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Saunders, Kathryn J.; Fowler, Stephen; Pitts, Raymond C.
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TRANSITIONS FROM RICH-TO-LEAN SCHEDULES INCREASE ATTACK IN A LABORATORY MODEL OF SOCIAL AGGRESSION IN PIGEONS: I. FIXED-RATIO SCHEDULES

LAS TRANSICIONES DE PROGRAMAS RICOS A POBRES AUMENTAN EL ATAQUE EN UN MODELO DE LABORATORIO DE AGRESIÓN SOCIAL EN PALOMAS: I. PROGRAMAS DE REFORZAMIENTO DE RAZÓN FIJA.

Dean C. Williams, Yusuke Hayashi, Adam Brewer, Kathryn J. Saunders,
Stephen Fowler
University of Kansas
Raymond C. Pitts
University of North Carolina Wilmington

Abstract

Two pigeons key pecked under a two-component multiple fixed-ratio (FR) FR schedule. Each component provided a different reinforcer magnitude (small or large) that was signaled by the color of the key light. Large- (rich) and small- (lean) reinforcer components randomly alternated to produce four different types of tran-

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Dean C. Williams, Kathryn J. Saunders, Stephen Fowler University of Kansas, Yusuke Hayashi, now at Pennsylvania State University, Hazleton, Adam Brewer, now at Western Connecticut State University, Raymond C. Pitts, University of North Carolina Wilmington

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sitions between the size of the immediately preceding reinforcer and the size of the upcoming reinforcer: lean-to-lean, lean-to-rich, rich-to-lean, and rich-to-rich. During probe sessions, a mirror (which was covered during baseline sessions) was uncovered and attack responses toward the mirror were measured, along with the force of individual mirror attacks. The pigeons paused the longest, and attacked most frequently during the rich-to-lean transitions. The pigeons also exhibited some attacks during lean-to-lean transitions, and pauses were longer during these transitions than during the lean-to-rich and rich-to-rich transitions. Pauses were short and attack infrequent during these last two transition types. In addition, attacks were more forceful during the rich-to-lean transitions than during the other transition types. These data are consistent with the view that rich-to-lean transitions function aversively and, as such, generate behavior patterns, including aggression, commonly produced by other aversive stimuli.

Key words: Aggression, aversive stimuli, elicited behaviors, fixed-ratio schedules, rich-to-lean transition, incentive shift, behavior problems, pigeon

Resumen

Dos palomas picotearon una tecla bajo un programa múltiple de dos componentes, razón fija-razón fija. Cada componente proporcionó una magnitud de reforzamiento diferente (pequeña o grande) que se señaló por el color de la luz de una tecla. Los componentes de reforzamiento grande (rico) y pequeño (pobre) se alternaron aleatoriamente para producir cuatro tipos diferentes de transiciones entre el tamaño del reforzador inmediatamente anterior y el tamaño del reforzador siguiente: pobre a pobre, pobre a rico, rico a pobre y rico a rico. Durante las sesiones de prueba, se colocó un espejo (que se cubrió durante las sesiones de línea base) y se midieron las respuestas de ataque hacia el espejo, junto con la fuerza de los ataques de espejo individuales. Las palomas se detuvieron por más tiempo y atacaron con mayor frecuencia durante las transiciones de componentes ricos a pobres. También se observaron algunos ataques durante las transiciones de componente pobre a pobre, y las pausas fueron más largas durante estas transiciones que durante las transiciones de pobre a rico y de rico a rico. Las pausas fueron cortas y los ataques no fueron frecuentes durante estos dos últimos tipos de transición. Además, los ataques fueron más contundentes durante las transiciones de rico a pobre que durante los otros tipos de transición. Estos datos son consistentes con el argumento de que las transiciones de rico a pobre funcionan de manera aversiva y, como tal, generan patrones de comportamiento, incluida la agresión, comúnmente producidos por otros estímulos aversivos.

Palabras clave: agresión, estimulo aversivo, conductas elicitadas, programas de razón fija, transición rico-pobre, cambio de incentivo, conductas problema, palomas.

