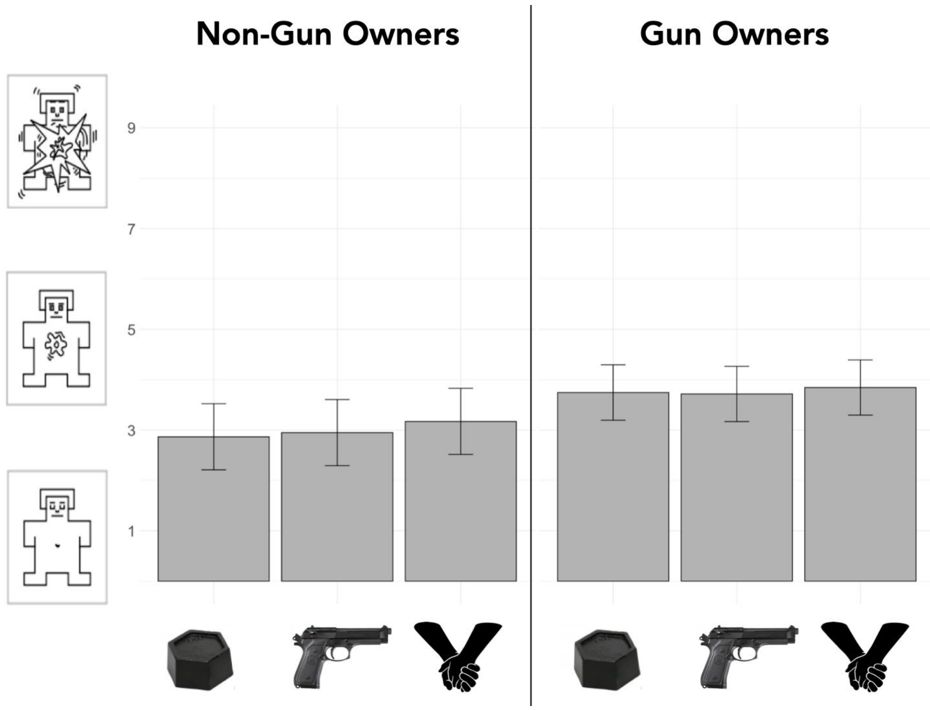
Effects of Condition on Self-Report Data

For our secondary analyses, we were able to extract self-report data from 90 participants nested within 50 dyads (36 from non-gun-owning households, 54 from gun-owning households). We did not find the expected interaction for reported arousal between gun ownership and condition, $F(2, 177.26) = 0.18$, $p = .83$, *partial* $eta^2 = 0.0021$ [0.00, 0.023], but we did find a main effect of gun ownership, $F(1, 87.33) = 4.60$, $p = .035$, *partial* $eta^2 = 0.050$ [0.00, 0.16] whereby gun-owners generally felt more arousal after each block, regardless of condition (M = 3.77, se = 0.25) than did non-gun owners (M = 3.00, se = 0.30).

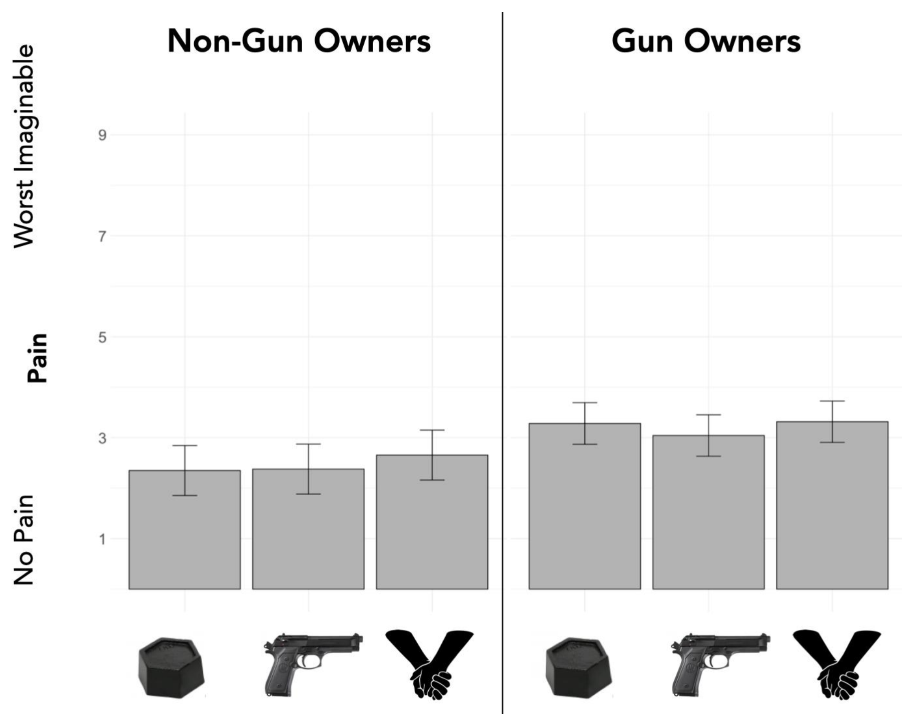
Similarly, we did not find the expected interaction for self-reported pain between gun ownership and condition, $F(2, 178.43) = 0.64$, $p = .53$, *partial* $eta^2 = .0071$ [0.00, 0.042], but we did find a main effect of gun ownership, $F(1, 88.15) = 7.81$, $p = .0064$, *partial* $eta^2 = 0.08$ [0.0069, 0.21], whereby gun-owners generally felt more pain after each block, regardless of condition (M = 3.21, se = 0.18) than did non-gun owners (M = 2.46, se = 0.22).

Finally, we again did not find the expected interaction for self-reported valence between gun ownership and condition, $F(2, 177.26) = 0.22$, $p = .81$, *partial* $eta^2 = 0.0025$ [0.00, 0.025], but we did find a main effect of gun ownership, $F(1, 87.26) = 4.22$, $p = .043$, *partial* $eta^2 = 0.046$ [0.00, 0.16], whereby gun-owners generally felt happier after each block, regardless of condition (M = 3.74, se = 0.25) than did non-gun owners (M = 3.01, se = 0.30). See Figure 2 for all self-report data.

a)


Non-Gun Owners
Gun Owners
9
7
5
3
1

b)


Worst Imaginable
Pain
No Pain
Non-Gun Owners
Gun Owners
9
7
5
3
1

c)

