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Response effort attenuates provoked aggression in men and women

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Previous efforts to manage aggressive behavior have generally focused on the emotion of anger, as opposed to aggressive behaviors. Several small-N studies have explored the promising approach of contingency-based interventions (e.g., the effort required to respond aggressively; Zhou et al., 2000), but have produced mixed results. Therefore, the present study aimed to determine whether experimentally-manipulated response effort effectively attenuates provoked aggressive responding using a modified version of the Taylor Aggression Paradigm (TAP; Berman et al., 2009). Participants included 123 (40 men; Mean age = 20.9, *SD* = 4.6) randomly assigned to either a low- or high-effort condition, crossed with a repeated measures provocation condition. Aggressive behavior was defined by the level of shock participants selected for their increasingly provocative "opponent" on a competitive reaction-time task. Results indicated that increased response effort attenuated both the overall average shock selected, as well as the use of "extreme" shocks in response to provocation.

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CHAPTER I

INTRODUCTION

Human aggression is a pervasive and significant problem, costing the world economy an estimated $1,240 billion annually (Hoeffler, 2017). This cost, which includes the financial consequences of homicides and assaults, amounts to approximately 7.5 times more than the expenses associated with war and terrorism combined (Hoeffler, 2017). Due to the substantial impact of human aggression on society, scientists have long been interested in the causes of aggression and have developed several theoretical models along the way to guide research in this area. For example, one theoretical framework is the General Aggression Model (GAM), which proposes a comprehensive framework that breaks aggressive behaviors down into three parts — inputs, routes, and outputs (Allen & Anderson, 2017; Anderson & Bushman, 2002). This model describes personological factors that influence a person's affect, cognition, and arousal to determine whether a person will respond with impulsive or thoughtful action following several appraisal and decision-making processes (Allen & Anderson, 2017). A more recent theory is the I^3 Theory ("I-Cubed Theory"), which is a process-based metatheoretical approach that conceptualizes aggressive behavior as the result of interactions between "Instigating triggers, Impelling forces, and Inhibiting forces" (Slotter & Finkel, 2011). Both models explicitly acknowledge that conditions exist which can either increase or decrease the likelihood of aggression following threat or provocation.

For the purposes of this study, aggression is defined as "…any behavior directed toward another individual that is carried out with the *proximate* (immediate) intent to cause harm" (Anderson & Bushman, 2002, *p*. 28). Aggressive behavior by this definition encompasses direct, psychological harm (e.g., verbal threats), indirect harm (e.g., destruction of property), and direct, physical harm, which can include severe and potentially lethal physical violence (Anderson, 2000). Although severe violence cannot be ethically studied experimentally, it is possible to investigate less lethal forms of aggression, including physical aggression, under controlled, laboratory conditions.

Efforts to manage aggressive behavior have focused primarily on its emotional or physical antecedents, such as anger or arousal, via anger management programs (e.g., Heseltine et al., 2010; McGonigal et al., 2018; Watt & Howells, 1999) or cognitive behavioral therapy (Fernandez et al., 2018; Henwood et al., 2015; Deffenbacher, 2011 Deffenbacher et al., 2002). A small number of studies have explored the promising approach of changing contingencies associated with aggression (e.g., response effort to aggress; Irvin et al., 1998; Van Houten, 1993; Wallace et al.,1999; Zhou et al., 2000). These studies have produced promising, but inconclusive results.

For instance, comparison of a 20-hour anger management program to a control condition among offenders at various Australian correctional facilities showed notable improvements in the treatment participants' anger-related knowledge, but negligible improvements on measures of their anger experience and anger expression emerged when compared to controls (Heseltine et al., 2010). Similarly, evaluation of an experimental Skills Training for Aggression Control (STAC) program among violent offenders incarcerated in Western Australia indicated participants saw few benefits from treatment relative to the control group participants (Watt &

Howells, 1999). In contrast, a study administering pre- and post-intervention self-report measures to incarcerated men enrolled in 12-session anger management groups demonstrated significantly decreased inmate-reported anger and disciplinary actions post-intervention (McGonigal et al., 2018). Overall, results of meta-analyses exploring the effectiveness of cognitive behavioral therapy (CBT) for anger (Fernandez et al., 2018) and CBT-based anger management programs (Henwood et al., 2015) suggested these efforts may be effective in reducing anger and in reducing recidivism amongst adult male offenders, respectively. However, there is a paucity of well-controlled randomized clinical trials specifically examining the effects of such treatments on actual aggressive behavior, as opposed to constructs related to aggression (such as anger or recidivism). Indeed, Division 12 of the American Psychological Association does not have any such treatment in its compendium of empirically-supported treatments covering a wide-range of diagnoses and symptoms ("Psychological Treatments," 2016).

Current approaches to treat aggressive behavior by targeting anger show promise and indicate a step in the right direction. It is worthwhile to note, however, that anger does not always lead to aggression and aggression is not always preceded by the conscious experience of anger (Averill, 2012; 1983). The present study aims to take a different approach with the goal of reducing aggression by manipulating response effort, as measured by a well-validated laboratory paradigm, thus potentially directly influencing the expression of this behavior. Using basic laboratory studies such as this to investigate human aggression has the potential to help guide the development of treatments and interventions for aggression in a novel and significant way by allowing for more complex experimental designs and providing evidence for causal inferences. In sum, the purpose of the present study is to determine whether experimentally manipulated response effort effectively attenuates provoked aggressive responding in a non-treatment seeking sample.

Background Research

Response Effort and Non-Human Animal Studies

Response effort is the amount of exertion required to complete a target behavior, often operationalized in experimental designs as the requisite force, energy expenditure, or number of key presses needed to make a desired response selection (Friman & Poling, 1995). Non-human animal studies have demonstrated that increasing response effort is generally associated with a decrease in choice behaviors. For example, pigeons trained to peck a key for food significantly decreased in their response rate as the required force to obtain the reinforcer increased (Chung, 1965).

