



# Contingencies for Aggression in the Point Subtraction Aggression Paradigm

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## Abstract

Aggression can be seen as a behavior that arranges conditions that functions as aversive for other organisms. The Point Subtraction Aggression Paradigm (PSAP) is a laboratory task designed to measure this phenomenon with human participants. Different versions of the PSAP program contingencies that may differentially interfere in the measurement of aggressive behavior. This article aims to identify the contingencies embedded in these versions and to suggest areas for future investigations. The literature was systematically searched, and six PSAP versions were identified. Three of these versions have added contingencies to the aggression task that may have confounded the measure of aggression with other positive and negative reinforcement processes. The PSAP versions may be organized into one or two aggressive response options, presence or absence of control response for the responding measured as aggressive, and availability of an independent escape response. These settings potentially establish various overlapping behavioral processes. Empirical solutions are suggested to improve the analysis of aggressive and other behaviors in the task.

**Keywords** Aggressive behavior · Aggression · Point subtraction aggression paradigm · Escape behavior

From the perspective of behavior analysis, aggression can be understood as a type of behavior that arranges conditions that functions as aversive for other organisms (Lewon et al., 2019). Aggressive behavior can be controlled by variables such as effects on the target (e.g., escape responses, bruises in a fight) and consequences not directly related to aggression (i.e., other reinforcers), or by antecedent aversive stimulation (Skinner, 1969). Such a functional approach, by definition, does not tie aggression to any specific topography, and covers many types of aggressive behavior that ranges from severe physical aggression (such as beating) to online aggression (such as cyberbullying). Skinner (1969) points out that harm to others can be reinforcing both because of the phylogenetic history (e.g., organisms who were sensitive to harm caused to sexual competitors, or to predators and

prey, may have had a greater probability of survival) and due to the pairing of harm with other stimuli (i.e., signals of harm can be paired, over the life of the organism, with other reinforcers).

Human aggressive behavior can be assessed through many experimental protocols (for reviews, see McCarthy & Elson, 2018; Ritter & Eslea, 2005). The Point Subtraction Aggression Paradigm (PSAP), a task with a free-operant procedure (Kelly & Cherek, 1993), was designed to objectively examine human aggressive behavior in controlled laboratory conditions. The experimental setup was first proposed by Donald R. Cherek in 1981 in an article entitled "Effects of Smoking Different Doses of Nicotine on Human Aggressive Behavior." Some of the empirical-methodological precedents for PSAP include research on human aggression using the Competitive Reaction Time Task (Taylor, 1967) and Buss Aggression Machine (Buss, 1961), and on nonhuman aggression performed under laboratory conditions (cf. Hutchinson, 1973; Ulrich, 1966). Since its original proposition, the PSAP has undergone procedural refinements and currently stands as one of the leading laboratory preparations for directly measuring aggression in human participants (Lane et al., 2020).

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The PSAP standard application involves exposing individual participants to a specific arrangement of contingencies. In its most modern version (see Geniole et al., 2017), the PSAP contains a computer screen that displays a point counter and the letters “A,” “B,” and “C” (or numbers “1,” “2,” and “3”), in addition to a device with buttons labeled according to these letters. The instruction provides the following information: when the participant presses “A” 100 times (Fixed Ratio 100 [FR 100]), one point (corresponding to a value in cents) will be added to their counter; when the participant presses “B” 10 times (Fixed Ratio 10 [FR 10]), one point will be deducted from the paired participant; when the participant presses “C” 10 times (FR 10), points cannot be subtracted from their counter for a period (called Provocation-Free Interval [PFI]). The instructions also inform that the participant and their partner, although exposed to the same type of equipment, are in different conditions: for the participant, the completion of the reinforcement schedule on the “B” option removes points from the partner without this point being added to their own counter; for the partner, the points taken from the participant are added to their counter. The partner is fictitious, and a software is responsible for subtracting the participant's points in a variable time (VT) schedule, according to the manipulation in effect. The frequency of response in option “B” is the aggressiveness data, as it is the option that results in harm to others (Cherek & Steinberg, 1987). It is noteworthy that, as there is no real partner, the harm produced is also fictitious, and the “B” option is established as aggressive completely via instructions.