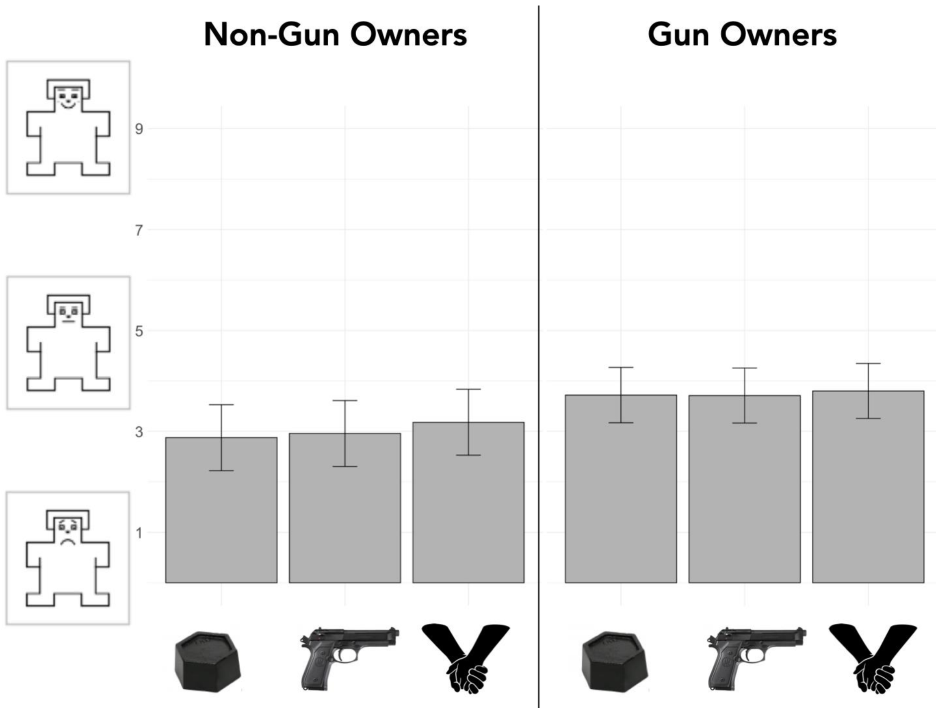


Figure 2. Self-reported feelings of a) arousal, b) pain, and c) valence after each condition block, by condition and gun ownership. Conditions, left to right, are the *object* condition, the *gun* condition, and the *handholding* condition. Error bars indicate 95% CIs.

Exploratory Analyses

In a set of exploratory analyses, we investigated whether dispositionally-perceived social support (measured using the MSPSS) and closeness to the experimental partner (measured using the IOS) moderated the experience across gun owners and non-gun owners. While the two measurements were essentially uncorrelated with each other (see the SI for all correlations), we nevertheless found evidence suggestive of potential differences in the meaning of social support between gun owners and non gun-owners. When dispositionally perceiving greater social support, non-gun-owners appear to have been less worried throughout the experiment (reporting less arousal, less pain, but also lower valence). By contrast, gun owners appear to have been feeling more worried (reporting higher arousal, more pain, and higher valence) when dispositionally perceiving greater social support. Among gun-owners, this also appears to have carried over to their heartrate in the shocking task, as, when dispositionally perceiving greater social support (relative to less social support), they additionally had lower inter-beat intervals (i.e. faster heartrate) when holding the hand of their partner and when holding the gun (with weaker differences when holding the control object).

We find a broadly-similar pattern when looking at the perceived closeness of the interaction partner, with those non-gun-owners who felt closer to the person they brought with them to the experiment feeling less arousal and lower valence throughout the experimental session, while those gun-owners who felt closer to the person they brought with them to the experiment feeling greater arousal and higher valence throughout the experimental session.

As our design was not powered to detect exploratory interactions involving individual-difference variables, we report these analyses in the Supplemental Materials.

Discussion

Do gun owners find comfort in their guns when psychologically threatened? In a preregistered laboratory study, we find that they do. As predicted, when repeatedly threatened with electric shock, participants from gun-owning households had slower heartrates when holding a highly-realistic prop pistol than when holding a control metal object or holding the hand of a same-sex friend. Participants from gun-free households, by contrast, found no palliative effect in holding a gun, with a slower heartrate when holding a control object than when holding the gun, and with the fastest heartrate when holding the hand of their relationship partner.

As inferring psychological states from a single psychophysiological indicator is problematic, given that multiple psychological states can lead to the same pattern of psychophysical response (Siegel et al., 2018, and see Mendes, 2016 for a further discussion of the *specificity* problem in psychophysiology), we additionally simply asked people how they were feeling. We found that, throughout the experience, gun-owners reported higher levels of arousal, reported feeling more pain, but also reported that the overall experience was more pleasant, than non-gun owners, a pattern of response that is consistent with gun-owners being more vigilant to potential threats in the environment (e.g. Aldrich, Eccleston, & Crombez, 2000; Oken, Salinsky, & Elsas, 2006).

In exploratory analyses (reported in the Supplemental Materials), we found suggestive evidence that this pattern was especially strong when gun owners felt more social support and felt closer to their experimental partner. We speculate that gun owners may have felt that this closeness required that they be able to protect their partner and significant others, recasting friendship as responsibility for others (that they be a "sheepdog" protecting against "wolves;" e.g. Grossmann & Christensen, 2004); as opposed to non-gun-owners, who generally felt more relaxed in the experiment when feeling greater social support, which may imply a friendship strategy more focused on the potential benefits that come from social connection (see Adams & Plaut, 2003; and Liu et al., 2019 for differing cross-cultural approaches to friendship and responsibility). We intend to follow this intriguing finding up in future studies.

Contrary to our expectations, we did not find strong evidence for a distinction in heartrate between periods of high stress (when a participant was at immediate threat of being shocked) and periods of lower stress (when a participant was told that they were not at immediate threat for shock). While, validating the paradigm, we did see the expected interaction in our control-object condition, with participants experiencing greater arousal under threat when holding the control object than when safe, we saw no such differences across our gun-holding or hand-holding conditions. We speculate that the degree of felt threat in the gun and handholding conditions at baseline were high enough that they washed out any difference between safety and threat trials; previous work using heartrate as a measure of stress has also found that heartrates are more responsive to the overall threat across a block of trials, and discriminate less between safety and threat trials within a block (see Fishman, Turkheimer, & DeGood, 1995).

We were also surprised at the reaction our participants had to holding their friend's hand. Prior work has shown that the degree of felt closeness moderates the palliative effect of handholding, with close marital partners getting the strongest benefit and total strangers the least benefit (Coan et al., 2006). In this study, we recruited close friends, instead of life partners as in previous work, and it appears that the friends that we recruited were not as close as they could be (IOS $M = 4.93$ (out of 7), $SD = 1.37$). In line with previous studies, those individuals who felt closer to their partner did have longer inter-beat intervals (i.e. slower heartrates) in the handholding condition, albeit non-significantly (due, we suspect, to the restricted size of our sample), $B = .24$ [-.05, .54], $p = .12$. For those who were less close, it appears that holding their partner's hand may have been actually aversive, more like holding the hand of a stranger than the hand of one's spouse. Regardless, of course, we still see the hypothesized pattern in heartrate for gun owners versus non-gun-owners when we compare just holding a gun to holding the control object.