Findings from Chung and other early studies were reviewed and summarized by Friman and Poling (1995). The authors concluded that a robust inverse trend between required effort and response rate exists in lower animal species (Friman & Poling, 1995). For example, studies of rodents show that response rates decrease as a function of increasing response effort to obtain food (Alling & Poling, 1995; Pinkston & Libman, 2017) or condensed milk reinforcement (Chelonis et al., 1998). In Chelonis et al. (1998), at the most extreme effort contingency (1.00 Newton), some of the rodents ceased responding altogether, highlighting that species exhibit suppressant effects as response effort reaches a given point.

In primates, choice behavior research underscores how changes in response effort also affect behavior. For example, Japanese monkeys (*Macaca fuscata*) were trained to perform a computerized discrimination task to earn a food reinforcer (Shibasaki & Kawai, 2011). Four discriminative shapes in total were presented, denoted as: $S+_{FR20}$ (earns a food reinforcer after

20 key presses at a fixed rate ratio), S- $_{FR20}$ (earns no food after 20 key presses), S+ $_{FR1}$ (earns a food reinforcer after 1 key press), and S- $_{FR1}$ (earns no food after 1 key press). At the start of each trial, each monkey was required to complete either 1 (low-effort) or 20 (high-effort) screen presses to reveal the shapes from under a virtual cover. Then they were required to select one of the two on-screen shapes associated with the above conditions. On the follow up test, the trained monkeys consistently chose the stimuli associated with the low-effort task condition.

In contrast to findings that show response effort is inversely associated with appetitive behaviors, some non-human animal studies have produced contradictory or non-significant effects with respect to response effort. For example, rodents in a study assessing the effect of increased effort on reward strength of distinctively flavored food pellets reported no significant differences based on response effort (Armus, 2001). In addition, a rodent study using sweetened, condensed milk as the reinforcer suggested that rodents' responding rates *increased* as a function of increased force requirements (Zarcone et al., 2009). Indeed, the relation between behavior and response effort has been shown to be dependent on several variables, such as the reinforcement schedule (Kanarek & Collier, 1973), reward amount (Kirshenbaum et al, 2000), and reinforcement delay (Kono, 2019). Although non-human animal studies contribute valuable information to our understanding of response effort, the results to date are not wholly consistent, dependent on various other factors, and might not generalize to complex human behaviors, such as aggressive behavior in the laboratory or in extra-laboratory (that is, "real world") settings.

Human Response Effort Research

Studies have also investigated healthy adult behavioral responses to increased effort requirements. These studies span a variety of settings and behaviors; however, the underlying association of interest, namely response effort and the frequency of a given target behavior, is the same. For example, in a study to determine the effect of response effort on the behaviors of recreational gamblers, participants placed bets via a digital slot machine using three buttons: “Spin,” “Bet 1,” and “Max Bet” (Gunnarsson et al., 2015). Response effort needed for a maximum wager across groups was manipulated by varying the physical distance of the “Max Bet” button from the “Spin” button. As expected, participants in the group with the greatest distance between the two buttons (i.e., the highest response effort) allotted significantly fewer maximum bets when compared to other participants (Gunnarsson et al., 2015).

Most of our knowledge regarding the effects of response effort in humans comes from applied behavior analysis research on harmful behaviors in individuals diagnosed with developmental delays. Usually, this research has focused on reducing self-directed aggression, also known as “self-injury,” in the literature (Devlin et al., 2011), employing physical impediments to reduce unwanted self-injurious behaviors, such as face slapping and head-hitting (Irvin et al., 1998; Van Houten, 1993; Wallace et al.,1999; Zhou et al., 2000). For example, one study used soft wrist weights worn for progressively longer periods of time to decrease, and ultimately eliminate, self-injurious face slapping in a young boy with a severe developmental disability (Van Houten, 1993). Another study gradually increased weighted arm restraints worn by a pair of individuals with developmental delays to reduce self-injurious head-hitting and hand-mouthing, which is when an individual forcibly puts their hand in their mouth. As the weights were increased for both participants, self-injurious behaviors decreased to extinction (Wallace et al., 1999). Self-injurious hand-mouthing was also effectively reduced in individuals diagnosed with developmental delays using resistance sleeves (Irvin et al., 1998) and arm restraints (Zhou et al., 2000) intended to increase response effort.

Overall, results from applied behavior analysis research indicate that self-injurious responding can be effectively mitigated in individuals diagnosed with developmental delays by requiring greater response effort. Although some may argue that studies of self-injury are tangential to the focus of the current study, research indicates that self-directed and other-directed aggression often covary, and have biosocial (e.g., Hillbrand, 2001), personality (Boxer, 2010; Hillbrand, 1995; Sadeh et al., 2011), and contextual factors (e.g., Vivona et al., 1995) in common. However, no study to date has experimentally examined the effects of response effort on other-directed aggression in non-treatment seeking adults.

Aggression

Existing evidence in animals (Alling & Poling, 1995; Chelonis et al., 1998; Chung, 1965; Friman & Poling, 1995; Pinkston & Libman, 2017; Shibasaki & Kawai, 2011) and humans (Irvin et al., 1998; Van Houten, 1993; Wallace et al., 1999; Zhou et al., 2000), as noted above, generally supports the notion that response effort is inversely related to the execution of target behaviors. However, existing studies investigating the influence of increased effort on other-directed aggression are extremely limited. For instance, studies of police officers' aggressive behavior on a simulated shooting task suggest that engaging in physical effort before shooting is associated with decreased aggression toward a target (Vrij, 1995; Vru et al., 1994). However, participants in the high effort condition cycled on an exercise bicycle before engaging in the shooting task (Vru et al., 1994). Thus, the exercise condition was not tied to participants' choice of aggressive outcomes. Although there is a body of literature that has examined variables associated with differential levels of *aggressive behavior* observed under controlled laboratory conditions, such as empathy (see Miller & Eisenberg, 1988), pain cues (e.g., Baron 1974a, 1979), interpersonal rejection (e.g., Leary et al., 2006; Twenge et al., 2001), sexual arousal (e.g., Baron, 1974b, 1977), self-awareness (e.g., Carver, 1975; Scheier et al., 1974), and provocation (see below), no study to date has addressed the research question: *Is increased response effort associated with lower levels of aggressive responding?*

Laboratory Measures of Aggression

In the current study, a contemporary version of the Taylor Aggression Paradigm (TAP; Taylor 1967) was used to elicit aggressive responding (see Berman et al., 2009). The TAP is a well-established measure of provoked aggression in which participants compete against a fictitious opponent in a reaction time task. The 1967 version of the TAP asked participants to select a shock value from one of five levels, but most newer versions allow participants to select values from 1- 10 (with 10 being equivalent to the participant's pain tolerance determined before the task) to be administered to the opponent if the participant is faster on a particular reaction time trial than the opponent (e.g., Giancola & Parrott, 2008). Of course, there is no actual opponent, and the deception is achieved through audio recordings and other procedures. In addition, the proportion of participant wins and losses on each trial is pre-determined (usually 50 percent across all trials) and computer controlled. The participant is shown the shock selected for them by their "opponent" on each trial, and the ostensible opponent gradually selects increasing shock values to simulate increasing levels of provocation.