Previous reviews of PSAP usage (Cherek et al., 2003; Cherek & Steinberg, 1987; Cherek et al., 2006; Geniole et al., 2017; Kelly & Cherek, 1993) indicate a vast collection of studies that have examined how aggression can be modulated by psychotropic drugs (e.g., Moeller et al., 1996), neuroendocrine alterations (e.g., Pope et al., 2000), frequency of point subtraction (e.g., Cherek et al., 1990), previous experience with violence (e.g., Cherek et al., 1997), facial metrics (e.g., Carré & McCormick, 2008), personality disorders (e.g., New et al., 2009), among other variables. Those reviews consist of compilations and syntheses of findings in experimental psychology and frontier areas involving the PSAP. Studies evaluating the extent to which the PSAP adequately measures the aggressive behavioral phenomenon are scarce. Tedeschi and Quigley (2000), a rare example, argued that the PSAP was a limited measure of aggression because it contained insufficient response options for interaction with the paired participant, had contradictory data on convergent validity, assumed that aggression occurring outside the laboratory would be predictive of aggression occurring on the task, and mainly failed to assess the intentions and motives of the participants.

Although discussing important limitations of the task, the definition of aggression used by Tedeschi and Quigley (2000) took into account the intentions and motives of the aggressor and the target. For behavior analysis, the causes of behavior must be found in relation to environmental variables. The damage produced by a response traditionally characterizes aggression (e.g., Bandura & Walters, 1963), and it is in the relationship of reinforcement between such a response and the damage that follows it that the control variables of this behavior may be identified (Skinner, 1969). Also, Cherek et al. (2003) pointed out that the PSAP does not force the participant to behave aggressively, gives them alternative responses to aggression, allows for inter-subject variability of responding without compromising experimental control, and it is supported by external validity findings. In this task, the response commonly associated with option “B,” which consists of removing points from the paired participant, meets the criteria described by Skinner for characterizing aggressive behavior. Functional neuroimaging evidence (Skibsted et al., 2017) showed that “B” responding occurs with activity in brain areas related to reward, suggesting that the harm produced, in the context of a brief exposition to the task, may have reinforcing properties.

Identifying the sources of environmental control of responding in the PSAP can provide relevant information about the characteristics of aggression measured by this task. This exercise is central, considering that the PSAP has configurations that vary across different studies. These variations are not mere changes in parameters: some of them involve changes in antecedent and consequent events for aggression. Empirical studies that used the PSAP as a way to assess aggression differ significantly from the original proposition (viz., Cherek, 1981), which includes, for instance, a reduction in the number of aggressive response options (Cherek et al., 1986a), increase in the number of response options (Cherek et al., 1991a), reduction in time of exposure to the task (e.g., Golomb et al., 2007), equalization of schedule ratios (e.g., Gan et al., 2016), and changes in the consequences of responding (e.g., Carré et al., 2010), among other modifications. Eventual overlapping contingencies can make it difficult to identify the sources of control of the aggressive response. The present review aims to describe these different PSAP versions by surveying the empirical literature, detail the reinforcement contingencies present in each of them and point out how behavior analysts could find in this task a useful resource for basic research on aggressive behavior.

## Method

### Protocol and Tools

This review was conducted in accordance with the PRISMA recommendation (Moher et al., 2009). The State of the Art

through Systematic Review tool (StArt v. 2.3.4.2; Fabbri et al., 2016) was used to manage the files imported from databases and helped to streamline the screening processes. Data extraction was performed in a spreadsheet generated from StArt, using LibreOffice Calc © 2019.

## Search Strategy

The following databases were accessed in February 2021: PMC, PubMed, ScienceDirect, Scopus, and Web of Science. The search string in these databases was: point subtraction aggression paradigm OR point-subtraction aggression paradigm OR PSAP AND aggress\* NOT surgery NOT cancer NOT geophysics NOT engineering NOT angiography. The references of selected studies were also inspected. Filters were applied to limit the range of publications from the year of publication of the first original study with the task to the most recent year completed: 1981 to 2020. In January 2022 the string was searched again to include the year 2021.

## Inclusion and Exclusion Criteria

Duplicate records were removed by the StArt tool and double-checked by the first author and an independent reviewer. Title, abstract, and keywords were evaluated in the first screening. A record was selected if it had the following characteristics: (1) empirical report; (2) year of publication between 1981 and 2021; (3) published in a peer-reviewed journal, use of the PSAP as a measure of human aggression; (4) “Method” section with a detailed description of the PSAP. Reviews, theoretical articles, letters to the editor, conference notes, theses, or dissertations were excluded from the analysis, as well as investigations with nonhuman subjects. For cases of unclear information, the record was selected for further review. Disagreements about the eligibility of a particular record were discussed by the reviewers until consensus.

## Data Extraction

A second screening was performed by the first author with the full text of each selected document. The “References” section of each record was inspected, and the inclusion and exclusion criteria were rechecked. The first three authors performed information extraction from the included studies and checked each other's work. Each of the included records was examined for title, authorship, participants, manipulated/organized independent variable, task parameters, study design, parallel measure of aggression, and main findings. Differences were discussed until unanimous agreement.