We chose to use heartrate as our primary physiological measure of stress due to its ease of measurement relative to the EEG or fMRI that have previously been used in this paradigm. What we gained in accessibility, we may have lost in granularity, and future work using this setup may wish to employ a measure (or series of measures) that allow for a more fine-grained measure of trial-to-trial threat. We also used a convenience sample of undergraduates and provided a pistol for them to hold. We suspect that specifically recruiting gun owners who regularly carry their weapons, and asking them to bring the firearm that they carry, would produce stronger effects in the paradigm.

One might worry about the sample we were able to clean heartrate data for. Though small, we point out that our sample is well within the range of prior studies that have made use of this paradigm - Coan et al. (2006) is based on 16 participants; Coan et al. (2013) is based on 22 participants; Maresh et al. (2013) is based on 25 participants; and Lopez-Sola et al. (2019) is based on 30 participants. Our power analysis, furthermore, indicates that we are more than well-powered to detect very small within/between interaction effects--the sort that we designed the study around and that we targeted in our preregistered hypotheses--even if we are underpowered to detect exploratory between-person main effects.

Finally, we note that believing that a gun keeps one safe should be a prerequisite for being able to use it as a coping device, and not all gun owners have this belief. The hunting and sport-shooting subcultures of American gun ownership, who tend to see their guns as a tool or a means of recreation (Kohn, 2004), are somewhat distinct from those who own their weapons as a means of protection (e.g. Azrael et al., 2017); and the belief that guns protect their owners may be unusually prevalent in American gun culture (e.g. Cooke, 2004; Kohn, 2004). We would therefore only expect to see threat-buffering type responses among groups such as American protective gun owners, and we would be somewhat surprised to see such responses among American target-shooters, hunters, or non-American gun owners. As American hunting culture is on the decline, however (Smith & Son, 2015), and is being replaced with an ever-more-militant protective gun culture (e.g. Conley, 2019; Lacombe 2019), we expect that these effects will grow stronger in the population of American gun owners, as the link between protection and guns becomes ever more central in the minds of their owners.

In conclusion, we find evidence that some American gun owners may be using firearms as a general-purpose coping mechanism, feeling calmer when holding a gun than when holding a control object, even in a situation where a gun cannot make them objectively any safer. This *feeling* of security highlights the symbolic power that protective gun owners imbue their weapons with, and is critical for any understanding of American debates over gun rights, gun control, and the current state of American gun culture.

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Supplemental Information for "'A True Friend with Six Hearts:' Holding a firearm helps gun-owners deal with the threat of electric shock"

Exploring the Effect of Felt Social Support

The threat response evoked by the prospect of electric shock in our paradigm has been shown to be moderated by the amount of social support that the target participant feels in their everyday life. In one study, for example, the quality of the marital relationship predicted how effective holding the hands of their husbands was for buffering the negative effects of shock for married women (e.g. Coan et al., 2006). In the current study, we measured felt social support in a more general context (since we were recruiting friend pairs, not married couples), using the Multidimensional Scale of Perceived Social Support (MSPSS; Zimet et al., 1988) and in a more specific context by using the Inclusion of Other in the Self Scale (IOS; Aron, Aron, & Smollan, 1992). The MSPSS asks about whether participants have people in their lives that they can talk to, whether there are friends to whom they can turn if things go wrong, and generally if they have social resources to draw on in case of misfortune. The IOS measures how close people felt to the specific friend that they brought with them into the experiment by asking participants to select from a set of pairs of circles, from non-overlapping to completely overlapping, that best represents the way that they feel about their partner.

We expected that those feeling greater social support would show less aversive reactions to the threat of electric shock, especially when holding the hand of their relationship partner, but given the power we had to detect effects, we were not willing to preregister the hypothesis. In exploring the data (and trying to understand an unexpected pattern in the relationships between variables), we fit models additionally interacting both MSPSS and IOS with gun-ownership status, which we present below.

Exclusions

After inspecting the distribution of the MSPSS responses (see Figure S1), we chose to remove four participants as a predictor who had abnormally-low values on felt support (MSPSS < 50) from any model using MSPSS, three of which came from gun-owning households, one of which did not come from a gun-owning household.

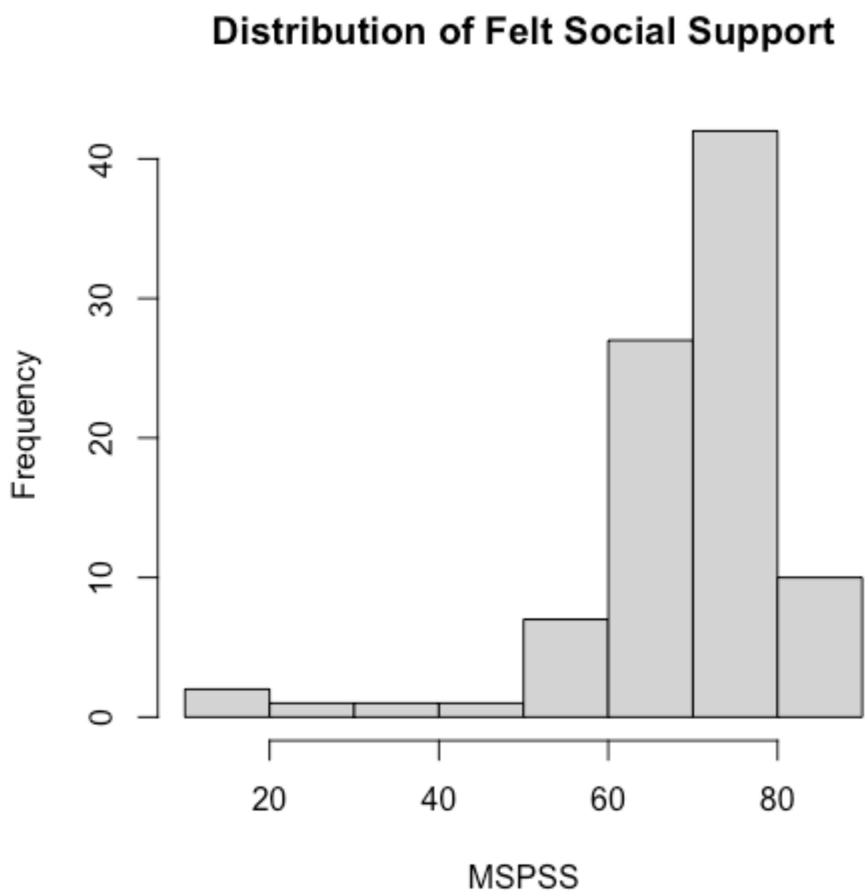


Figure S1. Distribution of participant scores for the Multidimensional Scale of Perceived Social Support (MSPSS).