A more contemporary version of the TAP includes 0 (no shock) and 20 (extreme shock) value options to afford the participant the chance to forgo administering a shock or to select a more extreme 20 shock, with the 20 shock ostensibly being two times the participant's pain threshold (Berman et al., 2009). The 20 shock provides a clearer index of aggression, as the selection of the 20 supports the notion that the participant intends to deliver a harmful stimulus to the opponent. In addition, this version allows the "opponent" to select a 20 for the participant (which is always on a trial the participant wins and is thus not received by the participant) to provide an index of unequivocal threat of harm (that is, provocation or attack) by the opponent. Thus, the TAP enhances researchers' ability to ethically study physical aggression in a controlled laboratory setting. Previous literature has shown the TAP to be a reliable and valid measure of provoked aggression (Ferguson et al., 2008; Ferguson & Rueda, 2009; Giancola & Parrott, 2008).

Another commonly used laboratory measure of provoked aggression is the Point Subtraction Aggression Paradigm (PSAP), originally developed by Cherek (1981). Similar to the TAP, PSAP participants are told they will be paired with an opponent (Cherek et al., 2003). The most recent version presents participants with three options—A, B, and C on a computer screen. Subjects are informed that 100 consecutive selections of the A option will add money to their counter, while 10 consecutive selections of the B option will subtract money from their opponent's counter (Cherek et al., 2003). They are also instructed that the periodic subtractions from their counter are attributable to their opponent's button presses. The participant is also told that 10 consecutive selections of the C option will protect their earnings for a brief time frame. This time frame, referred to as a provocation free interval (PFI) is manipulated to have a variable duration. Option B also produces a PFI, but participants are unaware of this benefit (Cherek et al., 2003). Unlike the TAP, the PSAP maintains a consistent provocation level across trials, which means that independent several sessions are required to examine the role of provocation. Although not a measure of physical aggression *per se*, several studies have shown the PSAP to be a reliable and valid measure of aggressive in general (see Cherek et al., 2003).

Aggression and Provocation

Both the TAP and PSAP allow manipulations designed to examine provoked aggression. Experimental research has recognized provocation as a prominent contributing factor in aggressive behavior (Baron & Richardson, 2004). In his early work, Taylor (1967) demonstrated that aggression significantly increased as a function of increased provocation. This paradigm development made Taylor's (1967) work a formative pillar of aggression research and paved the way for future empirical studies. For instance, Chermack, Berman, and Taylor (1997) used the TAP 30 years after its initial publication to compare aggressive responses between participants with a consistently low provocation opponent to those with an increasingly provocative opponent. Results revealed participants with an increasingly provocative opponent selected significantly higher shock levels (i.e., responded more aggressively) as provocation increased, whereas those with a low-provocation opponent maintained relatively stable aggression levels throughout (Chermack et al., 1997). A later study used the same general task as Chermack et al. (1997) to evaluate the effects of provocation on aggression in children with conduct disorder; rather than selecting shock values as in the TAP, however, children were asked to select a point value to be deducted from their opponent upon winning using a paradigm more closely related to the PSAP (Stadler et al., 2006). Consistent with Chermack et al.'s (1997) findings in adults, children in the increasing provocation group were more aggressive, operationalized by the point values to be deducted, compared to those in the low provocation group (Stadler et al., 2006).

Several studies indicate that, in the absence of provocation, men are more aggressive than women, particularly when it comes to direct, physical aggression (Archer, 2004; Bettencourt & Kernahan, 1997; Bettencourt & Miller, 1996; Weidler, Habel, et al., 2019). Interestingly, the presence of provocation seems to attenuate this gender disparity (Bettencourt & Kernahan, 1997;

Bettencourt & Miller, 1996; Weidler, Habel, et al., 2019). For example, participants in a study investigating the effect of differing provocation modalities on aggression found that prolonged, increasing provocation diminished sex differences, regardless of the provocation's nature (Weidler, Habel, et al., 2019). Therefore, it is reasonable to use samples that include both men and women in research on provoked aggression.

Hundreds of studies have used the TAP and its modifications over the past half-century across the world (e.g., Repple et al., 2018; Wagels et al., 2018; Wagels et al., 2019; Weidler, Habel, et al., 2019; Weidler, Wagels, et al., 2019). However, to date, there are no studies that have examined the effects of experimentally manipulated response effort and provoked aggression using the TAP in healthy men and women in a laboratory setting. Aggressive behavior in the PSAP in confounded with response effort, as heightened aggression is by design determined by more button presses. For the existing versions of the TAP, the effort to choose a low aggressive response (e.g., a 0 or 1 button) is the same as a highly aggressive response (e.g., the 20 button). Therefore, the aim of this study is to address this potentially important gap in the literature by comparing provoked aggression on a standard version of the TAP to a modified TAP that requires increasing effort to access higher levels of aggression.

Study Rationale and Aims

The research reviewed above suggests the performance of unwanted behaviors is often inversely related to the level of response effort required. Of note, it appears this relationship has not yet been investigated regarding aggression in human adults. Aggression has often been studied in the laboratory via subjective self-report measures due to safety and ethical concerns. Fortunately, advances in study designs have allowed researchers to objectively observe provoked aggression in a safe, controlled, and systematic way. Even with these objective protocols, however, no laboratory study to date has directly examined the effects of response effort on human aggression.