Aggression is an important social behavior in all vertebrate animals, including humans. However, the scope of behavior studied as aggression makes its study as a unitary construct impossible (Olivier & Young, 2002; Ramirez, 2000; Scott, 1992). Within-species responses described as aggression often serve important social functions (e.g., communication) and can present as highly stylized, even ritualistic, responses of dominance and submission that rarely result in injury (Lorenz, 1964). In the study of social behavior and its evolution in individual species, aggression is a necessary research topic. The study of human aggression is complicated by humans' unique, social repertoires, especially verbal behavior, as well as the heterogeneous topographies afforded to humans, ranging from verbal abuse to the use of lethal weapons (Ramirez, 2000). The study of social behavior of nonhuman species, including aggression, also is fraught with potential problems for generalizing to behavior in their natural "habitats." The complexity of the theoretical literature suggests that no single model can address all forms of aggression.

It is common to differentiate two broad classes of human aggressive behavior: operant (instrumental) and "frustrative", "irritable", or "impulsive" aggression (Chichinadze, Chichinadze, & Lazarashvili, 2011; Veenema, 2009). Operant aggression is learned through its consequences, motivated by deprivation or aversive stimulation and occasioned by discriminative stimuli. Irritable aggression is controlled by antecedent or contextual environmental events. Irritable aggression is of interest, as it is implicated in many forms of human, pathological behavior (e. g., Evans et al., 2017; Jensen et al., 2007; Robb, 2010).

A number of animal-laboratory procedures have been used to model irritable aggression. Painful stimuli (e.g., electric shock) reliably produce intense and sustained attack in a variety of species (e.g., Azrin, Hutchinson, & Hake, 1963; Azrin, Ulrich, Hutchinson, & Norman, 1964; Ulrich & Azrin, 1962; Ulrich, 1966). Of course, these stimuli also serve aversive functions under a variety of conditions (e.g., punishment and negative reinforcement). Use of painful stimuli, particularly electric shock, has been criticized as a model for naturally occurring aggression because some responses lacked ecological validity in rats such as rearing rather than biting (e. g., Blanchard & Blanchard, 1984), but other procedures also can produce intensive aggressive responses similar to those produced by shock (see Hutchinson, 1983; Viken & Knutson, 1992). In particular, signaled periods of extinction of operant behavior reliably produce aggression in a variety of species, including humans (e.g., Azrin, Hutchinson, & Hake, 1966; Lerman, Iwata, & Wallace, 1999; Thompson & Bloom, 1966). Intermittent schedules of positive reinforcement also can produce aggression. Most notably, fixed-ratio (FR) schedules reliably induce aggression (e.g., Cherek & Pickens, 1970; Flory, 1969; Gentry, 1968). The aggression induced under FR schedules occurs during the period of nonresponding after reinforcement, labeled the postreinforcement or preratio pause (PRP). This period appears to be functionally similar to extinction. Animals also emit escape responses that turn off the discriminative stimuli for FR reinforcement schedules during the PRP, indicating that this postreinforcement period has aversive properties (Appel, 1963; Azrin, 1961; Dardano, 1973).

Using a multiple FR FR schedule, Perone and Courtney (1992) demonstrated that the duration of the PRP was controlled by properties of both the past and upcoming reinforcer. The FR schedules were the same in both components, but the magnitude of the reinforcer was 1-s access (here after, a *lean* condition) in one component and 7-s access to grain in the other (hereafter, a *rich* condition). The components changed unpredictably after each reinforcer. Thus, there were equal numbers of the four types of transitions--a rich component could follow a lean component (rich-lean), a lean follow a rich (lean-rich, a lean follow a lean (lean-lean), or a rich follow a rich (rich-rich). Median pause durations were substantially longer during transitions from the rich to the lean reinforcer compared to the other three. Thus, the rich-lean transition increased pause duration greater than seen in other transitions. This effect is also called incentive contrast (See Flarhatey, 1986; Rosas et al., 2007). Increased pausing cannot be attributed to either the lean reinforcer itself (longer rich-lean pausing than lean-lean pausing) or to aftereffects of the rich reinforcer, such as local satiation (rich-lean pausing was longer than rich-rich pausing). This rich-to-lean effect has been replicated in rats (Brewer, Johnson, Stein, Schlund, & Williams, 2017; Galuska & Yadon, 2011), monkeys (Galuska, Wade-Galuska, Woods, & Winger, 2007), and humans with intellectual and developmental disabilities (IDD) (Bejarano, Williams, & Perone, 2003; Hayashi, Hall, & Williams, 2013; Williams, Saunders, & Perone, 2011). In addition to manipulations of reinforcer magnitude, rich-to-lean effects also occur with manipulations of ratio size (Baron & Herpolsheimer, 1999; Brewer et al., 2017), response force (Wade-Galuska, Perone,

