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Physical Aggression Is Associated With Heightened Social Reflection Impulsivity

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Physical aggression harms individuals, disrupts social functioning across multiple forms of psychopathology, and leads to destruction within communities. Physical aggression is associated with aberrations in the interpretation of ambiguous information. However, the specific cognitive mechanisms supporting this link remain elusive. One potentially relevant cognitive mechanism is reflection impulsivity, the amount of information gathered during decision-making. Reflection impulsivity characterizes how individuals resolve ambiguity in the process of forming judgments when multiple interpretations of a stimulus are possible. In a sample of 98 incarcerated men, we examined reflection impulsivity using a novel social information sampling task. The primary aim of the study was to investigate the relationship between physical aggression and social reflection impulsivity. Additionally, we assessed the frequency of different social judgments (hostile vs. benign), the extent to which reflection impulsivity varied in the context of these different social judgments, and subjective certainty about social judgments. Finally, we investigated whether social reflection impulsivity moderated the relationship between physical aggressiveness and violent crime. Results indicated that more physically aggressive individuals displayed heightened social reflection impulsivity, which was amplified in the context of hostile judgments. Moreover, more physically aggressive individuals were more certain about their hostile judgments and more certain when judgments were made with unconstrained access to behavioral information. Finally, impulsive hostile judgments in physically aggressive individuals related to a more extensive history of assault charges. These findings suggest that physically aggressive individuals exhibit deficits in information gathering, leading to ill-informed and inflexible social judgments.

General Scientific Summary

Physical aggression is a costly form of human behavior that is evident across multiple forms of psychopathology. This study provides the first direct evidence that more physically aggressive individuals gather less evidence during social decision-making (i.e., exhibit heightened social reflection impulsivity), particularly while making hostile judgments, and yet they are nevertheless more certain about their hostile judgments. Moreover, physically aggressive individuals with more pronounced social reflection impulsivity have a more extensive history of assault charges, highlighting the real-world implications of this social–cognitive process.

Keywords: aggression, reflection impulsivity, social decision-making, social cognition, violent crime

Supplemental materials: http://dx.doi.org/10.1037/abn0000448.supp

Aggressive behavior represents a pressing public health concern, not only because it leads to significant direct harm but also because it spreads within and devastates entire communities in the same manner as infectious disease (Patel, Simon, & Taylor, 2013). Aggression is commonly defined as behavior that is likely to result in physical, social, and/or emotional harm. Aggression can manifest in various forms (e.g., physical, verbal, and relational), but no form of aggression generates greater public concern than physical aggression, which is behavior that inflicts bodily harm or conveys a threat of bodily harm. The manifestations of physical aggression include a range of acts from bullying, physical fighting, and throwing objects, to more severe forms of violence, such as assault and murder. Research indicates that each year nearly 17,000 people are victims of homicide in the United States, and over 1.6

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million people are hospitalized for nonfatal injuries resulting from physical aggression (Sumner et al., 2015). The overall estimated costs associated with these deaths and injuries totals $96.8 billion (Centers for Disease Control and Prevention, 2017). Physical aggression exacts tremendous costs at all levels of society, from individuals to entire communities.

Central to many conceptualizations of the factors driving excessive physical aggression is the impact of ambiguity on information processing. Physically aggressive individuals are more likely to perceive anger in faces displaying ambiguous emotional expressions (Barth & Bastiani, 1997; Fine, Trentacosta, Izard, Mostow, & Campbell, 2004; Schönenberg & Jusyte, 2014; Schultz, Izard, & Bear, 2004; Wilkowski & Robinson, 2012), demonstrate a hostile attribution bias (i.e., a tendency to interpret others' ambiguous actions as signs of malicious intent; Chen, Coccaro, & Jacobson, 2012; De Castro, Veerman, Koops, Bosch, & Monshouwer, 2002; Dodge, 1980), and display reduced sensitivity to ambiguity during cost-benefit decision-making (Buckholtz, Karmarkar, Ye, Brennan, & Baskin-Sommers, 2017). Together, these findings suggest that physically aggressive individuals tend to interpret ambiguous information negatively and fail to consider ambiguity while making decisions. Although the link between aberrations in processing ambiguity and physical aggression is relatively well-established and uncontroversial, less is known about specific underlying cognitive mechanisms that support this link.

One cognitive mechanism that plays a pivotal role in decision-making under ambiguity is reflection impulsivity. Reflection impulsivity is a construct that characterizes how individuals resolve ambiguity when multiple interpretations of a stimulus are possible (Kagan, 1965). More specifically, reflection impulsivity is commonly operationalized as the extent to which individuals gather information while making a decision (Clark, Robbins, Ersche, & Sahakian, 2006; Clark et al., 2003). Individuals with heightened reflection impulsivity gather less information while making a decision, which provides them with a weaker evidence base for their chosen response and, thereby, increases the likelihood that they will respond inaccurately (Evenden, 1999; Kagan, 1965). Consistent with the idea that reflection impulsivity hampers adaptive decision-making, multiple studies link heightened reflection impulsivity to substance abuse (Banca et al., 2016; Clark et al., 2006; Clark, Roiser, Robbins, & Sahakian, 2009; Solowij et al., 2012; Townshend, Kambouropoulos, Griffin, Hunt, & Milani, 2014), which in turn is associated with wide-ranging decision-making deficits (Clark & Robbins, 2002). Thus, heightened reflection impulsivity represents a key mechanism influencing impaired decision-making under ambiguity. Yet, despite evidence for pervasive abnormalities in physically aggressive individuals' decision-making under ambiguity, reflection impulsivity has not been studied as it relates to aggression.[1]