Accordingly, the current study aims to systematically test the hypothesis that human retaliatory aggressive behavior is dependent, in part, on the effort required to engage in such behavior. It is therefore predicted that a higher level of response effort will reduce aggressive responding following provocation as assessed by the TAP compared to when aggressive behavior is not restricted by such response effort (that is, a TAP procedure where equal effort is required to respond at any level of aggression). If this prediction is supported, these results could have potentially important implications for the design of policy (such as gun-control measures) and intervention programs (such as treatments for aggressive behavior) by incorporating mechanisms that require effortful processes to acquire the means for aggressive acts.

CHAPTER II

METHODS

Participants

Data were retrieved from a larger study titled, “Personality matching and joint performance on a reaction time task” conducted at a university in the Southern United States. The purpose of the original study was to examine the role of rumination in aggressive behavior ($N = 150$), and this study received approval from the university’s Institutional Review Board. The selected analyses for the current study are designed to address a different research question: Does response effort required affect aggressive behavior in response to provocation? To date, no peer-reviewed results from this original project have been published. Data from 27 participants were excluded from the original data set after debriefing suggested deception regarding the study’s true purpose was unsuccessful. The remaining 123 participants (83 women and 40 men) were valid for inclusion; their ages ranged from 18-51 years ($M = 20.9$, $SD = 4.6$). Of the included sample, 56.9% of participants identified as African-American/Black, 39.8% identified as Caucasian, 1.6% identified as Hispanic, and 1.6% identified their race as “other.”

TAP Protocol

At the start of the experiment, each participant’s shock pain tolerance was determined by administering increasing levels of electric shock in increments of 100 microamperes until the participant rated the shock as “definitely very unpleasant” and did not want to continue to the next level (maximum, 2.5 milliamperes for safety). Following the pain tolerance procedures, an anger-induction protocol was administered by giving participants two additional measures (the Wisconsin Card Sorting Task and a pen-and-paper version of the Trail Making Task) and then providing negative pseudofeedback about their performance on the tasks. Participants were told they performed a "bit below average" on the card sorting task, which they were informed was a measure of intelligence, whereas their opponent performed a "bit above average" on it. The participant was also told they and the other participant performed similarly on all other measures. The researcher then played an audio of pre-recorded TAP instructions over the intercom. At the conclusion of the TAP instructions, the researcher played a voice recording of Subject B (which was gender-matched to the participant) saying: "I'm ready, and I'm pretty sure I'm going to beat Subject A [the participant] on the reaction game just like I did on the intelligence test." Before the participant could respond, the researcher indicated they would be moving forward with the protocol.

After the anger induction protocol, participants completed a version of the TAP that included a 20-level shock option, which the participants were told represents "an extremely painful shock twice the intensity of the pain threshold that could cause minor tissue damage that will quickly heal," to increase ecological validity (Berman et al., 2009; Fanning et al., 2014). Per this description, a selected shock value of 20 was characterized as an aggressive act, defined as an action with intent to cause harm. Participants completed 28 trials with the opponent's shocks becoming increasingly more provocative over the course of four blocks. Each block consisted of an initial trial followed by six provocation trials. Intermediate shock levels between the first three blocks were used to smooth the transition between blocks. In the task, the simulated "opponent" behaves as if they are competing from another room; however, wins and losses are set *a priori* to 50% of the trials. Outcome variables obtained from this protocol to assess provoked aggression include the average selected shock value per block (with the 20 recoded as a 11 shock to reduce the effects of outliers) and number of 20 shock values selected per block.

During the TAP, participants were randomly assigned to either a high or low effort condition. Participants used a computer keyboard to select the shock value from 0-10 or 20 to be administered to their opponent if the participant “won” the reaction time trial. Participants were told a shock value of 10 is equal to their specific pain tolerance level, whereas a shock value of 20 is double their pain tolerance. Participants were presented with the shock values available to them via computer monitor. In the high effort group, participants began with only having access to the 0-level shock and were required to press the spacebar an increasing number of times to select higher shock values. Specifically, they had to press the space bar 10 times for every 1-point increase in available shock value, which means 200 presses were required to unlock a level 20 shock. After pressing the spacebar the desired number of times, participants in the high effort group selected a shock from the available options via a single press of the corresponding button at the top of the keyboard. The low effort group did not have to exert any extra effort to unlock higher shock values, and participants were required to simply press the corresponding button at the top of the keyboard once to select their desired shock value. In other words, the high effort group required participants to exert more effort than the low effort group in order to use increasing levels of aggression towards their opponent.

Data Analysis

All data analyses except for the power analysis were conducted using IBM SPSS Statistical software for Windows, Version 26 (IBM Corp, 2019). Data from 123 participants (male = 40) are valid for inclusion, with ages ranging from 18-51 years (M = 20.9, SD = 4.6).

Power Analysis

The previously unpublished archival data used for the current study has never been used in this way to address the question of whether changes in required response effort attenuates aggressive responding. Therefore, two power analyses were conducted using G*Power3 (Faul et al., 2007) to ensure our mixed-model repeated-measure analysis of variance (ANOVA) were sufficiently powered a priori. The mean shock power analysis was conducted using a conservative value for the Greenhouse-Geiser correction for violation of sphericity ($\varepsilon = .66$), a correlation between repeated measures of .70 (from previous related studies; e.g., Bullock, 2010), a sample size of 123, an alpha of .05, and a power value of .80. Results indicate adequate power for a small effect size of .09. The second power analysis for the number of extreme (20) shocks variable was also conducted using a correction for violation of sphericity ($\varepsilon = .66$), a sample size of 123, an alpha of .05, and a power value of .80. This analysis used a correlation between repeated measures of .69, and results indicate adequate power for a small effect size of .10.

CHAPTER III

RESULTS

Mean Shock Analysis

To test the prediction that participants are less likely to aggress, as operationalized by mean shock selected, when a higher response effort is required, a 2 (Effort) x 2 (Gender) x 4 (Block) Mixed-Model ANOVA with block as a repeated measures variable was conducted. Mauchly's test for sphericity was significant, $W(5) = .38$, $p < .001$ with an epsilon correction of ($\varepsilon = .60$). The pattern of significance testing was the same for epsilon corrected and uncorrected degrees of freedom. To ease interpretation of results, test results using uncorrected degrees of freedom are reported. Alpha was set a .05 for all tests, with 95% confidence intervals reported. Bonferroni adjusted post hoc tests were conducted for significant repeated measures outcomes.