& Wirth, 2005), and reinforcement delay (Harris, Foster, Levine, & Temple, 2012) as well as with reinforcers other than food (Galuska, Wade-Galuska, Woods, & Winger, 2007), money (Williams, Saunders, & Perone, 2011) and high vs low preference items (Jessel, Hanley, & Ghaemmaghami, 2016). Because this phenomon can be generated by transitions between high- and low-value conditions other than reinforcer magnitude, (thus the common nomenclature of rich and lean instead of large-small).

Escape responding also is a function of the PRP context on FR schedules (e. g., Azrin, 1961), and is increased during rich-lean transitions under multiple schedules (Perone, 2003; Retzlaff, Parthum, Pitts, & Hughes, 2017). Retzlaff et al. (2017) arranged the same multiple schedule procedure as Perone and Courtney (1992), but with an added "escape" key. Responses to the added key initiated a timeout during which the houselight was turned off, the food keys darkened, and the FR schedule was suspended. A second response reinstated the schedule and stimuli. Pigeons pecked the escape key most frequently during the rich-lean transitions and pause duration also was extended. Perone (2003) also reported increased escape responding during rich-lean transitions and both pausing and escape increased as a function of the ratio requirement. These results indicate that the post-reinforcement contexts of the discriminable shifts from the rich to lean reinforcers were more aversive than for the other three transition types, and that pausing, and escape might be functionally similar as indicators of the aversive properties of the stimulus context.

If the rich-to-lean transition increases the aversive properties of the FR schedule, it may also increase the likelihood of engaging in aggressive behavior (i.e., schedule-induced attack), and be a model of irritable aggression. Pitts and Malagodi (1996), showed that richer reinforcement maintained higher levels of attack in pigeons induced by fixed-interval (FI) schedules. This seems inconsistent with the idea that schedule-induced attack is generated by aversive stimulation, because pigeons strongly prefer schedules arranging richr reinforcers than those arranging lean ones (e. g., Neuringer, 1967). Pitts and Malagodi reasoned that the transitions from periods of reinforcement to periods of nonreinforcement under intermittent schedules of reinforcement inevitably involve signaled extinction (also see Dews, 1969), analogous to that occurring during the PRPs during transitions from the rich-to-lean reinforcement conditions reported by Perone and Courtney (1992). If nonreinforcement periods following a rich reinforcer were more aversive than those following a lean reinforcer, this may have resulted in more attack under the rich reinforcer condition.

Pitts and Malagodi (1996) manipulated reinforcer magnitude across conditions but did not directly arrange rich-to-lean transitions within sessions. In the present experiment, attack by pigeons was investigated as a function of the four transition types used by Perone and Courtney (1992). Given the functional similarity between pausing and escape under *single* FR schedules, and the rich-to-lean effects under *multiple* FR schedules, it is reasonable to predict that rich-to-lean transitions will induce more attack than the other transition types. Such information might lead to a better understanding of the conditions under which irritable aggression occurs in both normal and pathological behavior.

Method

Subjects

Two, experimentally naïve, White Carneau pigeons were housed individually in a temperature-controlled room with a 12:12 hour light/dark cycle. Health grit and water were continuously available. They were maintained at 85% of their free-feeding weights throughout the experiment, with supplemental feedings after sessions as necessary.