Multiple cognitive theories of aggression suggest that aggressive individuals' decision-making abnormalities stem from a failure to adequately consider relevant information and jumping to conclusions (Crick & Dodge, 1994; Fontaine & Dodge, 2006; Tone & Davis, 2012; Wilkowski & Robinson, 2012). Translation of these theories into well-established models of decision-making (e.g., sequential sampling models; Forstmann, Ratcliff, & Wagenmakers, 2016; Ratcliff & Smith, 2004) emphasizes that decision-making unfolds through an iterative process of gathering information about a stimulus (e.g., a target person) until a sufficient quantity of evidence has been amassed. Each possible judgment about the stimulus (e.g., whether the target person is hostile or not) may require different quantities of evidence. Gathering information about a stimulus actively reduces ambiguity, steering the agent toward the judgment that has more evidence in its favor. Once the required quantity of evidence has been amassed for one judgment or another, the corresponding judgment is made and information gathering is terminated. Certainty about the judgment serves to strengthen the judgment (Pouget, Drugowitsch, & Kepecs, 2016). Furthermore, both information gathering and certainty can vary as a function of which judgment the agent makes. For example, an agent might require less evidence in the context of judging someone as hostile versus not hostile, or an agent might be more certain about their choice in the context of making a hostile (vs. non-hostile) judgment. Applying this framework to social decision-making in aggression offers the possibility to identify variations in these cognitive processes (i.e., information gathering, certainty) that may help explain why aggressive individuals fail to consider relevant information during decision-making and interpret ambiguous social information in aberrant ways.

Present Study and Hypotheses

To examine cognitive processes implicated in the social decision-making of physically aggressive individuals, we administered a novel adaptation of the information sampling task, an experimental task developed by Clark and colleagues (2003), whose validity has been established (Clark et al., 2003, 2006, 2009; see Method section for validation of the novel adaptation in the present study). In a sample of incarcerated offenders with varying levels of physical aggressiveness, we measured reflection impulsivity in the context of social judgments (i.e., social reflection impulsivity), as well as the frequency of different social judgments (hostile vs. benign), and subjective certainty about those judgments.

The primary aim of the study was to examine the relationship between physical aggression and social reflection impulsivity. To this end, we hypothesized that (1) physical aggression would be associated with heightened social reflection impulsivity (i.e., negatively associated with information gathering), above and beyond the level of reflection impulsivity evident in decision-making more broadly. Secondary aims were to examine whether other aspects of the social decision-making process were associated with aggression. Based on previous research demonstrating a hostile attribution bias in aggression (Chen et al., 2012; De Castro et al., 2002; Dodge, 1980), we aimed to examine the relationship between

[1] Although reflection impulsivity might appear to overlap with constructs such as trait impulsivity and executive functioning (that have been studied extensively in relation to aggression), multiple studies establish reflection impulsivity as a distinct construct (Clark et al., 2003, 2009; Crockett et al., 2012; Jepsen et al., 2018; Perales, Verdejo-García, Moya, Lozano, & Pérez-García, 2009), a pattern of findings replicated in the present study (see Validity subsection of the Method section). Furthermore, although previous research indicates that aggressive individuals generate fewer response alternatives to socially provocative situations (Dodge, Lochman, Harnish, Bates, & Pettit, 1997; Fontaine & Dodge, 2006), reflection impulsivity occurs during an early stage of decision-making (i.e., when individuals are deciding how many cues to encode), whereas response generation occurs later in decision-making (i.e., when individuals are deciding how to respond to the cues they encoded).

physical aggression and frequency of hostile judgments in the task, hypothesizing that (2) physical aggression would be positively associated with frequency of hostile judgments. Additionally, based on theoretical conjectures that aggressive individuals tend to jump to conclusions prematurely in their social decision-making, particularly when those conclusions involve judging others as hostile (Crick & Dodge, 1994; Fontaine & Dodge, 2006; Tone & Davis, 2012; Wilkowski & Robinson, 2012), we hypothesized that (3) physical aggression would be associated with heightened reflection impulsivity (i.e., negatively associated with information gathering) particularly in the context of hostile social judgments. Additionally, based on theory suggesting that aggressive individuals hold more rigid beliefs about others' hostility (Dodge, 2006), we hypothesized that (4) physical aggression would be positively associated with subjective certainty about hostile social judgments. Finally, a tertiary aim of the study was to examine whether social reflection impulsivity interacted with physical aggressiveness to predict real-world physically aggressive behavior (i.e., assault charges). To this end, we hypothesized that (5) higher physical aggression combined with higher social reflection impulsivity would be associated with the greatest number of assault charges.

Method

Participants

Participants were 98 male offenders from a high-security correctional institution in Connecticut who ranged in age from 21 to 59 ($M = 35.33$, $SD = 10.54$); 54.1% of participants identified as African American, 44.9% identified as White, and 1% identified as American Indian. 21.4% of participants identified as Hispanic (see Supplementary Table 1 for sample characteristics and correlations among key study variables). Additionally, 95.7% of participants in the final sample had been charged with a violent crime in their lifetime (see Supplementary Table 2), and 46.2% had been charged with a violent institutional infraction while incarcerated (i.e., violations against persons, including fighting and assault on correctional staff; see Supplementary Table 3). We used a prescreen of institutional files and assessment materials to exclude individuals who had: a history of psychosis or bipolar disorder, current mood/anxiety disorders, current psychotropic medication, a family history of psychosis, medical problems that could impede comprehension of or performance on the experimental task (e.g., uncorrectable auditory or visual deficits, three or more serious head injuries), IQ below 70, or reading level below 4th grade (see Supplementary Measures).

An a priori power analysis based on published studies on related topics (i.e., individual differences in reflection impulsivity; Clark et al., 2006, 2009; Townshend et al., 2014) indicated that a sample size of approximately 90 participants would be sufficient to detect moderate effects with 80% power. To ensure sufficient power to account for the normative loss of data because of invalid task performance, we collected data from 98 participants.