## Results

### PRISMA Flowchart

Figure 1 shows the steps performed from searching the databases to obtain the relevant records for analysis.

### PSAP versions

The analysis of the 139 selected articles led to the identification of six main PSAP versions. Such versions were differentiated from each other based on the manipulations in the response options and their consequences. These versions are mapped in Table 1.

#### “Two Aggressive Responses”

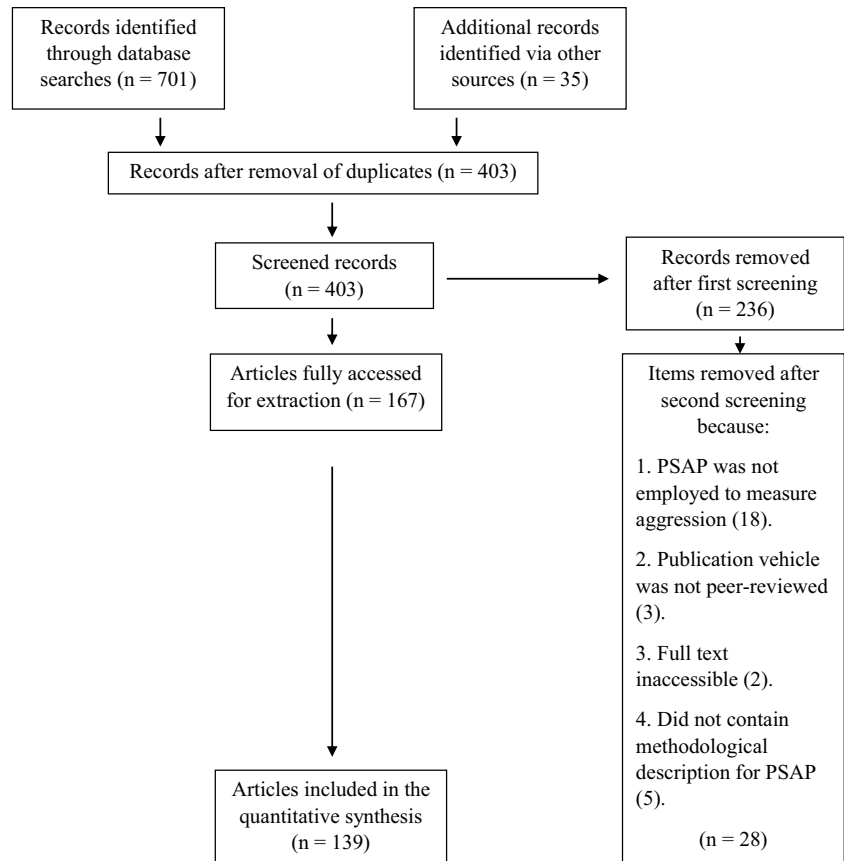
The original version of the PSAP is found in Cherek (1981), still without the nomenclature “Point Subtraction Aggression Paradigm.” In this article, the task contained an apparatus with three response options, “A,” “B,” and “C.” As in the current versions, option “A” was responsible for generating points exchangeable for cash (FR 100), and “B” was the option that deducted points from the paired participant (FR 10), an option considered aggressive. Option “C” was also considered an aggressive option and consisted of presenting a burst of white noise of approximately 60 dB to the fictitious participant (FR 10). An experimental session lasted 50 min and each participant was exposed to five sessions, one per day. The subtraction of points occurred with low frequency (five subtractions on average per session) for some participants and with high frequency (20 subtractions on average per session) for others, which produced, respectively, a lower and higher frequency of aggressive responses. Participants were not exposed to white noise.

**Aggression Measurement** In selecting two topographically compatible but different effect response options, Cherek (1981) documented that, based on reports from participants in preliminary studies, subtraction of points was considered “very aversive and representing significant aggression, while the bursts of white noise were perceived as annoying but minimally aversive” (p. 340). For that reason, in this study (Cherek, 1981) participants were only exposed to point subtraction, and not to white noise bursts. All participants chose “B” option in a much higher frequency than “C” option. Other studies (e.g., Cherek et al., 1985) also indicated a more frequent choice of “B” as aggressive option.