Correlations Between the Two Social Support Measures

The two social-support scales seem to be indexing different constructs, as scores on the MSPSS correlate very weakly with scores on the IOS, $r(84) = .025$ [-.19, .24], $p = .82$.

Interbeat Intervals

We fit a model predicting interbeat intervals from the fixed-effect interaction of block condition, of whether the trial was a threat or a safety trial, whether the participant came from a gun-owning household, and their social-support score (MSPSS or IOS), with a random intercept for participant nested within their dyad.

MSPSS

We found evidence for a three way interaction between gun ownership, block condition, and MSPSS score, $F(2, 73559) = 52.86$, $p < .001$, *partial* $eta^2 = 0.0014$ [0.00092, 0.0020]. Among non-gun-owners, there was no interaction between MSPSS and block condition, $F(2, 33097) = 1.93$, $p = .16$, *partial* $eta^2 = 0.00011$ [0.00, 0.00042], and no effect of MSPSS, $F(1, 18) = 0.15$, $p = .70$, *partial* $eta^2 = 0.0086$ [0.00, 0.23], just a main effect of block condition, $F(1, 33097) = 6.61$, $p = .001$, *partial* $eta^2 = 0.00040$ [0.000064, 0.00091], similar in pattern to the data presented in the main text.

Among gun owners, by contrast, we found an interaction between block condition and MSPSS, $F(2, 40477) = 122.90$, $p < .001$, *partial* $eta^2 = 0.0060$ [0.0046, 0.0076]. An analysis of the simple slopes found the strongest relationship between MSPSS and increased heartrate (i.e. decreased interbeat intervals) in the handholding condition, $b = -2.54$ [-6.77, 1.68], followed by the gun condition, $b = -1.80$ [-6.02, 2.43], with the weakest relationship in the object condition, $b = -0.63$ [-4.85, 3.60]. All three simple slopes differed significantly from each other: object vs handholding, $z = 15.52$, $p < .001$, object vs gun, $z = 9.64$, $p < .001$, gun vs handholding, $z = 6.092$, $p < .001$. See Figure S2.

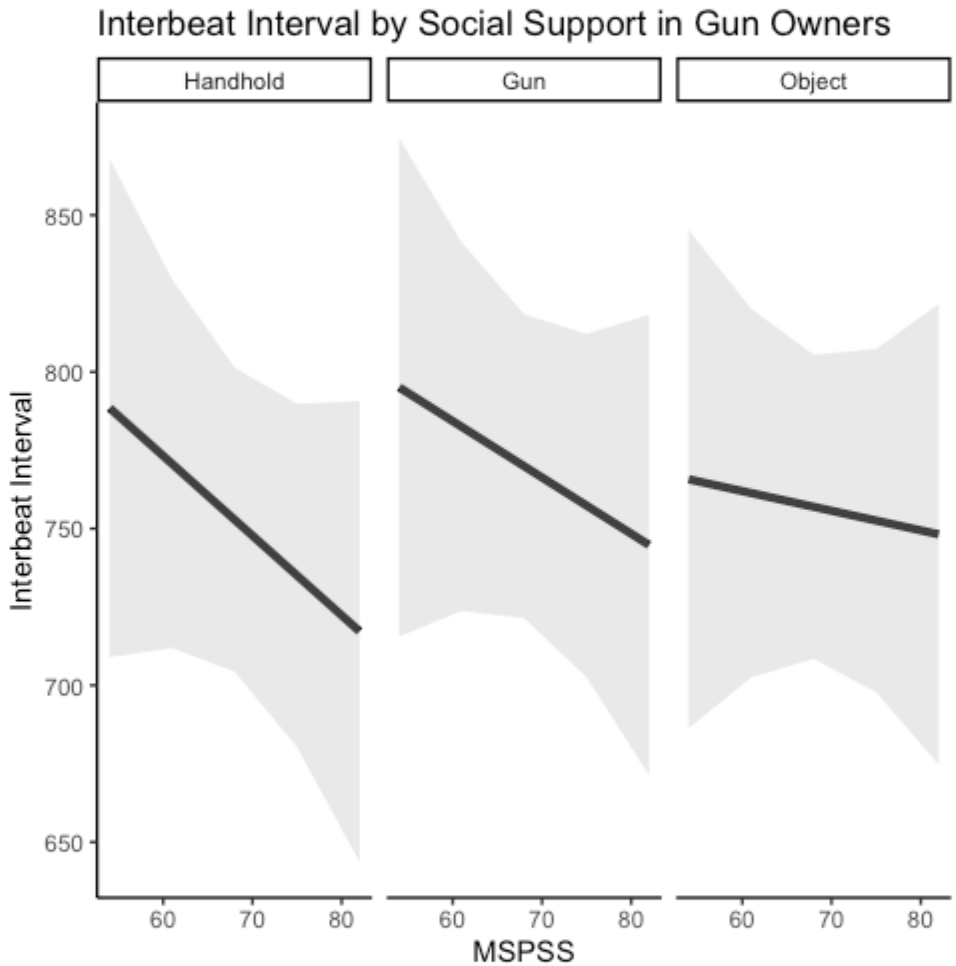


Figure S2. Interbeat intervals predicted by scores on the Multidimensional Scale of Social Support (MSPSS) and block-condition among those from gun-owning households. Grey envelopes indicate 95% confidence intervals.

IOS

We found no evidence for an interaction between IOS and gun ownership: three-way interaction between gun ownership, condition, and IOS, $F(2, 73566) = 0.97$, $p = .38$, *partial* eta^2

= 0.000026 [0.00, 0.00013]; two-way interaction between just IOS and gun ownership, $F(1, 39) = 0.0004$, $p = 0.98$, *partial* $eta^2 = 0.000011$ [0.00, 0.0000069].