Aggression Measures

Buss-Perry Aggression Questionnaire (AQ; Buss & Perry, 1992). The AQ is a 29-item self-report measure of aggression. Participants rate each item on a 5-point Likert scale (1 = *extremely uncharacteristic of me* to 5 = *extremely characteristic of me*). The four questionnaire subscales, established through factor analysis, are Physical Aggression (9 items), Verbal Aggression (5 items), Anger (7 items), and Hostility (8 items). The AQ is a reliable, valid, and widely used measure of aggression (Harris, 1997; Tremblay & Ewart, 2005), with evidence for adequate reliability and validity in incarcerated samples (Archer & Haigh, 1997; Ireland & Archer, 2004). Analyses in the present study focused on the AQ Physical Aggression subscale (see Supplementary Results for additional analyses with AQ Total score). Internal consistency for the Physical Aggression subscale (Cronbach's $\alpha = .77$) and the AQ as a whole (Cronbach's $\alpha = .84$) in the present sample was acceptable and comparable to reliability coefficients reported by Buss and Perry (1992).

Criminal charges. Self-reported number of assault charges, a severe and legally sanctioned form of physical aggression, were cross-validated using official State of Connecticut Department of Correction files and mittimus reports.

Experimental Task

Whereas the original information sampling task provides a measure of reflection impulsivity based on how much information participants gather while making a decision about which of two colors is dominant in a visual array, the social information sampling task developed for the present study provides a measure of reflection impulsivity in a social decision-making context. More specifically, participants made decisions about which of two attributes was predominantly displayed by a person who engaged in a range of behaviors. In the social information sampling task, participants were presented with information about a person's behaviors and instructed to decide whether the person was nasty (hostile judgment) or nice (benign judgment; Dodge, 2006) based on the behaviors. Stimulus presentation and response collection were controlled using the Psychtoolbox extension (Brainard, 1997; Kleiner et al., 2007; Pelli, 1997) as implemented in MATLAB 2017b (Mathworks).

Stimuli. Stimuli consisted of behavioral descriptions that contained three words using the following construction: Verb + Article + Object. The verb in each description was either positively valenced (consistent with a "nice" behavior; e.g., "helped a man") or negatively valenced (consistent with a "nasty" behavior; e.g., "offended a man"). Twenty positively valenced verbs and 20 negatively valenced verbs were selected from the Affective Norms for English Words (ANEW) database (Bradley & Lang, 1999) on the basis of readability (i.e., comprehensible to individuals with reading ability as low as the 4th-grade level) and being mild to moderate rather than extreme in terms of valence/arousal (e.g., we included "hit" but not "killed"). Overall, the 20 positively valenced words did not differ from the 20 negatively valenced words in terms of extremeness of valence (i.e., distance from a "neutral" rating).

Conditions. The task consisted of 20 trials equally divided into *two* conditions: *partial information* and *full information*. In both conditions (per trial), participants were presented with a display containing 25 boxes arranged in a 5×5 grid. Participants were told that each grid represented one person, and each of the 25 boxes in that grid contained a description of a behavior performed

by that person. The visibility of the behavioral descriptions at the onset of each trial varied according to the task condition.

In the *partial information condition*, all 25 boxes were gray (i.e., showed no behavioral descriptions) at the start of the trial. When participants clicked a box, the behavioral description inside the box was revealed. This description remained visible for the duration of the trial to minimize demands on working memory. In this condition, participants were instructed to open as many boxes as they wanted while deciding whether the person was mainly nasty or nice. In the *full information condition*, the information inside each of the 25 boxes was visible from the onset of the trial. Thus, participants could view the full extent of available information about the person without having to open any boxes. On each trial, participants indicated their decision about the person by clicking one of two panels (one labeled "nasty," one labeled "nice") at the bottom of the screen. Finally, in both conditions, participants rated how certain they were about their decision using a sliding rating bar (see Figure 1).

The full information condition always followed the partial information condition to avoid potential contamination of the social reflection impulsivity measure (i.e., the primary dependent variable in the present study, which was derived from the partial information condition). If participants were exposed to the full information condition first, they may have learned that their decision-making was facilitated when they had access to all of the available information, and this could have influenced them to open more boxes than they otherwise would have in the partial information condition. There is no reason to believe that placing the partial information condition first would impact performance in the full information condition. Thus, based on concerns about asymmetric transfer effects (i.e., participants learning to use one strategy in an early portion of an experiment and then carrying that strategy into subsequent portions of the experiment; see Poulton [1982] for a discussion of the disadvantageousness of counterbalancing in the context of asymmetric transfer effects) and our desire to obtain as pure a measure of social reflection impulsivity as possible, we held condition order constant across participants.

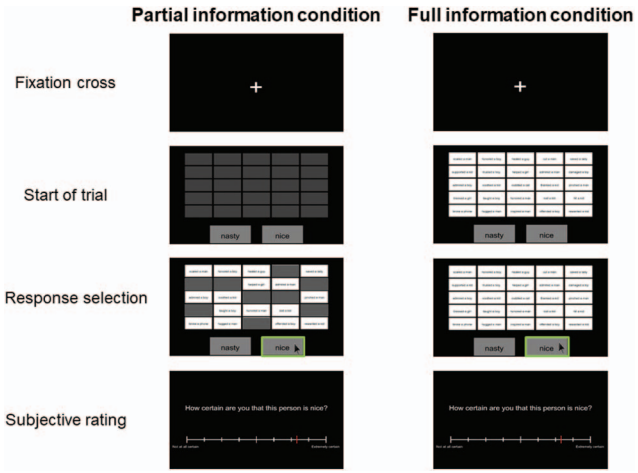

Figure 1. Schematic representation of the experimental task. The vertical sequence (top to bottom) in the left column depicts stages of trial progression in the partial information condition, while the sequence in the right column depicts stages of trial progression in the full information condition. In the partial information condition (left), participants were initially presented with a grid of dark gray boxes, with behavioral descriptions "inside" the dark gray boxes. Participants clicked individual boxes to "open" them and reveal the behavioral descriptions inside. Participants were instructed to open as many boxes as they wanted while deciding whether the person was mainly nasty or nice. In the full information condition (right), all of the information inside the boxes was visible from the beginning of each trial. Participants selected their choice by clicking on the corresponding light gray panel at the bottom of the screen (third row). On the next screen, participants were asked to rate their level of certainty regarding their decision (bottom row). See the online article for the color version of this figure.