#### “One Aggressive Response”

Characterized by the option “A” as a positively reinforced response and “B” as a point remover, this version did not program the response option that generated white noise. The

**Fig. 1** PRISMA flowchart, detailing the number of articles selected or excluded by stage



**Table 1** Characteristics of PSAP versions

Version	First publication	Operationalization of aggression	Unique features of the version	# of articles using it
Two aggressive responses	Cherek (1981)	Option 1: Removal of a point from the paired participant Option 2: Presentation of a 60 dB 1-s tone to the paired participant	Aggression is measured with two competing response options	4
One aggressive response	Cherek et al. (1986b)	Removing a point from the paired participant	Aggression is measured by a response option with no additional effect	12
One aggressive response with PFI	Cherek et al. (1986a)	Removing a point from the paired participant	Aggressive response produces PFI as an additional effect	38
One aggressive response with PFI and one response with PFI only	Cherek et al. (1991a)	Removing a point from the paired participant	Nonaggressive PFI generation option (single effect)	42
One aggressive response and one response with PFI only	Carré & McCormick (2008)	Removing a point from the paired participant	Nonaggressive option has exclusivity in PFI production	39
One proactive aggressive response, and response with PFI only	Nouvion et al. (2007)	Removing and adding to the counter itself a point from the paired participant	Aggressive response keeps the point removed instead of taking it away	3

All versions have one positively reinforced response option. Two studies used two different PSAP versions, making the sum of publications using each version differ from the number of analyzed articles

first implementation of this version is found in Cherek et al. (1986b). In that study, the authors maintained the standard of a 50 min session for 5 days, with low and high frequency point subtractions for different participants. Recent uses of the version have reduced the total time of participation, with exposure to three or four sessions of 6–25 min in duration (e.g., Alcorn et al., 2015; Gan et al., 2016), and subtractions of points between 6 and 125 s.

**Aggression Measurement** This version used responding on option “B” (removal of points from the fictitious participant) as the aggressive response.

#### “One Aggressive Response with PFI”

This PSAP version, comprised of option “A” (point production) and option “B” (point removal), was first implemented in Cherek et al. (1986a). Keeping an apparatus with only two response options, this version added the PFI (point loss timeout, a negative reinforcement contingency) as an additional consequence to the selection of option “B,” because fictitious point removal alone was not able to maintain responding on that button over multiple sessions. Cherek et al. (1990) stated that extinction of aggressive responding may occur because “the instructional set is frequently compromised (i.e., discriminative control by the instructions is lost”; p. 294), and that PFI would prevent the loss of control by instructions.

The consequences of completing the schedule in “B” became two: removal of points from the paired participant, and PFI. With “One aggressive response with PFI,” the experimental sessions still followed the pattern of 50 min duration for 5 consecutive days in initial studies (e.g., Cherek et al., 1987, 1989), but in later studies the session duration would be reduced to 20–25 min and the number of sessions could go from 3 (e.g., Dougherty et al., 1997) to 64 (e.g., Cherek et al., 2002), depending on the variable examined.

The PFI was tested in two negative reinforcement settings (e.g., Cherek et al., 1986a, 1989): as an avoidance contingency, where the aggressive option could produce PFI at any time in the session, or as an escape contingency, in which the aggressive option could only generate the PFI after the participant had a point subtracted. The PFI as avoidance allowed for the complete absence of point subtractions—that is, the fictitious participant could never subtract points from the actual participant—making the instructions not credible (Cherek et al., 1989).

Regarding differences in the behavior produced by each contingency, PFI as avoidance implied a lower sensitivity of the aggressive response rate to experimental manipulations given that point subtractions were infrequent (Cherek et al., 1990). Furthermore, the pattern of responses on the “B” button is different according to the type of PFI: in general, with avoidance-type PFI, responses to this option occur even

without contiguity with the removal of points, and only one ratio is typically completed before the participant responds again on the “A” button. On the other hand, with escape-type PFI, the typical behavioral pattern produced is that of several complete ratios on the “B” button shortly after a participant point withdrawal (Cherek et al., 1989, 1990). The PFI as an escape contingency guaranteed the exposure of participants to loss of points, and became standard in subsequent studies (e.g., Dougherty et al., 1997).

**Aggression Measurement** The frequency of responses in option “B” continued to be taken as an index of aggression, even though the PFI had been added as another consequence for responding.

#### “One Aggressive Response with PFI and One Response with PFI Only”

In this version, “A” was maintained as the positively reinforced option, “B” as the aggressive option with PFI (escape contingency), and option “C” returned, maintaining the requirement of complementing a FR 10 for producing a consequence. Unlike in the original version of the PSAP (i.e., “Two aggressive responses,” Cherek, 1981), here the option “C” also produced PFI (Cherek et al., 1991a). Cherek et al. (1991b) have pointed out that adding an escape option allows comparisons between “B” and “C” responding, which have the same antecedents (point loss) and consequences (PFI), but are described with different functions in the instructions (aggressive and escape, respectively).

Six sessions of 25 min each on a single day were frequently reported for “One aggressive response with PFI and one response with PFI only” version in early work (e.g., Allen et al., 1996; Cherek et al., 1993). Even though PFI on option “B” was introduced to maintain aggressive responding during long-term studies (Cherek et al., 1990), recent studies that use this version of PSAP reduced to one or two 10–12 min sessions (e.g., Carré et al., 2017; Chen et al., 2021).