A significant main effect emerged for effort condition, $F(1, 119) = 30.08$, $p < .001$, with the mean shock set in the high effort condition ($M = 4.01$, $SD = .27$, $CI = 3.48$, - 4.54) being significantly lower compared to the mean shock selected in low effort condition ($M = 6.09$, $SD = .27$, $CI = 5.56$, - 6.62). A main effect was also found for block condition, $F(3, 357) = 100.30$, $p < .001$. Post hoc mean comparisons revealed that means from Block 4 ($M = 6.10$, $SD = .26$) and Block 3 ($M = 6.05$, $SD = .23$) were both significantly higher than means from Block 2 ($M = 4.62$, *SD* = .20) and Block 1 (*M* = 3.43, *SD* = .19). The mean from Block 2 was also significantly higher than the mean from Block 1. No other significant mean contrasts emerged.

The significant effort and block effects, however, were limited by a significant condition by provocation interaction, $F(3, 357) = 13.75$, $p < .001$. See Figure 1. This interaction was decomposed by simple effects analyses, examining mean differences at each level of provocation for the two effort conditions using pooled error terms. Results revealed a simple main effect for the high effort condition, $F(3, 119) = 22.13$, $p < .001$ and for the low effort condition, $F(3, 119) = 47.57$, $p < .001$. As can be seen in Table 1, mean contrasts for the high effort condition revealed that means from Block 4 (*M* = 4.52, *SD* = .34) and Block 3 (*M* = 4.82, *SD* = .31) were both significantly higher than means from Block 2 (*M* = 3.86, *SD* = .27) and Block 1 (*M* = 2.54, *SD* = .25). The mean from Block 2 was also significantly higher than the mean from Block 1. No other significant mean contrasts emerged. Mean contrasts for the low effort condition revealed that all blocks were significantly different from each other, with Block 4 being the highest (*M* = 7.68, *SD* = .34), followed by Block 3 (*M* = 7.10, *SD* = .31), Block 2 (*M* = 5.05, *SD* = .26), and Block 1 (*M* = 4.05, *SD* = .25). No gender main effect or interactions emerged for this analysis.

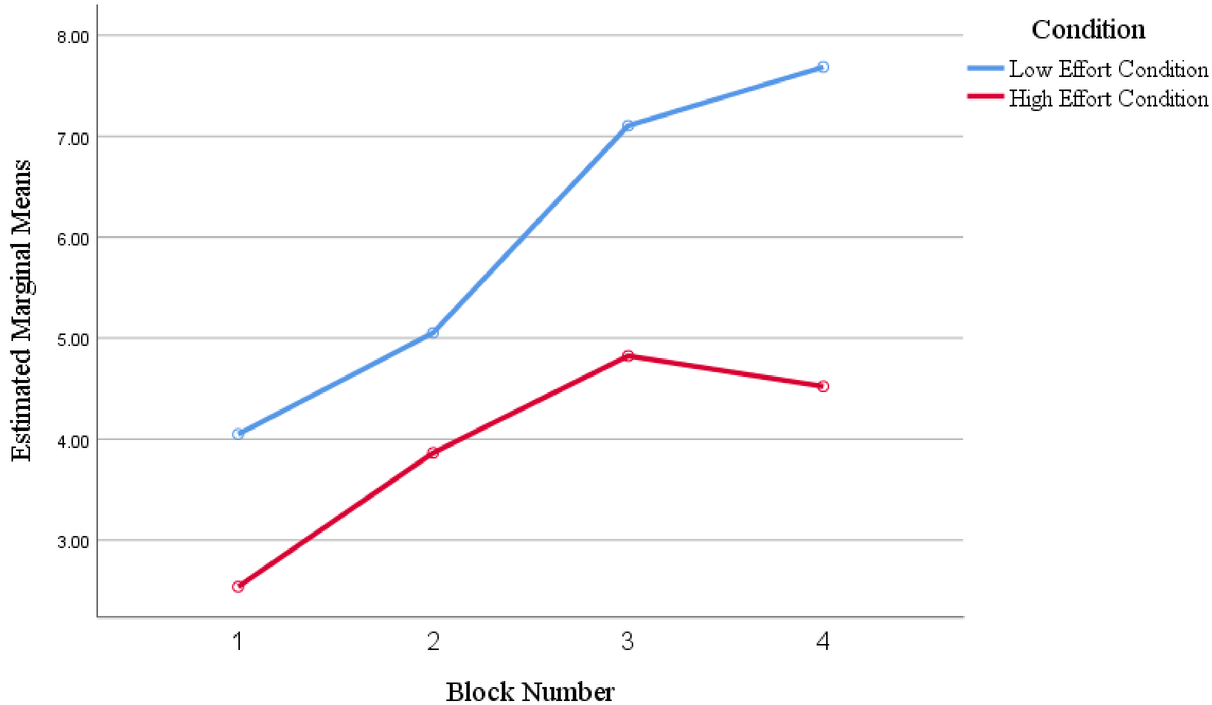

Figure 1. *Average Shock Selected by Block and Condition*

Participants in the low effort condition (blue line) demonstrated a significant increase in the average shock selected moving from block 1 through block 4. Participants in the high effort condition (red line) demonstrated a significantly higher average shock selected in blocks 3 and 4 than in blocks 1 and 2. The average selected shock in the high effort condition was also significantly higher in block 2 than in block 1. Block 4 represents participant responses following their “opponent” selecting a level 20-shock to increase provocation.

Table 1

Pairwise Comparisons: Average Selected Shock

(I) Block	(J) Block	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	-1.2*	.1	<.001	-1.57	-.81
	3	-2.6*	.2	<.001	-3.21	-2.03
	4	-2.7*	.2	<.001	-3.31	-2.03
2	1	1.2*	.1	<.001	0.81	1.57
	3	-1.4*	.2	<.001	-1.85	-1.02
	4	-1.5*	.2	<.001	-1.97	-1.00
3	1	2.6*	.2	<.001	2.03	3.21
	2	1.4*	.2	<.001	1.02	1.85
	4	-0.1	.1	1.00	-0.37	0.27
4	1	2.7*	.2	<.001	2.03	3.31
	2	1.5*	.2	<.001	1.00	1.97
	3	0.1	.1	1.00	-0.27	0.37

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Overall average selected shock value compared across trial blocks for both high and low effort conditions combined.