Trials. On each trial (10 per condition), the 25 boxes contained a ratio of approximately 3:2 in terms of positively valenced versus negatively valenced behaviors (or vice versa, depending on the trial). Positively valenced behaviors made up the majority of behaviors on half of the 10 trials in each condition, and negatively valenced behaviors made up the majority on the other half of the trials. Within each trial, positively valenced words did not differ from negatively valenced words in terms of extremeness of valence.

Each trial began with a 1-s fixation cross displayed in the center of the screen to indicate the start of the next trial, and each trial lasted 40 s. If participants did not click a response panel within the 40 s allotted for the trial, the trial ended and the next trial began. If participants clicked a response panel within 40 s, a black screen was displayed for the remainder of the trial time. In this way, each trial lasted 40 s regardless of decision speed, so as to discourage rushed responding. Across participants, stimuli were presented in the same order regardless of the order in which specific boxes were opened to maximize consistency of exposure to information. Before completing the 20 experimental trials, participants completed 8 practice trials (4 partial information, 4 full information), during which they received feedback regarding whether they made their decisions within the allotted amount of time.

Nonsocial control task. Following completion of the social information sampling task, participants completed a separate control task, which assessed reflection impulsivity in a nonsocial context. The layout and number of trials were the same as in the social task; however, instead of making decisions about people, participants made decisions about baskets of fruits and vegetables. Each of the 25 boxes on a trial contained a description of a type of fruit or vegetable that was either red (e.g., "is a strawberry") or green (e.g., "is a cucumber"). Fruits and vegetables were chosen for inclusion in the stimuli on the basis of being clearly either red or green, and on the basis of readability. The average letter count of the descriptions on each trial matched those for the social task so that descriptions inside the boxes would not take longer or shorter to read in either task. Participants were instructed to open as many boxes as they wanted while deciding whether the basket of fruits and vegetables was mainly red or green.

Participants always played the control task after the social task for reasons similar to those noted above (see Conditions subsection). Specifically, the social task provided our primary measures, and we wanted to avoid the potential contamination of responses in the social task because of asymmetric transfer effects (Poulton, 1982). Our goal was to encourage participants to respond in the social task as they would in a real-life social scenario, and accordingly participants were told that there were no "right" answers.

Thus, ordering the tasks so that the control task followed the social task reduced the likelihood that participants would use contrived strategies in the primary social task (e.g., counting boxes) and in this way fostered more natural responding.

Key variables. The primary dependent variable derived from the social information sampling task was social reflection impulsivity. Additionally, we examined the frequency of different social judgments (hostile vs. benign) and subjective certainty about those judgments. Social reflection impulsivity was operationalized as the average number of boxes opened across trials in the partial information condition in the social task, with fewer boxes opened denoting higher social reflection impulsivity. Frequency of different social judgments was operationalized as the percentage of choices made that were nasty (i.e., percentage of judgments that were hostile) across trials within each condition of the social task. Subjective certainty was operationalized as the average certainty rating given by participants across trials within each condition of the social task.

The key variable derived from the nonsocial control task was a general measure of reflection impulsivity (i.e., average number of boxes opened in the partial information condition), which was assessed so that the role of general reflection impulsivity in the relationship between physical aggression and social reflection impulsivity could be examined. "Accuracy" was derived as a secondary measure from both the social task and the nonsocial task, as a means of assessing task validity, and was operationalized as the percentage of choices that matched the dominant behavior (social task) or color (nonsocial task) on each trial.

Validity. The reliability and validity of the social information sampling task was established through a series of analyses modeled after the validity analyses conducted by Clark et al. (2003). First, we calculated internal consistency and found that the social reflection impulsivity measure exhibited excellent reliability across trials (Cronbach's $\alpha = .97$). Second, we confirmed that less information gathering was related to lower accuracy in both the social task, $r = .54$, $p < .001$, 95% confidence interval (CI) [.43, .63], and the nonsocial task, $r = .73$, $p < .001$, 95% CI [.62, .83]. Third, we established divergent validity by demonstrating that, consistent with previous research (Clark et al., 2003, 2009; Crockett, Clark, Smillie, & Robbins, 2012; Jepsen et al., 2018; Perales et al., 2009), extent of information gathering was associated with neither trait impulsivity (i.e., MPQ-B Constraint, see Supplementary Measures; social task: $r = -.02$, $p = .822$; nonsocial task: $r = -.02$, $p = .836$) nor executive functioning (i.e., Color-Word Interference Test Inhibition/Naming contrast scaled score, see Supplementary Measures; social task: $r = -.07$, $p = .506$; nonsocial task: $r = -.03$, $p = .762$).