Self-Report Scales

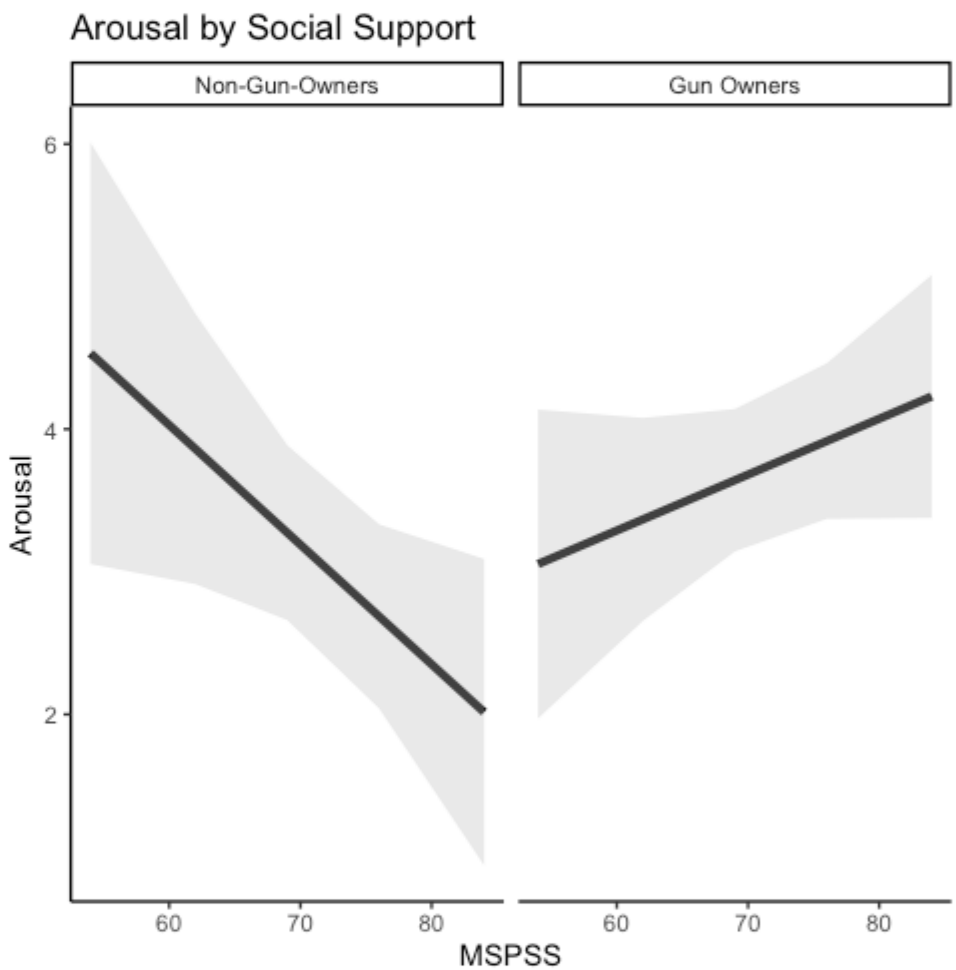
We fit separate models for each of the three self-report scales, predicting arousal, felt pain, and valence from the fixed-effect interaction of block condition, whether the participant came from a gun-owning household, and their self-report score, with a random intercept for participant nested within their dyad.

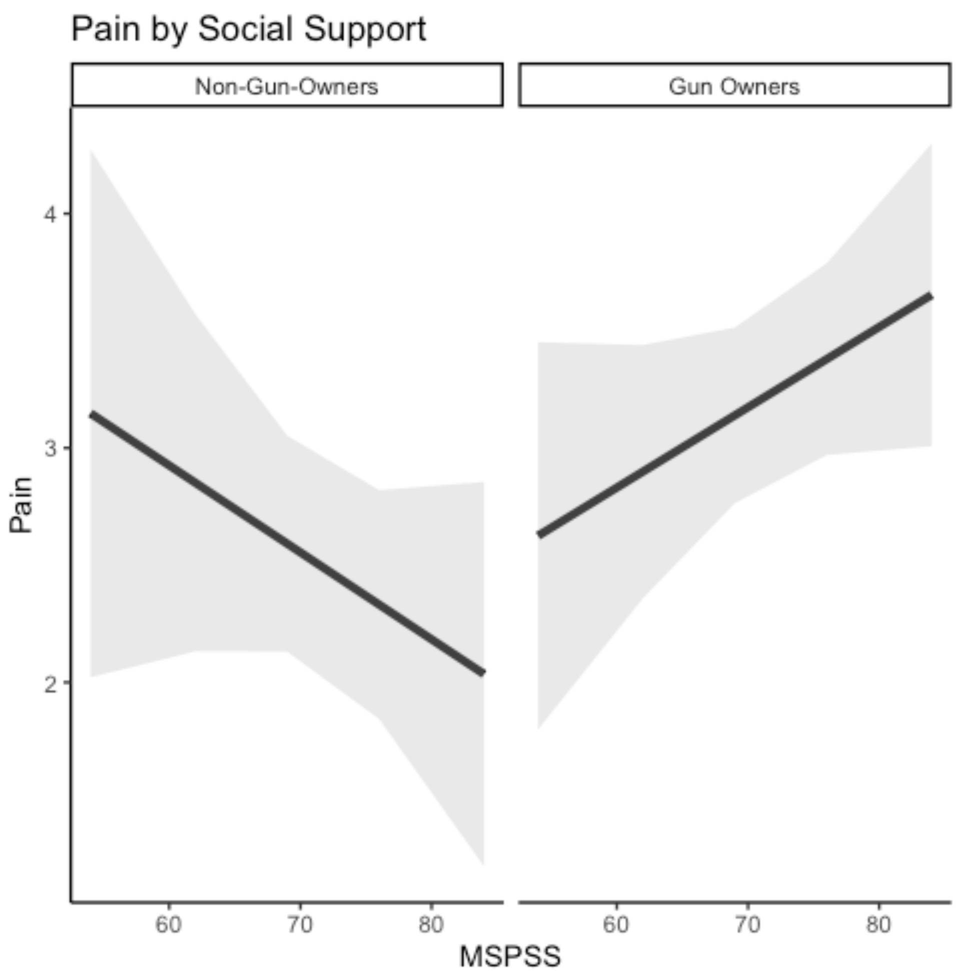
MSPSS

For arousal, we did not find evidence for the three-way interaction between block condition, gun-ownership, and MSPSS: $F(2, 163.167) = 2.69$, $p = .071$, *partial* $eta^2 = 0.032$ [0.00, 0.095]. We did, however, find evidence for an interaction between gun-ownership and MSPSS, $F(1, 80.33) = 6.44$, $p = .013$, *partial* $eta^2 = 0.074$ [0.0032, 0.20]. A simple slope analysis found that among non-gun-owners, higher MSPSS predicted lower arousal throughout the experiment, $b = 0.084$ [-0.16, -0.0054]; but not among gun owners, where the trend was in the opposite direction, with higher MSPSS marginally predicting higher arousal throughout the experiment, $b = 0.039$ [-0.018, 0.097].

For felt pain, we also did not find evidence for the three-way interaction: $F(2, 164.37) = 0.18$, $p = .84$, *partial* $eta^2 = 0.0022$ [0.00, 0.024], but did find marginal evidence for the interaction between gun-owning and MSPSS: $F(1, 80.88) = 3.73$, $p = .057$, *partial* $eta^2 = 0.044$ [0.00, 0.16]. A simple slopes analysis found that higher MSPSS predicted marginally less pain in non-gun-owners throughout the experiment, $b = -0.037$ [-0.097 , 0.023], while predicting marginally more pain in gun-owners throughout the experiment, $b = 0.034$ [-0.0097, 0.078].