Extreme (20 Shock) Analysis

To test the prediction that participants are less likely to aggress, as operationalized by number of extreme (20) shocks selected, when a higher response effort is required, a 2 (Effort) x 2 (Gender) x 4 (Block) Mixed-Model ANOVA with block as a repeated measures variable was conducted. Mauchly's test for sphericity was significant, $W(5) = .39$, $p < .001$ with an epsilon correction of ($\varepsilon = .64$). The pattern of significance testing was the same for epsilon corrected and uncorrected degrees of freedom. To ease interpretation of results, test results using uncorrected degrees of freedom are reported. In addition, to adjust for the highly positive skewness values (2.54 – 6.56) for the extreme shock count variables, the corresponding variable for each block was transformed using a natural logarithmic function, resulting in lowered skewness values (1.65 – 4.74). Alpha was set at .05 for all tests, with 95% confidence intervals reported. Bonferroni adjusted post hoc tests were conducted for significant repeated measures outcomes.

A significant main effect emerged for effort condition, $F(1, 119) = 5.17$, $p = .03$, with the number of extreme (20) shocks selected in the high effort condition ($M = .09$, $SD = .05$, $CI = .00 - .18$) being significantly lower compared to the number of extreme (20) shocks selected in low effort condition ($M = .24$, $SD = .05$, $CI = .15 - .33$). A main effect was also found for block condition, $F(3, 357) = 27.03$, $p < .001$. As can be seen in Table 2, number of selected extreme (20) shocks were significantly higher in the last block, after the 20-shock provocation, compared to all preceding blocks. Blocks one through 3 did not significantly differ with respect to number of extreme (20) shocks selected. No other significant mean contrasts emerged.

The significant effort and block effects, however, were limited by a significant condition by provocation interaction, $F(3, 357) = 10.06$, $p < .001$. See Figure 2. This interaction was decomposed by simple effects analyses, examining mean differences at each level of provocation for the two effort conditions using pooled error terms. Results revealed a simple main effect for the low effort condition, $F(3, 119) = 18.18$, $p < .001$, but not for the high effort condition. As can be seen in Table 3, mean contrasts for the low effort condition revealed that the mean from Block 4 ($M = .53$, $SD = .07$) was significantly higher than the means for all preceding blocks. No other significant mean contrasts emerged, and no gender main effect or interactions emerged for this analysis. The simple main effect seen in the low effort condition also emerged when only including participants that selected at least one extreme (20) level shock (See Figure 3).

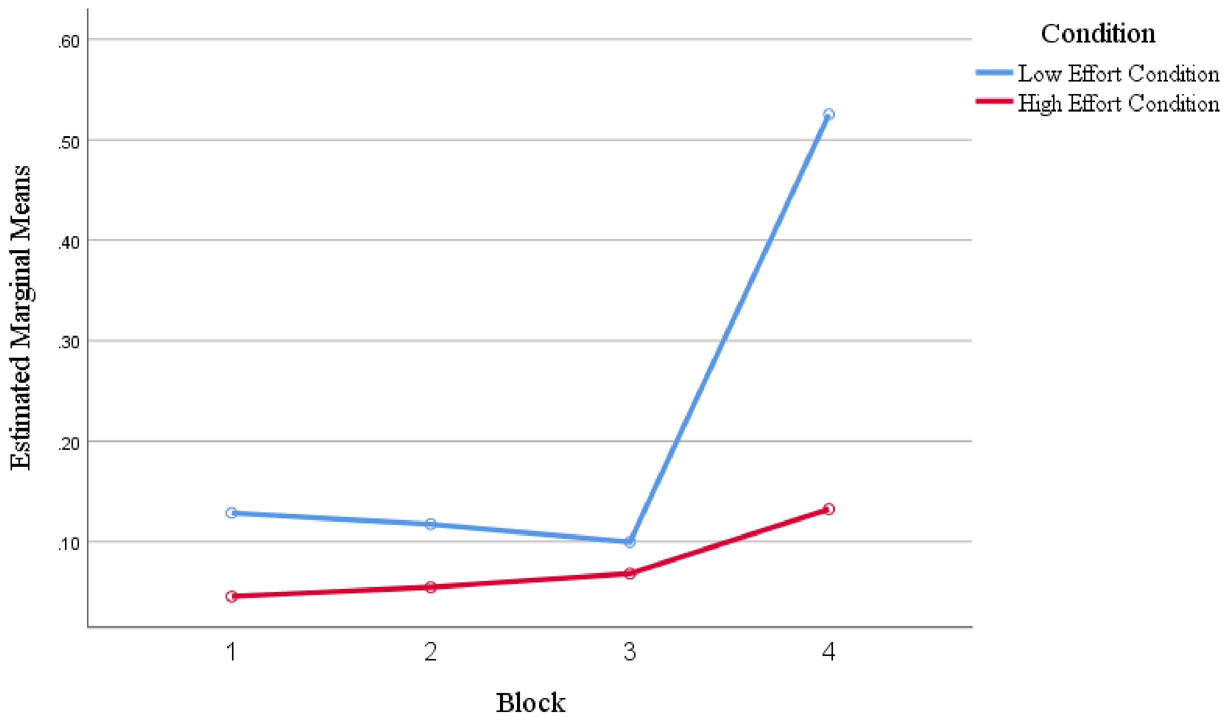

Figure 2. *Number of Extreme (20) Shocks Selected by Block and Condition*

Participants in the low effort condition (blue line) demonstrated a significantly higher number of extreme (20) shocks selected in block 4 as compared to blocks 1, 2, and 3. Participants in the high effort condition (red line) did not demonstrated any significant interaction effects. Block 4 represents participant responses following their "opponent" selecting a level 20-shock to increase provocation.