The addition of option “C” as an option producing PFI influenced the frequency of choosing “B.” Participants exposed first to more frequent point subtractions tended to select “C” at a higher rate than “B,” and participants exposed first to less frequent point subtractions selected “B” at a higher rate than “C,” even if the point subtraction periodicity was reversed under the following conditions (Cherek et al., 1991a). Another study demonstrated that the “One aggressive response with PFI” version generated more aggressive responses (option B) than “One aggressive response with PFI and one response with PFI only” (McCloskey et al., 2005).

**Aggression Measurement** Cherek et al. (1991a) identified the aggressive response as option “B,” which produced point removal and also PFI.



### “One Aggressive Response and One Response with PFI Only”

This version, first found in Carré and McCormick (2008), preserved “A” as the positively reinforced response, “B” as the aggressive response (without PFI), and “C” as the escape response. It consists of a version that combines aspects of the versions “One aggressive response” and “One aggressive response with PFI and one response with PFI only.” The total duration of exposure to the experimental sessions matches the recent studies with the PSAP: one to three sessions of 10–40 min in duration (e.g., Asaoka et al., 2021; Carré & McCormick, 2008).

**Aggression Measurement** In this version, the response option “B,” which implied in removal of points from the fictitious participant, was identified as the aggressive response.

### “One Proactive Aggressive Response, and one response with PFI Only”

Nouvion et al. (2007) programmed options “A” and “C” as, respectively, positively reinforced response and escape response. For option “B” there were two simultaneous consequences: removing a point from the fictitious participant and adding this point to the participant's own counter—an effect of positive reinforcement similar to that programmed for option “A.” The authors called this new option “proactive aggression.” There was no PFI for option “B.” In this version, participants' exposure to the task could last from one to three sessions of 10–25 min in duration (Nouvion et al., 2007; Schlüter et al., 2017).

Instead of the usual imbalance between options requirements (usually, FR 100 for option “A” and FR 10 for options “B” and “C”), “One proactive aggressive response, and one response with PFI only” uses similar schedules: Nouvion et al. (2007); Carré et al. (2010) used FR 50 for all three options; Schlüter et al. (2017) used FR 50 for “A” option and FR 35 for both “B” and “C” options, whereas preventing point gain in 25% of “B” ratios completion in order to simulate “C” option completion by the partner.

Carré et al. (2010) compared the aggressive response rates obtained through the present version with (1) an identical version without point loss; (2) the version “One aggressive response and one response with PFI only”; and (3) a version identical to the latter without point loss. Carré et al. observed that the proactive aggression versions generated higher rates of aggressive responding (statistically significant) than the reactive aggression versions.

**Aggression Measurement** In this version, option “B” was identified as aggressive, with a positive reinforcing

consequence added to the consequence of removing points from the fictitious participant. Some participants responded aggressively even prior to provocations.

## Discussion

In half of the six identified PSAP versions (“Two aggressive responses,” “One aggressive response,” and “One aggressive response and one response with PFI only”) the aggressive response removed points from the paired participant, with no other consequences. In the other half of versions, although the behavior involved presentation of aversive stimuli to another person, additional contingencies of negative (initiate PFI) or positive (money production) reinforcement were involved. Details regarding the effects of these contingencies and areas of future research are described below.

### Operationalizations for Aggression

In all PSAP versions the completion of a schedule of reinforcement (in general, FR 10) produced point removal from the counter of the fictitious participant. In this task, the consequence of the behavior is central to consider it aggressive, whereas the response topography is not a relevant criterion. In addition to removing a point, another aggressive operationalization was tested: the production of a white noise of 60 dB for 1 s, found in the “Two aggressive responses” version. Studies that used this version (e.g., Cherek et al., 1983, 1984, 1985) reported that the measure of aggression generated by exposition to white noise was less sensitive to manipulations of independent variables than the measure of aggression by removal of points. This reduced sensitivity could be related to the stimuli mismatch (exposition to point loss favored point-related activity instead of white noise presentation), but that possibility requires empirical investigation.