Apparatus

Experimental sessions were conducted in an operant chamber 39.4 cm high, 59.7 cm wide, and 62.2 cm deep. Two response keys, 2.5 cm in diameter, were mounted on the solid back panel, 16.5 cm apart and 19.1 cm from the floor. Only the left key was used. The key was transilluminated by projectors (ENV-130M, MED Associate, St. Albans, VT). A pigeon pellet feeder, outfitted with photocell pellet-detectors (Pinkston, Ratzlaff, Madden, & Fowler, 2008), dispensed 45-mg food pellets into the 6.4 cm x 6.4 cm recessed receptacle located 5.1 cm above the floor. The receptacle was illuminated during pellet delivery. Another photocell in the feeder detected the pigeon's head in the receptacle. A 24.1 cm x 12.1 cm mirror was mounted vertically on the left side wall, 3.8 cm from the ceiling and 3.8 cm from the front panel. Except in attack-probe conditions, the mirror was covered with a light, cardstock, cardboard panel. Two isometric force transducers (Model 31a, Sensotec, Columbus, OH) were attached to the back of the mirror (top and bottom). Voltages from the transducers were amplified and read by a Labmaster 8-bit, analog-to-digital converter (Scientific Solutions, Mentor, OH) at a 200 Hz sample rate. A 28-VDC houselight on the ceiling was lit throughout the session. The transducers produced a wave-like output where a response was recorded when mirror contacts exceeded the force detection threshold (5g), rose to peak force, then decreased below threshold (see Fowler, 1987 for a detailed description of this response definition). White noise masked extraneous sounds. Custom software recorded mirror pecks. All other experimental events were controlled and recorded with MED-PC software and interfacing.

Procedure

Multiple-schedule training. Sessions were conducted 7 days per week. Key pecking was autoshaped (Brown & Jenkins, 1968), after which the pigeons were exposed to a two-component multiple schedule with the same FR requirement and reinforcer magnitude (4 pellets) in each component. The components differed only in key color (red or green). Details of component sequencing were as described in Perone and Courtney (1992). Components changed quasirandomly such that there were 10 of each transition type per session (e.g., red-red, red-green, green-green, and green-red). A new component started when the pigeon's head was removed from the hopper for at least 1 s after the delivery of the last pellet. A session lasted for 41 components or until 120 min had elapsed.

The FR requirement was increased gradually, as long as all 41 components were completed within the 120-min session, until stable pause-respond patterns were obtained (FR 55 and FR 80 for Pigeons 44 and 68, respectively). Then, disparity in reinforcer magnitude was introduced. Seven pellets were delivered for completing the response requirement when the key was red (rich component), and 1 pellet when the key was green (lean component). This arrangement yielded 10 transition types with respect to reinforcement magnitude: lean-to-lean, lean-to-rich, rich-to-lean, and rich-to-rich. During this phase, both pigeons began pecking the mirror, but pecking gradually decreased across sessions to low levels. To promote recovery of attack, we covered the mirror was then covered with the cardboard panel to prevent the pigeons from seeing their reflected image during baseline sessions and introduced the uncovered mirror only during “attack probe” sessions. The covered mirror could still detect pecks for analysis, however.

Attack Probes. Because of the decrease in attacks across sessions, the mirror remained covered while key pecking and pausing stabilized. Attacking was measured during probe sessions; the cardboard cover was removed prior to the start of the session. Probe sessions were conducted four times during the experiment, each after at least 60 transitions of each type were completed (i.e., a minimum of 6 sessions) with the mirror covered, and the number of responses to the covered mirror was stable, as judged by visual inspection. Probe sessions were identical to baseline sessions except that the mirror was uncovered. Probes continued until at least 10 of each transition type were presented. Thus, if the pigeon did not complete all 41 components in one probe session (sessions ended after 120 min. or 41 components), a second probe session occurred the next day. For example Pigeon 44 completed only 31 transitions in 120 min on the first session of probe 4, so a second probe session was conducted, and the first 3-lean-lean, 3-rich-rich, 3-lean-rich, and 4-rich-lean transitions were combined with data from the first session for analysis. Between the second and third attack probes the schedule requirement was increased to FR 110 and FR 160 for Pigeons 44 and 68, respectively, across several sessions, because of decreasing attack rates.