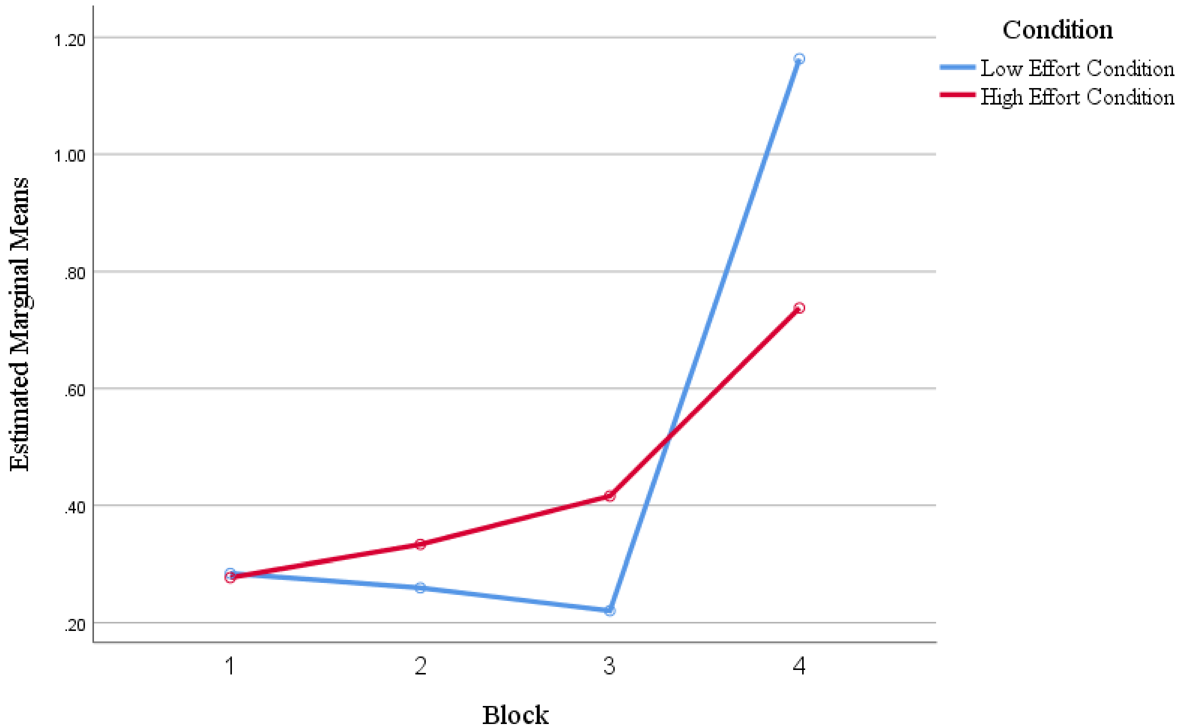

Figure 3. *Number of Extreme (20) Shocks Selected by Block and Condition for Participants Who Selected At Least One Extreme Shock*

For participants who selected at least one extreme level shock for their opponent, those in the low effort condition (blue line) still demonstrated a significantly higher number of extreme (20) shocks selected in block 4 as compared to blocks 1, 2, and 3 as seen in Figure 2. Block 4 represents participant responses following their "opponent" selecting a level 20-shock to increase provocation.

Table 2

Pairwise Comparisons: Number of Extreme (20) Shocks Selected

(I) Block	(J) Block	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	0.0	0.0	.97	-0.05	0.05
	3	0.0	0.0	.90	-0.05	0.05
	4	-0.2*	0.0	<.001	-0.33	-0.16
2	1	-0.0	0.0	.97	-0.05	0.05
	3	0.0	0.0	.91	-0.03	0.04
	4	-0.2*	0.0	<.001	-0.33	-0.16
3	1	-0.0	0.0	.90	-0.05	0.05
	2	-0.0	0.0	.91	-0.04	0.03
	4	-0.3*	0.0	<.001	-0.33	-0.16
4	1	0.2*	0.0	<.001	0.16	0.33
	2	0.2*	0.0	<.001	0.16	0.33
	3	0.3*	0.0	<.001	0.16	0.33

Based on estimated marginal means

*. The mean difference is significant at the .050 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Number of extreme (20) shocks selected compared across trial blocks for both high and low effort conditions combined.

CHAPTER IV

DISCUSSION

Results from the present study indicate that aggressive behavior can be attenuated as a function of required effort. Participants in the low effort condition acted as expected and selected higher shocks for their opponent, on average, than those in the high effort group. This is significant because it indicates that as participants had to work harder to access aggressive responses, they were less likely to pursue this behavior, even when provoked. Even more notably, participants in the high effort condition opted to select a higher frequency of maximum (level 20) shocks as compared to the participants in the low effort condition. This suggests that beyond the lower levels of non-specific aggression, there were also lower levels of extreme aggression observed among those in the high-effort condition. Together, the findings support the initial prediction that requiring an increased response effort would prompt a general dampening of participants' aggressive behavior.

Despite the mitigation of aggressive behavior seen in the high effort condition, participants in both groups increased the frequency of their aggressive responding as their fictitious opponent became more aggressive in subsequent blocks. Specifically, participants selected a higher average shock value in later blocks (3 and 4) compared to the earlier blocks (1 and 2). Similarly, in block four, participants selected a higher number of level 20 aggressive shocks than they did in blocks 1 through 3. The overall increase in aggressive responding following provocation is consistent with previous literature (e.g., Chermack et al., 1997) and what might be expected when considering how people respond to provocation in "real-world" settings (e.g., bar fights). The pattern of responding also indicates that the provocation manipulation was effective, as demonstrated in previous studies (Giancola, 2004; McCloskey & Berman, 2003). It is worth noting that the only psychiatric diagnosis in the DSM-V that has aggression as a cardinal feature is Intermittent Explosive Disorder, which is characterized by aggressive outbursts that are "grossly out of proportion to the provocation or to any precipitating psychosocial stressors" (American Psychiatric Association, 2013). Thus, the present findings are also applicable to better understanding approaches to reduce clinically relevant manifestations of aggressive behavior.