Based on the understanding of aversive events as motivating operations (MOs) for aggression (Lewon et al., 2019; Michael, 1993), the subtraction of points established higher reinforcing value for point removal compared to presentation of noises to others. The reasons for this difference have not been sufficiently clarified. In Cherek (1981) report, the magnitudes of different forms of harm were not parametrically tested for their effects on responding. The information available are unsystematic reports from the pilot experiments participants, who reported the removal of points as more “aversive” than the presentation of noise. Such reports suggest that the removal of points was a type of damage that had more reinforcing properties than the presentation of noise. This property was possibly attributed to the instructions: whereas point removal was described as an event that

influenced “the amount of money obtained by the other person,” the noise served to merely “annoy” the other person<sup>1</sup> (Cherek, 1981; Cherek et al., 1983, 1985). Considering that aggressive behavior may be reinforced by the effects caused on others (Skinner, 1969), participant reports suggest that producing the most aversive event (loss of points) for another person is more reinforcing after they have lost points themselves. The fact that participants in this PSAP version were provoked by point loss but not noise may have influenced their preference for the removal of points—which should be examined in detail. In any case, the presence of two options with the same effect (producing damage) may have distributed the total frequency of aggressive responses.

As discussed by Geniole et al. (2017), the completion of a fixed-ratio schedule in “B” option to successfully aggress contributes to the ecology of data obtained through PSAP, as the aggressive behaviors in the modern life are not displayed without costs for the aggressor. Indeed, the total earnings are reduced when the participant presses more “B” than other participants. Even though this operationalization (i.e., press a button to remove a point) has not changed more than 40 years of PSAP applications, the “aggressive” feature of this response is partially dependent on effective instructions, as participants do not see the other fictitious participants, neither have access to their counter. The temporary cessation of point loss (PFI) is the sole consequence participants have on the effects of their own point-removal behavior. PSAP versions that do not use PFI added to the aggressive option (see Table 1) rely on instructions’ formal properties such as accuracy, explicitness, complexity, source, and timing of contingencies (Pelaez, 2013) for point subtractions work as motivators for aggression during sessions. Considering that the instructional control of human behavior may vary in effectivity according to past and present contingencies (Baron & Galizio, 1983) the relationship between feedback for aggression and instructions may be closely examined.

### Consequences for Aggression

The versions “One aggressive response with PFI” and “One aggressive response with PFI and one response with PFI only” added negative reinforcement (PFI) to the damage generated by responding. The “One proactive aggressive

response and a PFI-only response” version added positive reinforcement (obtaining points from the fictitious participant) to that responding. The explanations for such additions are presented and evaluated below.

### Aggression with Negative Reinforcement

According to Kelly and Cherek (1993); Kelly et al. (1988), the inclusion of the PFI improved the ecological validity of the aggressive measure, given that the response would be more similar to aggression occurring in a natural environment, which often has other consequences, like the elimination or reduction of aversive stimulation. Cherek et al. (1990); Dougherty et al. (1998) documented that the absence of the PFI for the aggressive option resulted in the extinction of the response in prolonged exposures to the PSAP. Cherek et al. also remarked that the period immediately after an aggression, in which there is normally no aversive stimulation (due to point loss schedule), promoted adventitious negative reinforcement of that responding. Therefore, in the PSAP aggression would also be followed by the absence of aversive stimulation, regardless of whether the PFI is explicitly included or not.

Although the PFI addition contributed to the ecology of the measure of aggression and solved the problem of extinction of the responding, it created two possible sources of control over the aggressive response: the damage generated (point removal), and the period without aversive stimulation (PFI), making it difficult to discriminate which process is controlling aggressive responding. The “One aggressive response with PFI and one response with PFI only” version controlled and equalized the antecedents (point loss) and consequences (PFI) of options “B” and “C,” which would possibly make the preference for “B” (aggression) over “C” (escape) exclusively under the control of harm to another. Still, the aggression measured in this version is possibly controlled mainly by negative reinforcement, unlike PSAP versions that do not include PFI in the aggressive response, and therefore are controlled mainly by the harm produced (and may depend on effectiveness of instructions, as discussed below). Both basic and applied behavior analysis studies reported that additional positive and negative reinforcement may contribute to the strength of aggression (Lewon et al., 2019). Such an overlap of contingencies is not a problem for the definition of aggression (see Skinner, 1969), but experiments that parametrically examine what perturbations the PFI can bring to the measure of aggression in the versions of the PSAP that employ it on the aggressive option may be opportune. In addition, they could be informative about the loss of reinforcing value of damage generated by aggressive responding without PFI over long exposures to the task.