Results

Figure 1 shows pause duration (measured from component onset to the 5th response to the food key) as a function of transition types with the mirror covered (hereafter, *baseline*) and with the mirror uncovered (probes). For Figures 1 through 3, data from the baseline condition are a pool of the last 10 components of the four transition types before each probe session. These data came from the session immediately prior to a probe session, if all 41 components were completed in that session. If all components were not completed, sufficient data were drawn from the end of previous sessions to provide data from 10 of each transition type. Data from the four probe conditions are also pooled. Therefore, each bar in Figure 1 represents the mean from 40 transitions (10 transitions from each of the 4 baseline or probe sessions). Under both the baseline and probe conditions, pause duration was longer when the key color signaled the upcoming lean reinforcer (lean-to-lean and rich-to-lean transitions). Moreover, pause duration during the lean components was substantially longer when the past reinforcer was rich (rich-to-lean transition) than when it was lean (lean-to-lean transition). For both pigeons, pausing was longer under the baseline condition (covered mirror) than under the probe condition.

The peak force of mirror contacts (pecking and ancillary contacts) detected by the mirror transducers ranged from 10 g (the minimum detectable) to 828 g (P44) and 782 g (P68). Peak force was measured by the maximum force of each "re-

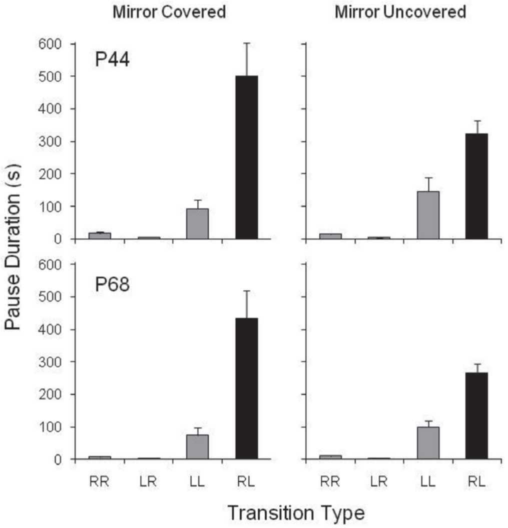

Figure 1. Mean pause durations as a function of transition types with the mirror covered (left panel) and uncovered (right panels). The error bars represent the standard error of the mean. The abbreviations on the x-axis, RR, LR, LL, and RL, refer to rich-to-rich, lean-to-rich, lean-to-lean, and rich-to-lean, respectively.

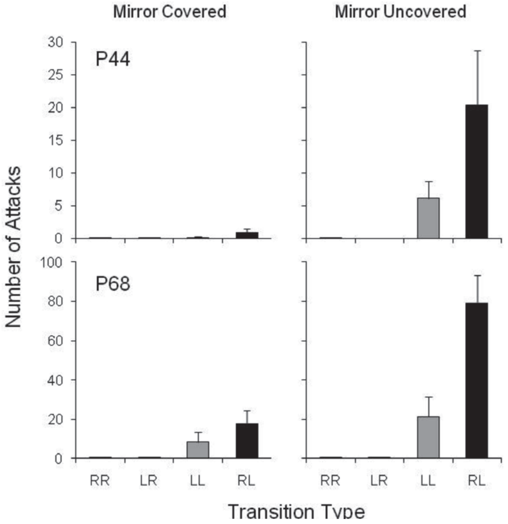

Figure 2. Mean number of attacks per component as a function of transition types with the mirror covered (left panel) and uncovered (right panels). The details are the same as in Figure 1.

sponse," The majority of recorded mirror responses were under 50 g. Observation of sessions indicated that these low-force events were associated with responses other than pecking, such as wing flapping and walking in circles. These other responses were recorded both when wing and tail feathers contacted the mirror and in the absence of contact with the mirror (presumably from vibrations transmitted from