For valence, finally, we also did not find evidence for the three-way interaction $F(2, 163.17) = 2.71$, $p = .070$, *partial* $eta^2 = 0.032$ [0.00, 0.095]. We did, however, again find evidence for the interaction between gun ownership and MSPSS, $F(1, 80.27) = 6.40$, $p = .013$, *partial* $eta^2 = 0.074$ [0.0031, 0.20]. A simple-slope analysis found that higher MSPSS predicted decreased valence among non-gun-owners throughout the experiment, $b = -0.084$ [-0.16 - 0.0054], while predicting marginally higher valence among gun owners throughout the experiment, $b = 0.039$ [-0.019, 0.096]. See Figure S3 for interaction plots for all three self-report variables.




Pain by Social Support
Non-Gun-Owners
Gun Owners
Pain
4
3
2
60
70
80
60
70
80
MSPSS

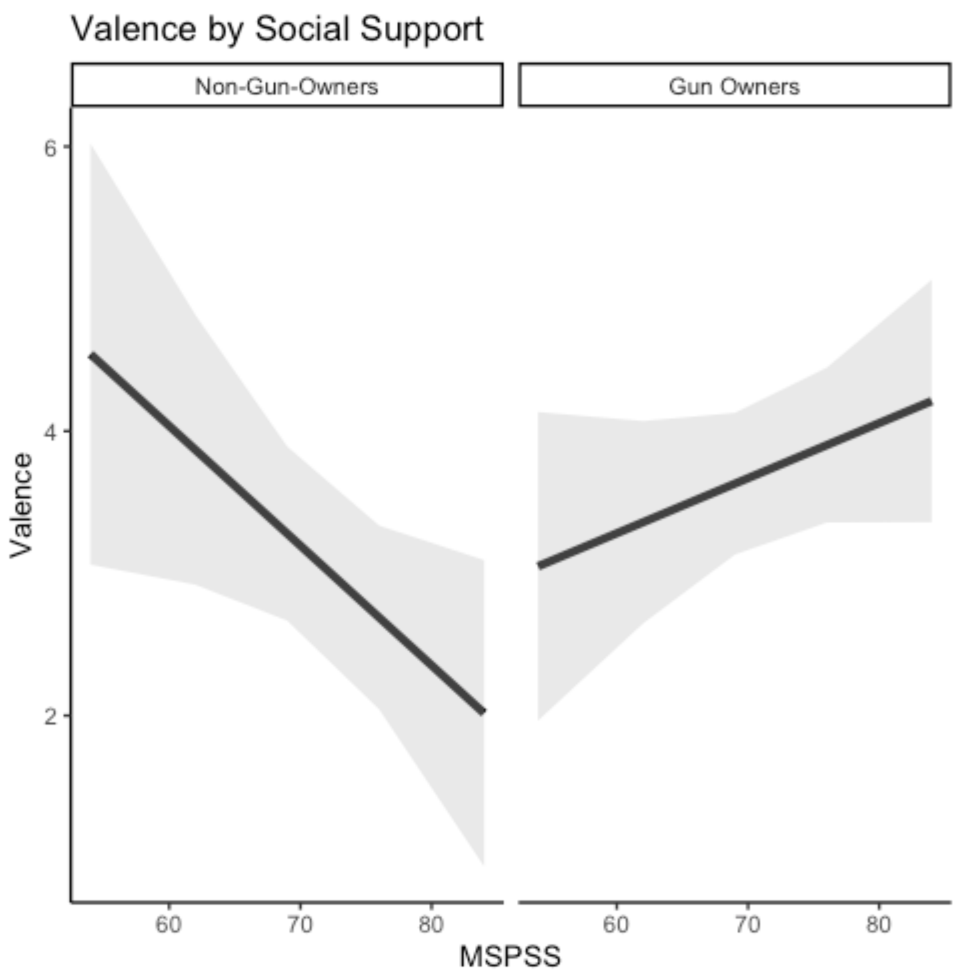


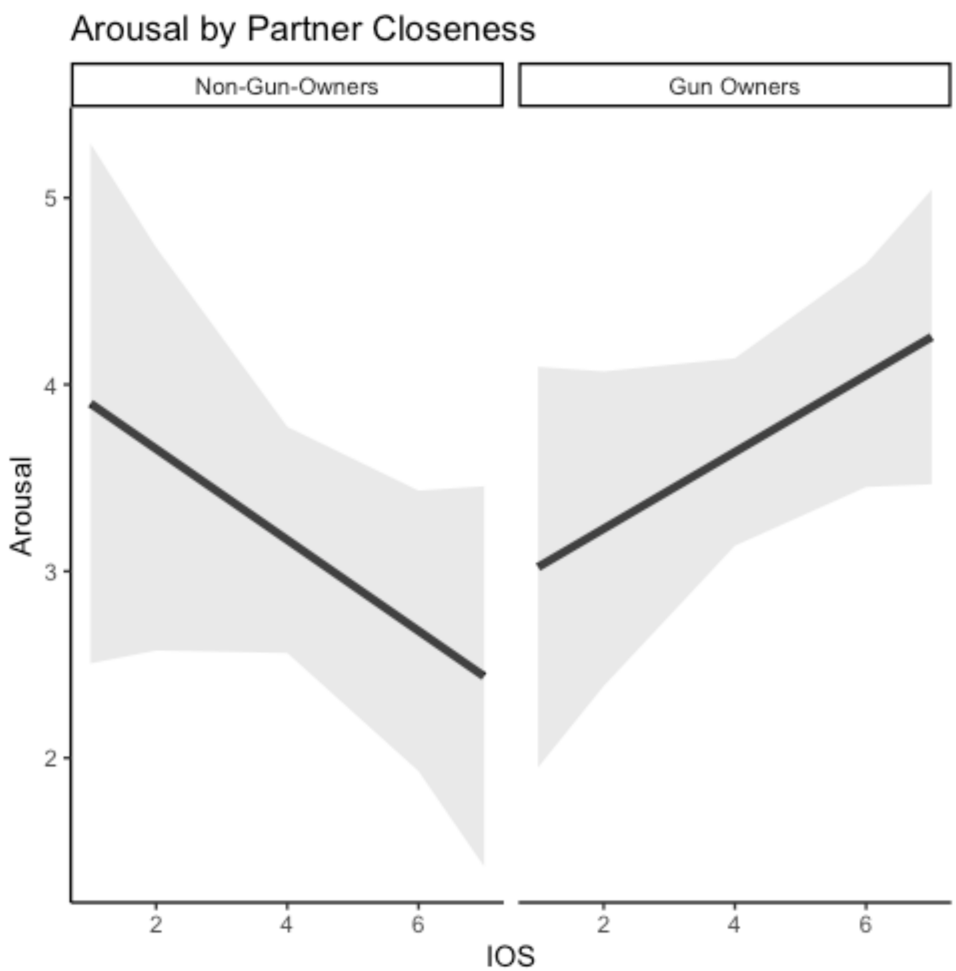
Figure S3. Responses to self-report scales predicted by scores on the Multidimensional Scale of Social Support (MSPSS) and whether participants came from gun-owning households or not. Grey envelopes indicate 95% confidence intervals.