Although these findings contribute to the overall scientific understanding of human aggression, the present study has several specific strengths and potential limitations worth noting. One major strength of the study's design is the inclusion of both men and women. Historically, studies excluding women have been criticized for their lack of diversity, and subsequently, their lowered external validity (e.g., Woolf & Hulsizer, 2019). The current study sought to reduce this potential bias by recruiting both men and women to participate. Results indicated that there were no main effects of gender for either the average selected shock or the number of extreme shocks chosen in either condition. Given the inclusion of provocation in the current study, these findings are consistent with previous literature suggesting provocation attenuates gender disparities in aggressive behavior (Bettencourt & Kernahan, 1997; Bettencourt & Miller, 1996; Weidler, Habel, et al., 2019). The lack of main gender effects might also be attributed to the potential lack of sufficient power to detect an existing gender effect due to the sample size or the overrepresentation of women in the sample. Future studies may benefit from using a larger size or proportional representation of men and women within their samples. Of note, the investigation of gender differences was included as an exploratory analysis in the current study, rather than as a primary aim.

One feature of the current study that could be interpreted as both a strength and limitation is the sample's racial composition. The included sample consisted of 56.9% of participants identifying as African-American/Black, 39.8% identifying as Caucasian, 1.6% identifying as Hispanic, and 1.6% identifying their race as "other." Indeed, the current sample is more diverse than many studies in this area, considering research has historically been conducted on largely White majority populations (Woolf & Hulsizer, 2019). Moreover, the sample's racial composition closely reflects the population of the performance site. Based on U.S. Census Bureau estimates, the racial composition of the city where the sample was recruited is: 43.1% White, 53% Black or African American, and 3.2% Hispanic or Latino (U.S. Census Bureau, 2019). Although, there were no a priori indications to suggest there would be any differences in performance between participants with different racial identities, the racial composition of the United States, overall, is somewhat different than the performance site: 76.3% White, 13.4% Black or African American, and 18.5% Hispanic or Latino (U.S. Census Bureau, 2019), and it is unclear whether or how these differences limit the generalizability of the results.

Regarding the study design, one may argue another limitation of the current study is the use of deception. Within the provocation protocol, participants were led to believe they were competing against a real opponent and were not told that they were participating in a study of aggression. As the TAP has been widely used for decades and is considered a valid measure of aggressive behavior (Ferguson et al., 2008; Ferguson & Rueda, 2009; Giancola & Parrott, 2008), it is reasonable to posit that the deception was appropriate for the study goals. Additionally, participants who seemed to indicate post-TAP that the intended deception was unsuccessful were not included in the current analysis (*n* = 27). This comprises about 18% of the participants recruited. Although a standard approach to the TAP, it is unclear whether the excluded participants would respond differently to the manipulation. Unfortunately, the number of excluded participants is too small in TAP studies to examine this possibility reliably.

Given that extreme violence cannot be studied ethically, laboratory analogues are used to examine potential correlates of aggression experimentally to allow causal inferences to be drawn. However, whether findings from controlled experiments of aggressive behavior adequately transfer to "real-world" applications is somewhat controversial (e.g., Giancola & Chermack, 1998; Tedeschi & Quigley, 1996). Evidence suggests laboratory aggression paradigms have adequate external validity (Anderson & Bushman, 1997; Baron & Richardson, 2004; Cherek et al., 1997). Nonetheless, it is worth considering alternative explanations for participants' behavioral patterns within laboratory studies (McCarthy et al., 2018). For instance, the way a participant views the task conditions and the value they place on their participation may influence the expression of aggression (Berkowitz & Donnerstein, 1982). For example, the participant may view the experiment as a low stakes activity and thus behave more aggressively than they would typically behave (such as in a social setting or in the community when faced with a minor threat or provocation). A participant might also experience a sense of boredom or respond in a particular way to simply pass the time in the laboratory. However, testing these possibilities was beyond the scope of the current study and may help guide future research.

Examining the current findings through the lens of human motivation might provide additional context for why the participants responded the way they did and what purpose the behavior may have served. For example, a participant's *desire* for revenge or to punish the opponent for losing might have been dampened by requiring increased response effort.

Aggressive behavior in general could also represent the result of an internal cost-benefit analysis, in which the participants weighed the costs, or negative aspects of engaging in aggressive behavior (Reeve, 2018, p. 251), against the perceived benefits resulting from the act. For example, participants might have responded to provocation differently in the high effort group as compared to the low effort group because the benefits of retaliation were diminished by the potential effort required (a clear cost). It is worth considering that each participant may have had other motivations for their response patterns, such as a desire to finish the study quickly, to behave in a way that is socially desirable, to respond to the perceived intentions of their opponent, or even to establish or maintain a sense of dominance (Reeve, 2018).

One might wonder if the current study has potential policy implications. Though possible applications of the current study's findings will be discussed, any extrapolation of the results should be done very cautiously. Existing public policy attempts to reduce human aggression by making access to aggressive means more difficult in some cases (e.g., requiring background checks and waiting periods for gun purchases; Vernick et al., 2017). Results of this study suggest that such policies may be effective when the person is seeking an immediate, but currently unavailable, means to aggress in response to provocation. Beyond public policy, other restrictive efforts, such as random sweeps of prison cells to seize difficult to obtain contraband that could be fashioned into weapons represent additional approaches to curtailing aggressive human behavior often used. In domestic settings, gun owners may choose to keep their firearms in gun safes with the key in a separate location to reduce accessibility to others in a household. In other social settings, attempts to reduce aggressive behaviors have often relied on making response cost efforts highly salient, including via the presence of nightclub security ("bouncers"), the implementation of restraining orders, and the overwhelming presence of armed National Guards to secure government buildings. In sum, the results of the current study have the potential to add credibility to policies and interventions seeking to reduce aggressive behaviors, including interpersonal violence, through the inclusion of response effort cost as a component of prevention or intervention programs.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD EXEMPTION RESPONSE

Protocol ID: IRB-21-173 (Mitchell Berman)

Comments Close

S.No	Comment Title	Comment/Response	Response Necessary	Panel Name
Cycle: 1				
1	**Comment:** 1	Thank you for submitting this protocol for HRPP review. My name is Tama Enroth and I have conducted your review. It has been determined that this study does qualify for Exemption Determination. Please feel free to contact our office should any additional data collection be needed or any other questions arise.	No	MSU Exempt