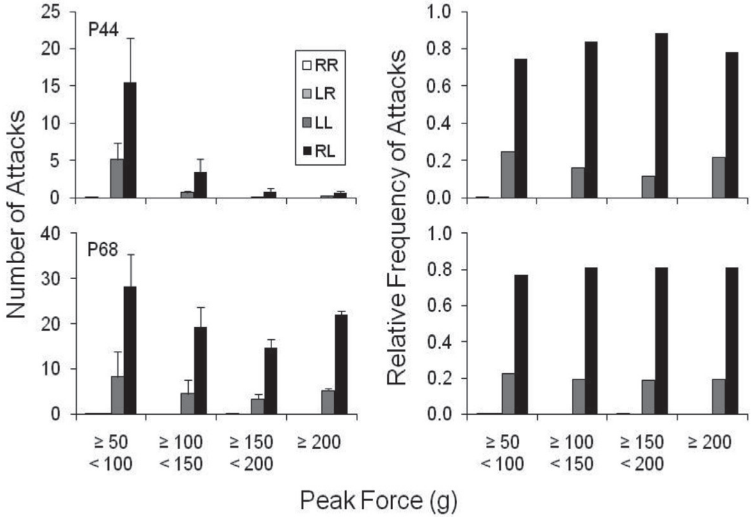

Figure 3. Mean number of attacks per component (left panels) and relative frequency of attacks (right panels) as a function of their peak force in 50 g bin sizes during the probes. Other details are the same as in Figure 1.

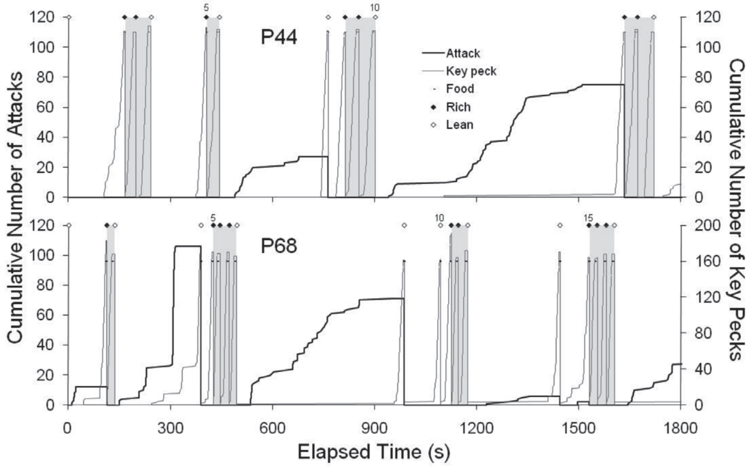

Figure 4. Cumulative number of attacks (bold black line, plotted on the left x-axis) and keypecks (gray line, plotted on the right x-axis) during the first 30 min of the last probe. The numbers reset to zero immediately before an onset of the next component. Short horizontal bars represent food delivery. Closed and open diamonds indicate an onset of rich and lean components, respectively. The numbers above the diamonds represent component numbers. Gray areas represent periods in which a rich signal was presented.

the chamber walls). These considerations led to a definition of attack responses as events with peak forces of at least 50g. These occurred only when a ballistic movement of the beak, or occasionally the breast, made contact with the mirror.

Figure 2 shows the mean number of attacks per component as a function of the four transition types during the baseline and probe conditions. Like the pause duration shown in Figure 1, attacks occurred almost exclusively in lean components, and substantially more attacks occurred in lean components following rich components (rich-to-lean transitions). Responses to the covered mirror occurred, but they were much less frequent than those to the uncovered mirror.

Figure 3 shows attack responses under the probe condition as a function of peak force in 50-g bin sizes (i.e., responses with peak forces of 50 g to 99 g, 100 to 149 g, 150 to 199 g, and 200 g and greater). The left panels show the mean number of attacks for each of the four transition types as a function of the peak-force bins. Across all force levels, attacks occurred almost exclusively in lean components, and more attacks occurred in lean components following rich components than in lean components following another lean component. The right panels of Figure 3 show the relative frequency of attacks during each transition as a function of the peak-force bins (i.e., the distribution of attacks across the four types of transitions). Approximately 70% to 80% of attacks occurred in the rich-to-lean transition for both birds across all force bins, with the remainder occurring in lean-to-lean transitions. Again, almost none occurred in a rich component.