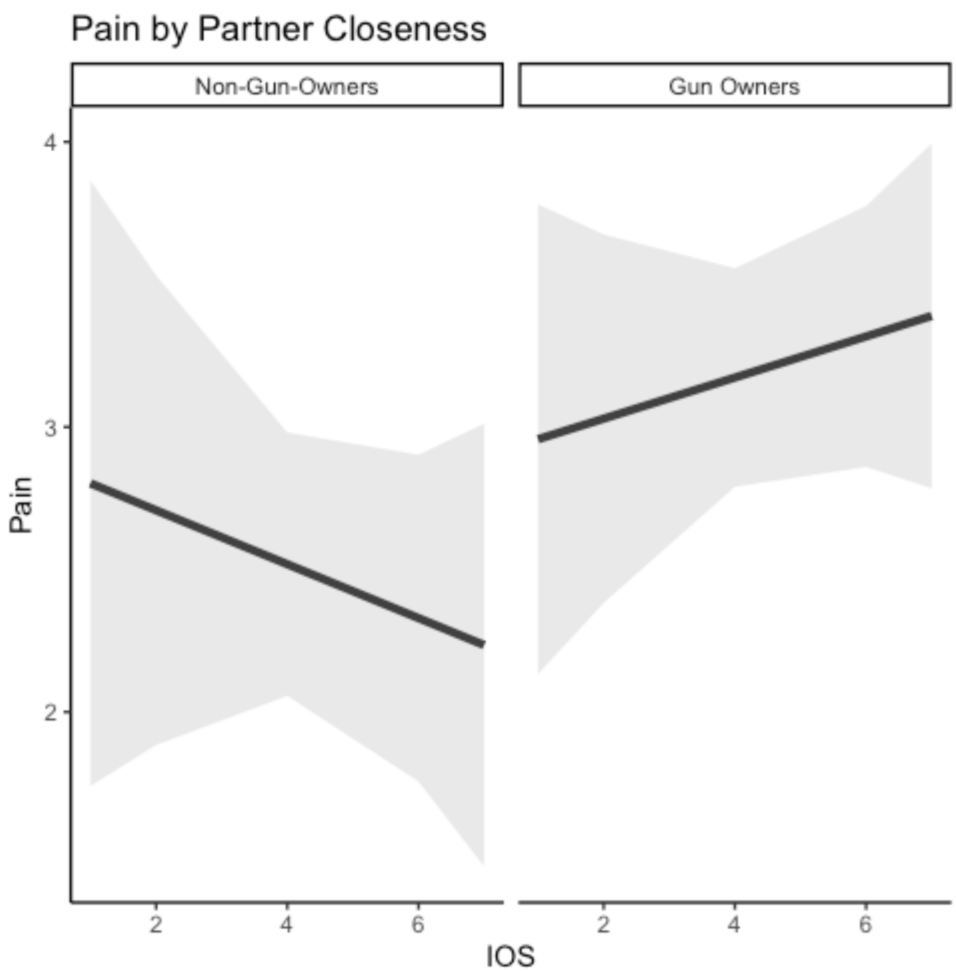
IOS

For arousal, we did not find evidence for the three-way interaction between block condition, gun-ownership, and IOS: $F(2, 172.96) = 0.47$ $p = 0.63$, *partial* $eta^2 = 0.0053$ [0.00, 0.037]. We did, however, find evidence for an interaction between gun-ownership and IOS, $F(1, 96.42) = 4.17$, $p = .044$, *partial* $eta^2 = 0.042$ [0.00, 0.14]. A simple slope analysis found that, among non-gun-owners, feeling closer to the interaction partner predicted marginally less arousal throughout the experiment, b = -0.24 [-0.61, 0.12], while for gun owners, feeling closer to the interaction partner predicted marginally more arousal throughout the experiment, b = 0.21 [-0.068, 0.48].

For felt pain, we also did not find evidence for the three-way interaction: $F(2, 174.32)$ = 1.032, p = .36, *partial* eta^2 = 0.012 [0.00, 0.054], nor did we find evidence for the interaction between gun-owning and IOS: $F(1, 96.82)$ = 0.98, p = .32, *partial* eta^2 = 0.010 [0.00, 0.082].

For valence, finally, we also did not find evidence for the three-way interaction F(2 172.97) = 0.68, p = 0.50, *partial* eta^2 = 0.0078 [0.00, 0.045]. We did, however, again find evidence for the interaction between gun ownership and IOS, $F(1, 96.71)$ = 4.14, p = 0.045, *partial* eta^2 = 0.041 [0.00, 0.14]. A simple-slope analysis found that feeling closer to the interaction partner predicted marginally decreased valence among non-gun-owners throughout the experiment, b = -0.25 [-0.61, 0.11], while among gun owners, feeling closer to the interaction partner predicted marginally increased valence throughout the experiment, b = 0.20 [-0.075, 0.47]. See Figure S4 for interaction plots for all three self-report variables.


Arousal by Partner Closeness
Non-Gun-Owners
Gun Owners
Arousal
5
4
3
2
2
4
6
2
4
6
IOS