With the version “One aggressive response,” that does not include PFI, Golomb et al. (2007) demonstrated that a

<sup>1</sup> Instructions are not usually available in full in most research reports, which prevented the analysis of this variable in this review. Often, they inform the participant that, according to a previously held draw, they will be assigned to a condition in which they can only eliminate points, whereas the paired participant will be able to keep their points. A social situation of inequality or even injustice can influence aggression rates (Carré et al., 2010). Differences in instructions influenced the rate of aggressive responding in other versions of the task (e.g., Schlüter et al., 2017).

single exposure to PSAP for 25 min would be sufficient to produce a measure of aggression with convergent validity regarding risk factors for aggression and some psychometric measures of it. As opposed to standard PSAP applications (such as “One aggressive response with PFI” and “One aggressive response with PFI”), which might require multiple daily sessions of up to 50 min, two or three times a week for 6 or even 8 weeks for responding to become stable (e.g., Cherek et al., 1989; Moeller et al., 1996), the data reported by Golomb et al. gave the task reliability for conducting research with large groups of participants in short periods of time, as opposed to small groups or individuals. This feature is illustrated by the reduced duration and number of sessions in recent works. The work by Golomb et al. was important in allowing the PSAP paradigm to be more suitable for the comparison between groups research strategy. The activation of brain areas related to reward, observed in a study that employed “One aggressive response and one response with PFI only” version (Skibsted et al., 2017), along with positive association between aggressive responding and point loss, add reliability to the task. It is worth examining which areas in the brain would be activated when the is PFI added to the aggressive response.

### Aggression with Positive Reinforcement

The production of extrinsic positive reinforcers in the “proactive” version of the task (“One proactive aggressive response, and one response with PFI only”), without prior aversive stimulation, is similar to the contingencies tested with nonhuman animals for direct reinforcement of responses that result in harm (e.g., Reynolds et al., 1963; Stachnik et al., 1966). Indeed, extrinsic reinforcers can attribute conditioned reinforcing effects to the harm generated by aggression (Skinner, 1969). However, the evaluation of this possibility in few works involving the PSAP prevents a more detailed analysis of the effects of adding this contingency, and more investigations are required.

Positive reinforcement of aggression initially generates a discrete response topography, but the sequence of positive reinforcement favors the occurrence of response episodes in which the topography is similar to that observed in experiments with direct exposition to aversive stimulation (Reynolds et al., 1963). Investigations using the PSAP could examine the extent to which the task is capable of producing a similar phenomenon—for example, measuring the biting behavior that usually follows aversive stimulation (Hutchinson, 1977; Lloveras et al., 2022). Furthermore, the characterization of aggressive responding as “proactive” or “reactive” implies a dichotomous and mutually exclusive division of the complex contingencies involved in aggressive behavior, being as uninformative as the labels of “attack” and “defense” (Hutchinson, 1983; cf. Merk et al., 2005).

## Nonaggressive Responses

### Positively Reinforced Response

All published PSAP versions contain a nonaggressive response option that produces positive reinforcement (money). In general, it consists of a schedule of Fixed Ratio 100. This parameter was modified in some studies in which it was relevant to compare the rates of aggression with positively reinforced responses (e.g., Carré et al., 2010; Gan et al., 2016) or in those in which the ratio value was tested parametrically (e.g., Cherek et al., 1992; Kelly et al., 1989).

A less discussed issue in PSAP applications is the effect of the aversive properties of reinforcement schedules on aggressive responding, a research interest explored extensively with both humans and nonhumans (Frederiksen & Peterson, 1977; Looney & Cohen, 1982). Reports employing the PSAP indicated no postreinforcement pause in the FR 100 (e.g., Cherek et al., 1986b, 1987) and a low frequency of aggressive responding in the absence of point subtractions (e.g., Carré et al., 2010; Kelly et al., 1988). It is important to consider that, in the absence of aversive stimulation, the frequency of aggressive responses is often not zero though (e.g., Carré et al., 2010). Therefore, the possibility that the FR 100 parameter may be an element of differential influence on aggressive response rates still needs additional empirical testing.

### Response with PFI Only

PSAP can be arranged with a response option whose single effect is PFI (versions “One aggressive response with PFI and one response with PFI only”; “One aggressive response and one response with PFI only”). In general, this option consists of a schedule with the same requirement as the aggressive response (FR 10). This response option addressed demands from the scientific community for more ways of interaction between participant and partner. A critique of wide resonance in experimental psychology (Tedeschi & Quigley, 1996) pointed out, among other observations, that tasks such as the PSAP would induce participants to behave aggressively because of the lack of alternative response options for interaction with the paired participant (see also Giancola & Chermack, 1998; Tedeschi & Quigley, 2000). The PFI-only response accounted for this (Cherek et al., 2003), even though it is only just one more way to interact. Nevertheless, today’s online environments have few ways of interaction between aggressor and target, what contributes to PSAP modern face validity.