Figure 4 shows cumulative number of attacks and key pecks during the first 30 min of the last probe. These temporal patterns are typical of responding for all probes. Key pecking in rich components (responses following a closed diamond under a gray area), on the one hand, was characterized by a very brief pause followed by a run of responses at a high and constant rate until food delivery. Key pecking in lean components (responses following an open diamond), on the other hand, was characterized by a longer pause followed by a run of responses at a high rate, with occasional pauses interspersed during a run (e.g., the 10th and 1st components for P44 and P68, respectively). Pigeon P68 showed a different pattern in some components: responding immediately after the component onset and then pausing for a long period. This pigeon sometimes started pecking the key while it was still dark, and thus before control by the signal for the upcoming reinforcement condition was possible (the key was not illuminated until 1 s after the head was removed from the hopper). This is the reason why pause duration is defined as the time from the component onset to the occurrence of the fifth key peck.

The majority of attacks occurred during the pause periods following food delivery. With all components pooled over the four probe conditions, 71.6% and 82.1% of attacks occurred before the fifth key peck for P44 and P68, respectively. Once attack started, it continued at a moderate rate with an occasional pause, which was followed by a period with no attack before key pecking was initiated.

Discussion

The primary purpose of this experiment was to determine whether the transition from rich-to-lean reinforcement conditions would produce increased levels of attack during the post reinforcement period on fixed ratio schedules. Under a multiple schedule with rich and lean components alternating unpredictably, both pigeons attacked almost exclusively when the upcoming reinforcement condition was lean. Moreover, the pigeons attacked most frequently in lean components that followed rich components. This pattern of attacking is similar to that of pausing: pause duration was the longest in the rich-to-lean transitions.

Comparing the frequency of attack between the rich-to-lean and lean-to-lean transitions indicates that attack is not under the exclusive control of the reinforcement condition in effect at the time. Rather, it is controlled by the transitions between reinforcement conditions. Thus, the lean reinforcement condition is not inherently aversive. It is the context that creates the aversiveness: the lean reinforcement condition, which by itself maintains sufficient responding, produces attack and extended pausing when it follows the rich condition (i.e., the rich-to-lean transitions). This is consistent with the results with simple schedules of reinforcement that attacks tended to occur during the early periods of the fixed interval when reinforcement conditions transitioned from relatively favorable to unfavorable (Pitts and Malagodi (1996). As mentioned previously, a lean component following a rich component in the present experiment would be functionally similar to the period of nonreinforcement following a food delivery in Pitts and Malagodi (1996). In both cases, there was a moment in which reinforcement conditions transitioned from relatively favorable to less favorable, and this negative incentive shift is interpreted as an aversive event that produced attack. This is in general agreement with previous theories of induced attack, stating that aversive aftereffects of reinforcement presentation generate schedule-induced attack (e. g., Azrin, Hutchinson, & Hake, 1966; Killeen, 1975; Solomon & Corbit, 1974).

A traditional account of schedule-induced attack is that it is adventitiously reinforced by periodic food delivery (Reynolds, Catania, & Skinner, 1963) There is, however, little evidence for this account in the line of research discussed here. Specifically, the temporal patters of attacking shown in Figure 4 indicate no attack occurred immediately prior to the pigeons' completion of the FR requirement (i.e., attack was never followed by food). The same patterns of responding were observed during the baseline condition (not shown). Therefore, it is unlikely that attack to the covered mirror was maintained by adventitious reinforcement.

It is possible that mirror pecking was a form of schedule-induced behavior unrelated to the specific social stimuli. The social nature of mirror pecking, however, is suggested by the differences in pecking to the covered mirror and the reflective mirror. There was some level of pecking to the nonreflective, covered mirror. Although the data are not shown, the force transducers allowed measurement of the location as well as the force of the pecks. Covered mirror pecks were concentrated around the periphery of the mirror, while pecks to the uncovered mirror were concentrated in the area corresponding to the images' breast area. In addition, in previous research, the topography and temporal pattern of mirror responding was comparable to the responding on the live and stuffed pigeons in the context of schedule-induced aggression (Cohen & Looney, 1973). Taken together with the findings of observational studies showing that various birds exhibit aggression toward the reflective surfaces as a defense of territory (Gallup, 1968; Lorenz, 1964), it is likely that the response to the mirror can be interpreted as aggressive behavior toward the image.