Procedure

Before recruitment, study personnel received an institutional roster of inmates. Study personnel used this roster to review institutional files and exclude individuals who clearly did not meet eligibility criteria (see Participants section above). Then, individuals were selected randomly from the list of eligible inmates and invited to participate. Invited individuals were provided with information about study procedures and informed that any information collected during the study would not go into their institutional files and would not affect any pending legal status or sentencing they might be facing. In keeping with Connecticut Department of Correction regulations, participants did not receive financial compensation. They were informed that they could withdraw from the study at any time. All participants provided written informed consent according to the procedures set forth by the Yale University Human Investigation Committee. After providing consent, participants completed an initial session that involved a series of clinical and neuropsychological assessments (e.g., Structured Clinical Interview for *Diagnostic and Statistical Manual of Mental Disorders-Fifth Edition* (*DSM–5*), Wide Range Achievement Test; see Supplementary Measures). Participants who did not meet eligibility thresholds on any of these assessments were excluded from further participation. Then, after completing questionnaires assessing personality (e.g., Multidimensional Personality Questionnaire–Brief; see Supplementary Measures), participants returned for a second session in which they completed the experimental task followed by aggression questionnaires (e.g., AQ; see Aggression Measures). Both in-person sessions took place in a private testing space within the prison. Finally, study personnel reviewed records to obtain a measure of criminal charges for each participant (see Aggression Measures).

Results

Data Quality Control

Participants were excluded from analyses if their task data were invalid. Data were considered invalid if at least one of the following conditions was met: (a) no response given (i.e., the participant did not respond in time) on more than 25% of trials, (b) statistical outliers (>3 *SD*s from the mean) on any key task variables, or (c) extreme difficulties comprehending the task as noted by the experimenter. Five participants were excluded from analyses based on these criteria, and accordingly the final sample consisted of 93 participants. Excluded participants did not differ from included participants in terms of age or physical aggression ($p > .7$).

Social Reflection Impulsivity

A linear regression, with AQ Physical Aggression (*z*-scored) as an independent variable, age and race/ethnicity as covariates,[2] and social reflection impulsivity as a dependent variable indicated that AQ Physical Aggression was negatively associated with extent of social information gathering, $B = -1.85$, $SE = 0.74$, $p = .014$, 90% CI [−3.07, −0.63]. Consistent with Hypothesis 1, more physically aggressive participants demonstrated greater social reflection impulsivity (see Figure 2).

To determine whether this effect persisted even after controlling for reflection impulsivity in the nonsocial control task, another linear regression was run with the addition of nonsocial information gathering as a covariate. The analysis showed that AQ Physical Aggression was negatively associated with extent of information gathering in the social task, $B = -1.02$, $SE = 0.40$, $p = .012$, 90% CI [−1.68, −0.36], above and beyond the effects of more general reflection impulsivity as measured in the nonsocial control task. In other words, more physically aggressive participants dem-

[2] Age and race/ethnicity were included as covariates in theses analyses (and all analyses to follow) because these demographic variables were associated with task dependent variables.

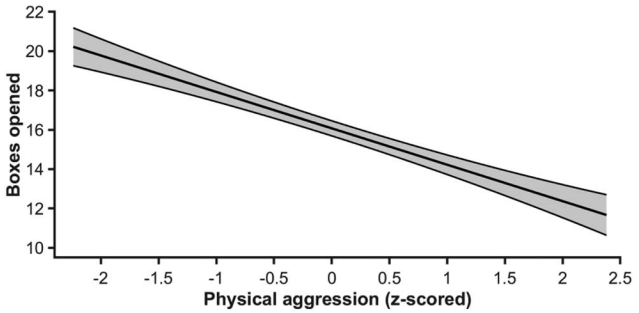

Figure 2. The relationship between physical aggression and social information gathering. Participants with higher levels of physical aggression opened fewer boxes (i.e., gathered less information) in the social information sampling task. Error band represents 90% confidence interval.

onstrated greater social reflection impulsivity even after controlling for general reflection impulsivity.

Frequency of Hostile Social Judgments

A two-way (condition: partial information, full information) repeated measures GLM, with AQ Physical Aggression (*z*-scored) as a continuous between-subjects independent variable and hostile social judgment frequency as a dependent variable, failed to detect a main effect of condition, $F(1, 91) = .01$, $p = .914$, $\eta_p^2 < .01$, 90% CI [0.00, 0.01], or physical aggression, $F(1, 91) = 3.90$, $p = .051$, $\eta_p^2 = .04$, 90% CI [0.00, 0.12]. Furthermore, the analysis failed to detect a Condition × Physical Aggression interaction, $F(1, 91) = .01$, $p = .907$, $\eta_p^2 < .01$., 90% CI [0.00, 0.01]. Thus, Hypothesis 2 (i.e., that physically aggressive individuals would display a higher frequency of hostile judgments) was not supported.

Reflection Impulsivity in the Context of Hostile Versus Benign Social Judgments

A two-way (judgment: nasty, nice) repeated measures GLM with AQ Physical Aggression (*z*-scored) as a continuous between-subjects independent variable and reflection impulsivity as a dependent variable failed to detect a main effect of judgment on reflection impulsivity, $F(1, 88) = 1.43$, $p = .235$, $\eta_p^2 = .02$, 90% CI [0.00, 0.08]. However, there was a main effect of physical aggression, $F(1, 88) = 5.05$, $p = .027$, $\eta_p^2 = .05$, 90% CI [0.003, 0.15], indicating that physically aggressive individuals gathered less information across both nasty and nice judgments. Furthermore, there was a Judgment × Physical Aggression interaction, $F(1, 88) = 4.81$, $p = .031$, $\eta_p^2 = .05$., 90% CI [0.003, 0.14]. In terms of this interaction, there was a simple main effect of physical aggression in the context of nasty judgments, $B = -2.18$, $SE = 0.75$, $p = .005$, $\eta_p^2 = .09$, 90% CI [−3.43, −0.93], but we failed to detect a simple main effect of aggression in the context of nice judgments, $B = -1.33$, $SE = 0.86$, $p = .125$, $\eta_p^2 = .03$, 90% CI [−2.75, 0.10].[3] Together, in line with Hypotheses 1 and 3, these results indicate that more physically aggressive individuals demonstrated greater reflection impulsivity overall in the social task, and their reflection impulsivity was particularly heightened in the context of hostile judgments (see Figure 3).