As the PSAP is a free-operant task (Kelly & Cherek, 1993) and is not based on discrete trials, participants experience no imposition to select any of the available options (Cherek et al., 2003). However, the selection of an option



requires the participant to finish that schedule before switching to another, making it a concurrent-chain schedule that therefore increases the cost for the aggressive option (Geniole et al., 2017). A recent investigation (Soares, 2022) that employed the versions “One aggressive response” and “One aggressive response with PFI” matched the schedule requirements (VR 20 for both reinforced and aggressive option) and presented them in a concurrent schedule fashion, but the data was inconclusive. Further experiments on this aspect may be informative.

The possibility of escaping point subtractions, in addition to producing points or obtaining them from the fictitious paired participant, seems to have been sufficient to meet the demand for more response options. The sole parametric analysis regarding the PFI-only response influence over the aggressive one (McCloskey et al., 2005) lacks additional systematic replications to control for exposure order effects and to scale up reversals of experimental conditions.

## Other Features

### Frequency of Point Subtraction

The loss of points is one of PSAP essential features, and it functions to motivate aggression (Cherek et al., 2003). As stated above, point subtractions may function as MOs by increasing the reinforcer value of aggressive effects on the target and increasing the frequency of the aggressive response. Indeed, Cherek and Dougherty (1997) reported that the frequency of aggressive responding was a direct function of frequency of point subtraction. Cherek and Dougherty defended that the relation between point subtraction and aggressive responses observed in the PSAP extends to human behavior previous nonhuman data in which the relation between aversive events and aggression was consistently registered (Hutchinson, 1973). However, these non-human studies generally exposed subjects to either painful stimulation or operant extinction (Soares & Goulart, 2015), which are not directly comparable to point subtractions. Those experiments also showed that aversive events work to motivate aggressive responding event after many hours of exposure (e.g., Ulrich & Azrin, 1962), contrary to aggressive behavior obtained through PSAP, which have decreasing frequency after some sessions unless additional negative reinforcement (PFI) is attached to responding (Cherek et al., 1990). Additional studies with an within-subject design may test the magnitude of point subtraction, as well of point removal, to check if aggression remains longer.

### Schedules for Responding

Each response option is comprised of a schedule of reinforcement, whose requirement vary within and across versions.

These variations largely depend on tested variables, but schedules of FR 100 for “A,” FR 10 for “B,” and “C” are of standard use. Schedules can be used to calculate rate of responding, which is an advantageous measure of behavior because it is more sensitive to independent variables (Cherek et al., 2003). The schedule of positive reinforcement in option “A,” and of negative reinforcement in option “C,” serve as a control for aggressive-inducing or -suppressing effects of different substances and contingencies: the rate of “A” and “C” button press is usually constant across sessions, whereas “B” pressing may vary according to the independent variable (e.g., Cherek et al., 1997; Tcheremissine et al., 2005). When FR requirements for the aggressive option increased from 10 to 80, frequency of pressing decreased (Cherek et al., 1992); the parametric manipulation of decreasing the FR of “A” option from 100 to 10, and the effects on rate of aggressive responding, waits for detailed within-subjects examination.

## Conclusion

Previous reviews of the PSAP (Cherek et al., 2003; Cherek & Steinberg, 1987; Cherek et al., 2006; Geniole et al., 2017; Kelly & Cherek, 1993) synthesized research findings on aggression or have discussed it (Tedeschi & Quigley, 1996, 2000) without discriminating the different PSAP versions. When analyzing the contingencies present in such investigations, six possible arrangements were found. They are distinguished by (1) the number of aggressive and nonaggressive responses options; (2) consequences for aggression (positive and negative reinforcement operations); and (3) availability of an exclusive escape response. These characteristics have differential effects on the measurement of aggression in the context of the task, as the different versions involve different controlling variables.

The implementation of the PSAP in future studies can benefit from the information gathered here when choosing or adapting the most appropriate versions to the research questions. Several aspects of the PSAP, however, have yet unknown effects on the measured responses. In some of their versions, there was no remarkable difference regarding the measurement of aggression based on the changes in the contingencies surrounding it; in others, the changes may have involved overlapping behavioral processes. Empirical tests were pointed out as possible ways to further explain the effects of such contingencies. Refinements to the task may provide it with more accurate measurement of the type of aggression assessed through it, as well as its control sources. Additional research on topics related to aversive control of behavior have been suggested to better understand the basic processes involved (e.g., Fontes & Shahan, 2021).

Finally, a potential limitation of this review is the method of selection of material for examination. The analysis

emphasized the identification of methodological aspects and contingencies of reinforcement, which were not always described in detail by the investigations examined, as most of them were not published in behavior analysis journals. This characteristic may have excluded some works from this exam and, hypothetically, other versions for the PSAP. When using the Boolean term NOT in the search string for specific terms, some records may also have been overlooked. The emphasis on reports that first published a version of the task may have also biased the analysis and privileged some discussions to the detriment of others.

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