To our knowledge, no previous experiment has reported peak force as a dimension of attack in the context of schedule-induced attack, perhaps due to the technological challenges of its measurement. The analysis of the relative frequency of attacks as a function of the peak force (right panels of Figure 3) is of significance for at least for two reasons. First, the analysis reveals which dimension of attack behavior is sensitive to effects of discriminable transitions of reinforcement conditions: the transitions affect frequency of attacks but not their peak force. Second, the analysis of attacks as a function of their peak force is important from a methodological perspective. Previous experiments have defined attack with various amounts of force requirement, ranging from 10 g (Yoburn, Cohen, & Campagnoni, 1981) to 127.5 g (Pitts & Malagodi, 1996). The present results demonstrate that the functional relation between the transitions of reinforcement conditions and attack behavior holds across force requirements greater than 50 g.

In this experiment, a probe procedure was used in which the mirror was covered during the majority of sessions. This was done because mirror pecking decreased sharply across the initial sessions, and the probe procedure (i.e., making access to the mirror periodic rather than continuous) was used to maintain high rates of attack. Other experiments have demonstrated that mirror attack is more robust than in the present study (e.g., Ator, 1980). This discrepancy could be a function of the multiple schedule of rich and lean reinforcers rather than simple schedules of constant reinforcer value. Another possibility is that the relatively low level of mirror attack may be due to the size of the chamber. The present chamber was considerably larger (59.7 cm wide, and 62.2 cm deep) than those used in previous mirror pecking studies that also employed multiple FR-FR schedules (approximately 35 X 35 cm, see Ator, 1980; Cohen and Looney, 1973). Larger chambers have been shown reduce irritable aggression but not territorial aggression in rats (e. g., Thor, 1976).

Schedule-induced aggression may be a more ecologically relevant model for human irritable/ impulsive/ frustrative aggression than models that use painful-noxious aversive stimulation. In many social situations that nonetheless produce aggression in humans, there is no obvious, physical noxious, or painful stimulation. Increased induced behaviors during transitions from rich-to-lean reinforcement conditions may be the clue to the behavioral processes operating in such social situations and may have wide generality to the further study of pathological aggression in humans. Conditions such as depression, PTSD, attention-deficit-hyperactivity disorder, and autism are associated with high levels of irritable aggression and difficulties with unpredictable environments, as well as restricted interests and behavior patterns. Individuals with such neurobehavioral conditions may be especially sensitive to discriminable reductions in reinforcement—negative incentive shifts (Flaherty, 1996) or transitions from rich-to-lean reinforcement conditions (Perone & Courtney, 1992). The study of rich-to-lean transitions is an important translational research area, in which the basic behavior-analytic research can lead to insights to behavioral disorders (e.g., Williams, 2015). Although Perone and Courtney (1992) was conducted to understand why pigeons pause on fixed-ratio schedules, it has yielded insights into why typically reinforcing or benign events become aversive, resulting in behavioral disruption, maladaptive escape and avoidance behaviors, and social aggression.

The present experiment was conducted in the context of a translational research program on chronic aberrant behavior in individuals with intellectual disabilities. The guiding hypothesis of this program is that discriminable shifts from relatively favorable to less favorable reinforcement conditions (negative incentive shifts) are aversive and that interruption in responding occurs either in the form of escape, or disruption of responding by elicited emotional behaviors or aggression. Given the previous finding that individuals with IDD exhibited extended pausing during transitions from favorable to less favorable conditions in a procedure virtually identical to the present one (Williams et al., 2011), and that pause duration is an index of aversiveness of transitions as measured by escape behavior (e.g., Perone, 2003), it is possible that a similar behavioral process operates in individuals with IDD when they exhibit aberrant behaviors. Needless to say, the validation of the process similarity in pigeons and humans awaits further investigation. If process generality is confirmed, the potential for having an animal model with which to conduct research on both behavioral and pharmacological treatments that would not be possible in clinical settings could accelerate scientific progress in understanding and treating often-baffling irritable and aggressive behaviors. It is counterintuitive, and perhaps not widely understood among those who interact with affected individuals, that schedules of positive reinforcement can have aversive components

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