Pain by Partner Closeness
Non-Gun-Owners
Gun Owners
Pain
4
3
2
2
4
6
2
4
6
IOS

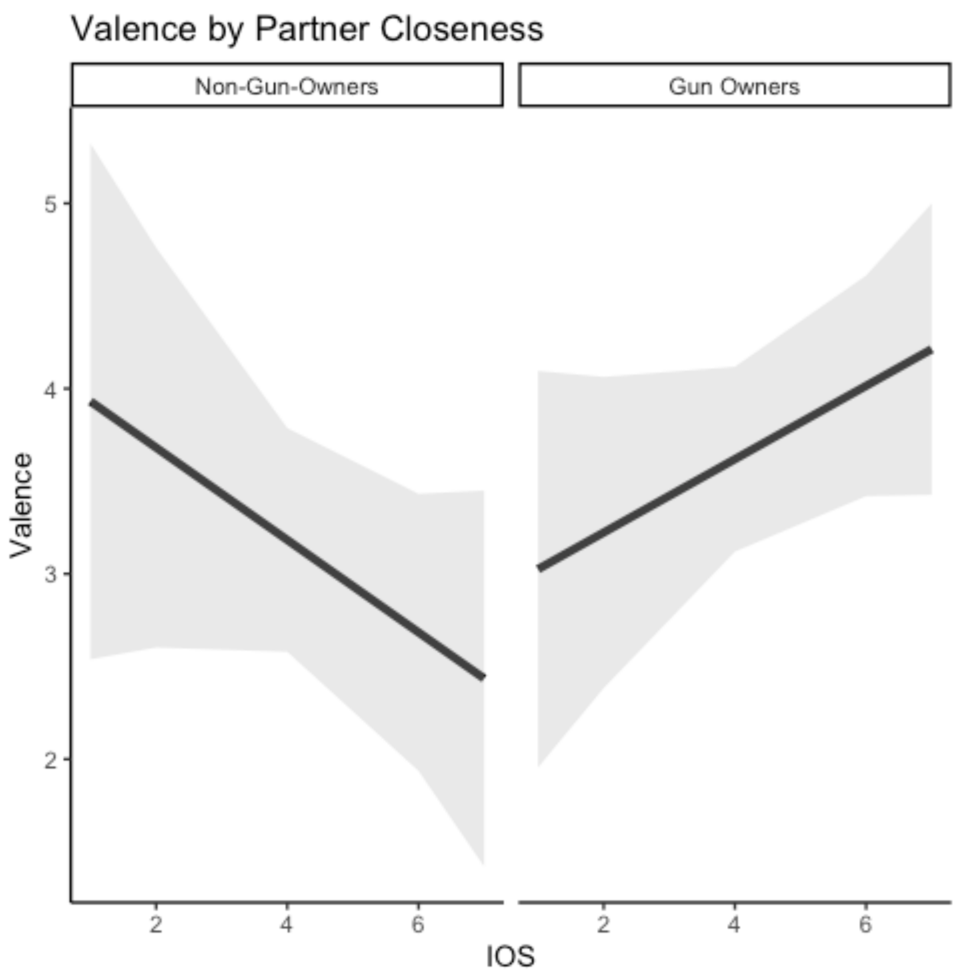


Figure S4. Responses to self-report scales predicted by scores on the Inclusion of Other in the Self Scale (IOS) and whether participants came from gun-owning households or not. Grey envelopes indicate 95% confidence intervals.

Summary

In a set of exploratory models, we find that the degree to which a participant feels that there is a group of people in their life whom they can lean upon when times are not so great, or the closeness they feel to their interaction partner, predicts the way that participants react to the threat of electric shock, but that this effect is diametrically opposed for those who come from gun-owning households and those who do not.

Among those who grew up without guns around, the more social support they felt, the *less* arousal, pain, and happiness they felt throughout the experimental session, with no effect on the interbeat intervals of their heartrate. By contrast, among those who grew up with guns in the household, the more social support they felt they had in their lives, the *more* arousal, pain, and happiness they reported throughout the experimental session, and the higher their heartrate, especially when holding their friend's hand or holding the prop pistol.

Similarly, among those who grew up without guns around, the closer they felt to their interaction partner, the *less* arousal and happiness they felt throughout the experimental session; while among those who grew up with guns in the house, the closer they felt to their interaction partner, the *more* arousal and happiness they felt throughout the experimental session. For felt closeness, we found no evidence for differences in heartrate patterns by gun-ownership status.

We speculate on the potential meaning of this pattern of results in the main text, but we wish to emphasize that this is an exploratory finding, with a sample that is underpowered to detect such an interaction with any degree of confidence. We present these analyses merely as a spur to further research.

Table S1

Principal components analyses of the variance-covariance matrices for all random-slope terms (with random intercepts)

	Intercept	Condition: Handhold	Condition: Object	Threat: Threat	Condition: Handhold:: Threat: Threat	Condition: Object:: Threat: Threat
Maximal Model - (Condition*Threat|Dyad/ID)						
ID:Dyad						
SD	1.5596	0.4390	0.25080	0.08703	7.946e-05	0
Proportion of Variance	0.9024	0.0715	0.02333	0.00281	0	0
Cumulative Proportion	0.9024	0.9739	0.99719	1	1	1
Dyad						
SD	0.8240	0.3566	0.13676	0.001807	4.642e-05	0
Proportion of Variance	0.8232	0.1541	0.02267	0	0	0
Cumulative Proportion	0.8232	0.9773	1	1	1	1
Dropping the Interaction Random Slope - (Condition+Threat|Dyad/ID)						
ID:Dyad						
SD	1.5264	0.45149	0.2415	0.005682	-	-
Proportion of Variance	0.8989	0.07864	0.0225	0.000010	-	-
Cumulative Proportion	0.8989	0.97748	1	1	-	-
Dyad						
SD	0.8885	0.3811	0.12962	1.721e-05	-	-
Proportion of Variance	0.8297	0.1527	0.01766	0	-	-
Cumulative	0.8297	0.9823	1	1	-	-

Proportion						
Dropping the Threat Random Slope - (Condition|Dyad/ID)						
ID:Dyad						
SD	1.541	0.46166	0.24450	-	-	-
Proportion of Variance	0.897	0.08045	0.02257	-	-	-
Cumulative Proportion	0.897	0.97743	1	-	-	-
Dyad						
SD	0.8766	0.3628	0	-	-	-
Proportion of Variance	0.8538	0.1462	0	-	-	-
Cumulative Proportion	0.8538	1.0000	1	-	-	-

Table S2

Principal components analyses of the variance-covariance matrices for all random-slope terms (without random intercepts)

	Condition: Gun	Condition: Handhold	Condition: Object	Threat: Threat	Condition: Handhold:: Threat: Threat	Condition: Object:: Threat: Threat
Maximal Model - (0+Condition*Threat|Dyad/ID)						
ID:Dyad						
SD	2.5016	0.38830	0.18118	0.08482	0.0001362	1.672e-21
Proportion of Variance	0.9704	0.02338	0.00509	0.00112	0	0
Cumulative Proportion	0.9704	0.99379	0.99888	1	1	1
Dyad						
SD	1.4819	0.21821	0.13153	0.00202	0.0002319	3.178e-21
Proportion of Variance	0.9713	0.02106	0.00765	0	0	0
Cumulative Proportion	0.9713	0.99235	1	1	1	1
Dropping the Interaction Random Slope - (0+Condition+Threat|Dyad/ID)						
ID:Dyad						
SD	2.4586	0.39419	0.17248	0.009307	-	-
Proportion of Variance	0.9703	0.02494	0.00478	0.000010	-	-
Cumulative Proportion	0.9703	0.99521	0.99999	1	-	-
Dyad						
SD	1.5262	0.21521	0.12090	0	-	-
Proportion of Variance	0.9745	0.01938	0.00612	0	-	-
Cumulative	0.9745	0.99388	1	1	-	-

Proportion						
Dropping the Threat Random Slope - (0+Condition|Dyad/ID)						
ID:Dyad						
SD	2.4848	0.39580	0.17692	-	-	-
Proportion of Variance	0.9705	0.02462	0.00492	-	-	-
Cumulative Proportion	0.9705	0.99508	1	-	-	-
Dyad						
SD	1.4994	0.20963	6.853e-05	-	-	-
Proportion of Variance	0.9808	0.01917	0	-	-	-
Cumulative Proportion	0.9808	1	1	-	-	-