Subjective Certainty

A 2 (condition: partial information, full information) × 2 (judgment: nasty, nice) repeated measures GLM with AQ Physical Aggression (*z*-scored) as a continuous between-subjects independent variable and subjective certainty as a dependent variable failed to detect a main effect of condition, $F(1, 84) = .002$, $p = .961$, $\eta_p^2 = .01$, 90% CI [0.00, 0.001], or physical aggression, $F(1, 84) = 3.73$, $p = .057$, $\eta_p^2 = .04$, 90% CI [0.00, 0.13]. However, consistent with previous research (Rand, Ohtsuki, & Nowak, 2009; Siegel, Mathys, Rutledge, & Crockett, 2018), there was a main effect of judgment on certainty, $F(1, 84) = 4.26$, $p = .042$, $\eta_p^2 = .05$, 90% CI [0.001, 0.14], such that participants were generally more certain when judging someone as nice ($M = 41.49$) than when judging someone as nasty ($M = 35.09$). Furthermore, there was a Judgment × Physical Aggression interaction, $F(1, 84) = 3.97$, $p = .049$, $\eta_p^2 = .05$, 90% CI [0.00005, 0.13], and a Condition × Physical Aggression interaction, $F(1, 84) = 4.60$, $p = .035$, $\eta_p^2 = .05$, 90% CI [0.002, 0.14]. In terms of the Judgment × Physical Aggression interaction, there was a simple main effect of aggression in the context of nasty judgments, $B = 7.80$, $SE = 3.47$, $p = .027$, $\eta_p^2 = .05$, 90% CI [2.03, 13.57], but we failed to detect a simple main effect of aggression in the context of nice judgments, $B = 1.00$, $SE = 3.36$, $p = .767$, $\eta_p^2 = .001$, 90% CI [−4.58, 6.58]. In terms of the Condition × Physical Aggression interaction, there was a simple main effect of aggression in the full information condition, $B = 7.46$, $SE = 3.22$, $p = .023$, $\eta_p^2 = .06$, 90% CI [2.11, 12.82], but we failed to detect a simple main effect of aggression in the partial information condition, $B = 2.09$, $SE = 2.81$, $p = .458$, $\eta_p^2 = .01$, 90% CI [−2.57, 6.75]. Together, these results indicate that more physically aggressive individuals endorsed greater certainty particularly in the context of nasty judgments (vs. nice; see Figure 4A), consistent with Hypothesis 4, as well as greater certainty particularly in the context of full information (vs. partial; see Figure 4B; see Supplementary Results for robustness, specificity, and additional exploratory analyses).

Social Reflection Impulsivity and "Real-World" Behavior

The relevance of social reflection impulsivity for moderating the association between physical aggression and assault charges was assessed using a negative binomial regression with AQ Physical Aggression and hostile reflection impulsivity (the extent of information gathering in the context of nasty judgments) as continuous independent variables and number of assault charges as a count-based dependent variable. In the model examining effects of aggression (*z*-scored) and hostile reflection impulsivity (*z*-scored) as well as their interaction, $\chi^2/df = 1.17$, $p < .001$, only the Aggression × Hostile Reflection Impulsivity interaction predicted number of assault charges, odds ratio (OR) = 0.58, $p = .002$, 95% CI [0.42, 0.82]. Specifically, consistent with Hypothesis 5, the greatest number of assault charges resulted from a combination of high physical aggression and low information gathering in the context of hostile judgments (i.e., high hostile reflection impulsivity; see Figure 5).

[3] These results remained unchanged after adding nonsocial (i.e., general) reflection impulsivity as a covariate in the analysis.

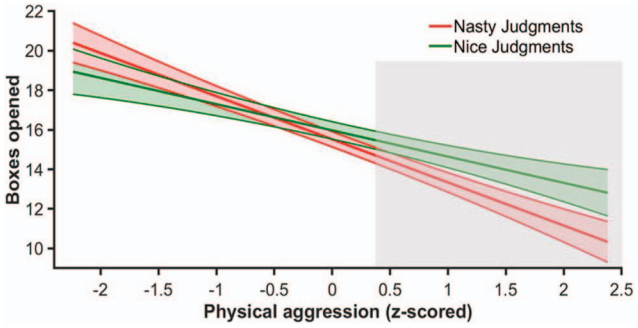

Figure 3. The relationship between physical aggression and information gathering in the context of hostile ("nasty") versus benign ("nice") judgments. Participants with higher levels of physical aggression gathered less information in the context of nasty judgments, but we failed to detect an effect of aggression on information gathering in the context of nice judgments. Error bands represent 90% CI. Region of significance is shown in gray shading: specifically, at *z*-scored values of physical aggression around 0.37 (i.e., AQ Physical Aggression scores around 27) and higher (representing 31 participants), there is a difference between reflection impulsivity for hostile versus benign judgments. See the online article for the color version of this figure.

Discussion

Physically aggressive individuals interpret ambiguous information in aberrant ways, which appears to bias their social cognition and exacerbate their aggressive behavior. The results of the present study suggest that these aberrations may stem, in part, from tendencies toward reflection impulsivity, a cognitive mechanism underlying decision-making under ambiguity. Using a novel experimental task designed to assess information gathering during social decision-making, this study is the first empirical demonstration that physical aggression is associated with heightened reflection impulsivity. Specifically, we found that more physically aggressive individuals gathered less information during social decision-making. Furthermore, physically aggressive individuals' tendency toward greater social reflection impulsivity was amplified in the context of hostile judgments. However, despite their tendency to base hostile judgments on fewer pieces of information, more physically aggressive individuals reported greater certainty about their hostile judgments. More physically aggressive individuals also demonstrated greater certainty when they were presented with the full range of available social information compared with partial information. Finally, translating the present findings to a real-world measure of violent behavior, physically aggressive individuals who displayed more pronounced hostile reflection impulsivity (i.e., reflection impulsivity in the context of hostile judgments) had the most assault charges, indicating that this specific form of reflection impulsivity may play a role in violent offending.

Consistent with previous research and models of decision-making, information gathering is a key process that supports social decision-making and diminishes the ambiguity surrounding decisions (Clark et al., 2006; Forstmann et al., 2016). In research on aggression using vignette-based methodology, studies have shown that physically aggressive youth tend to make decisions more rapidly and with less consideration of available cues (Dodge & Newman, 1981; Slaby & Guerra, 1988), thereby leaving more room for ambiguity in their decision-making. Extending this pattern, in the present study physically aggressive individuals engaged in limited information gathering (i.e., higher reflection impulsivity) while deciding whether someone was hostile or benign.

Notably, we found that physically aggressive individuals engaged in limited information gathering particularly in the context of deciding that someone was hostile, which may reflect a self-protective tendency. Physically aggressive individuals typically must navigate more hostile environments from an early age (Anderson, Buckley, & Carnagey, 2008; Guerra, Rowell Huesmann, & Spindler, 2003; Weiss, Dodge, Bates, & Pettit, 1992), making it particularly likely that they will be exposed to social threats.

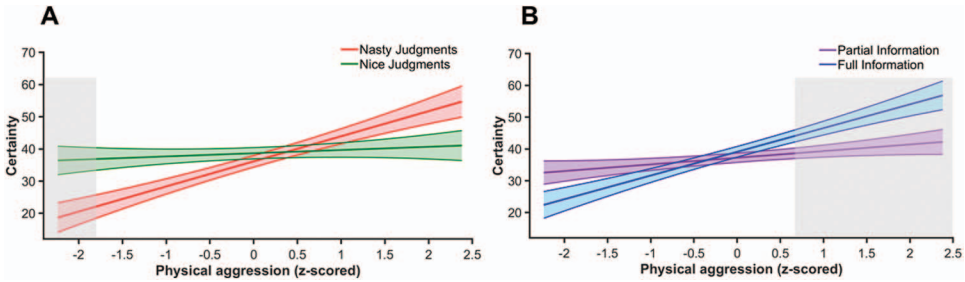

Figure 4. The relationship between physical aggression and certainty in the context of hostile ("nasty") versus benign ("nice") judgments (A) and in the context of partial versus full information conditions (B). Participants with higher levels of physical aggression endorsed greater certainty when judging someone as nasty, but we failed to detect an effect of aggression on certainty for nice judgments (A). Furthermore, participants with higher levels of physical aggression endorsed greater certainty in the full information condition, but we failed to detect an effect of aggression on certainty in the partial information condition (B). Error bands represent 90% CI. Regions of significance are shown in gray shading: specifically, at *z*-scored values of physical aggression around −1.84 (i.e., AQ Physical Aggression scores around 12) and lower (representing two participants), there is a difference between reflection impulsivity in the context of hostile versus benign judgments (A). Additionally, at *z*-scored values of physical aggression around 0.67 (i.e., AQ Physical Aggression scores around 29) and higher (representing 25 participants), there is a difference between reflection impulsivity in the partial versus full information conditions (B). See the online article for the color version of this figure.

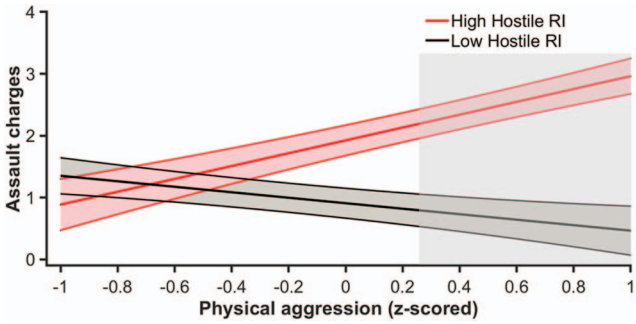

Figure 5. Simple slopes plotted 1 *SD* above the mean and 1 *SD* below the mean for hostile reflection impulsivity. Higher aggression was related to more assault charges at high levels of hostile reflection impulsivity ($B = 0.76$, $p = .006$), but we failed to detect an effect of aggression at low levels of hostile reflection impulsivity ($B = -0.31$, $p = .182$). Error bands represent 90% CI. Region of significance is shown in gray shading: specifically, at *z*-scored values of physical aggression around 0.26 (i.e., AQ Physical Aggression scores around 26) and higher (representing 40 participants), there is an effect of hostile reflection impulsivity on assault charges. RI = reflection impulsivity. See the online article for the color version of this figure.

Because the threat of mistreatment looms large when faced with a potentially hostile person, extensive information gathering or indecision under these circumstances could result in vulnerability to exploitation. The tendency toward heighted reflection impulsivity when making hostile judgments may allow aggressive individuals to constrict the timeframe during which they are vulnerable (i.e., by spending less time opening boxes) and thereby protect themselves from threat (i.e., mistreatment by hostile individuals; Hoglund & Leadbeater, 2007). The tendency to rapidly judge others as hostile may serve an adaptive function in the short term by reducing vulnerability to threats but likely serves maladaptive functions as well, such as blocking opportunities to develop positive social relationships.

Despite the fact that physically aggressive individuals' hostile judgments were based on less information, we found that they were characterized by greater certainty. In general, judgments marked by greater certainty exert stronger influences on behavior (Fazio & Zanna, 1978) and are more persistent and less amenable to new information (Tormala & Rucker, 2007). Related to aggression, greater certainty may heighten aggressive individuals' propensity to initiate and continue to engage in aggressive behavior over time. In terms of initiating acts of aggression, heightened certainty about hostile judgments may lead aggressive individuals to be more likely to act on these judgments by confronting or aggressing against the supposedly hostile individual. For example, an aggressive individual, driven by an inflated sense of certainty, may exhibit stronger determination to carry out violent retaliation against a perceived enemy, despite the fact that their reason for desiring revenge may be based on limited information. Additionally, in terms of continuing to engage in aggression over time, greater certainty that others are hostile may promote self-serving cognitive distortions (e.g., derogating and shifting blame to victims) that allow individuals to justify their harmful behavior (Slaby & Guerra, 1988; van Leeuwen, Rodgers, Gibbs, & Chabrol, 2014). Being more certain about a victim's hostility (one possible form of victim derogation) and clinging to that judgment even after inflicting harm on the victim may facilitate aggressive individuals' justification of their aggression on the basis that it neutralized the ostensible threat posed by the victim, thereby reducing sympathy for the victim and undermining motivation to change. Thus, less flexible judgments about others' hostility may promote aggression against perceived enemies, as well as contribute to the maintenance of a chronic pattern of aggressive behavior.

In addition to being more certain about their hostile judgments, we found that physically aggressive individuals reported greater certainty when they had full and unconstrained access to all available social information (i.e., in the full information condition) compared with when they gathered the information themselves (i.e., in the partial information condition). On the one hand, when all individuals were exposed to equal amounts of information and, thus, should have experienced comparable levels of certainty, aggressive individuals' certainty was bolstered. On the other hand, when individuals chose how much information to gather and certainty should have tracked the amount of information gathered (i.e., gathering less information should have resulted in less certainty), aggressive individuals gathered less information but their sense of certainty paradoxically was not diminished. Taken together, it appears that aggressive individuals do not appropriately adjust their level of certainty to the level of ambiguity present in the decision-making context. This interpretation is consistent with previous research indicating that aggressive individuals do not appropriately adjust their cost-benefit decisions according to varying levels of ambiguous information (Buckholtz et al., 2017). Overall, expressing more certainty when judging others as hostile (based on less information) and when exposed to equal amounts of information reflects an inflexible and overconfident style of social decision-making (see Supplementary Results for a follow-up analysis of a potential contributing factor to aggressive individuals' certainty).

Before concluding, limitations of the present study should be noted. First, the fact that we did not find support for our hypothesis that physically aggressive individuals would be more likely to judge others as hostile may reflect limitations of our experimental design. The social information sampling task was specifically designed to measure reflection impulsivity, and consequently it may not have been an adequately sensitive measure of hostile attribution bias. Effect sizes for the association between aggression and hostile attribution biases are quite small, particularly in adult samples (De Castro et al., 2002), and multiple studies failed to find an association (Coccaro, Fanning, Fisher, Couture, & Lee, 2017; Helfritz-Sinville & Stanford, 2014). The present study, though adequately powered to detect moderate effect sizes associated with reflection impulsivity, was likely underpowered to detect smaller effect sizes associated with hostile attribution biases. More specific experimental design elements may have contributed to the null finding as well. As noted in the Method section, stimulus words that were extreme in terms of valence or arousal were excluded; the relatively low-intensity behaviors that served as stimuli in the present study may have had a minimal impact on aggressive participants' tendency to judge people in the task as hostile (Skowronski & Carlston, 1987). Additionally, previous research indicates that hostile attribution biases are more likely to arise when the decision-making context is self-relevant (Dodge & Frame, 1982), threatening (Dodge & Somberg, 1987), and spontaneous rather

than deliberate (Zelli, Rowell Huesmann, & Cervone, 1995). However, none of these factors were introduced or manipulated in the present study. Future research should examine whether these factors influence the likelihood of hostile attributions in the social information sampling task.

Second, the order of the experimental conditions and tasks was not counterbalanced, raising the question of whether the ordering of experimental components impacted the present results. For example, it is possible that strategies used in the partial information condition could have carried over into the full information condition, and that strategies used in the social task could have carried over into the nonsocial task. However, our decision to present experimental components in a fixed order was based on concerns about asymmetric transfer effects (see Method section), which are rooted in evidence that social and nonsocial decision-making are subserved by separable processes (Van Overwalle, 2011). While the lack of counterbalancing and the specific ordering of experimental components were deliberate decisions made to reduce unknown or unwanted influences on the primary dependent variable (social reflection impulsivity), future research could examine the impact of different condition/task orders on social information sampling task performance.

In summary, more physically aggressive individuals displayed a more impulsive and less flexible social decision-making style, particularly in the context of hostile judgments. Furthermore, aggressive individuals who made more ill-informed hostile judgments had the most extensive history of assault charges, highlighting the relevance of social decision-making aberrations for understanding real-world violence. The present study contributes to the mounting evidence that physically aggressive individuals exhibit a host of general cognitive deficits (Giancola, Martin, Tarter, Pelham, & Moss, 1996; Hancock, Tapscott, & Hoaken, 2010; Kuin, Masthoff, Kramer, & Scherder, 2015) and a pervasive pattern of aberrant ambiguity processing (Buckholtz et al., 2017; Dodge, 2006). Moreover, the findings pinpoint a previously unidentified mechanism, social reflection impulsivity, which may contribute to the distinctive ways in which aggressive individuals construe and navigate their social worlds.

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