

Evaluation of an automated response-independent schedule on the behavioral welfare of shelter dogs

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Abstract

Response-independent schedules involve the delivery of an item independent of a response requirement. Often described in the applied behavior analytic literature as “noncontingent reinforcement” (NCR), they have also frequently been used to reduce undesired or problematic behaviors. The current study examined the use of an automated response-independent food schedule on the behaviors and sound levels of shelter dogs. Several dogs were included in a 6-week reversal design, where a fixed-time 1 min schedule was compared with a baseline condition. Eleven behaviors were measured, as were two areas of each kennel and the overall and session sound intensity (dB) that occurred during the study. The results demonstrated that the fixed-time schedule increased overall activity while decreasing inactivity and led to a reduction in the overall sound intensity measured. Session and hour-to-hour sound-intensity data were less clear, suggesting a potential contextual conditioning effect as well as a need for adjusted methods to study shelter sound. The above are discussed in terms of their potential welfare benefits for shelter dogs as well as the translational approach that this and similar research could contribute to the application and functional understanding of response-independent schedules.

KEYWORDS

animal welfare, applied animal behavior, behavior analysis, noncontingent reinforcement, response-independent schedules

Response-independent schedules, or schedules of some stimulus/event delivery (typically food) based on the passage of time rather than contingent on a response, have been used in both basic and applied research with both human and nonhuman animals. Theoretically, they were originally discussed as a form of adventitious or “accidental” reinforcement, producing superstitious behavior independent of any contingent response–reinforcer relationship (Skinner, 1948). Laboratory studies continued to focus on adventitious reinforcement explanations of behavior imposed by response-independent schedules, including those involving possible conditioned stimuli or transitions from response-dependent to response-independent schedules (Herrnstein & Morse, 1957; Lachter et al., 1971; Morse & Skinner, 1957; Neuringer, 1970). Alternatives to operant reinforcement-based explanations of behavior generated by response-independent schedules also emerged from laboratory

studies, including those reliant on learned (respondent) and unlearned (species-typical or niche-related) functions (Fernandez & Timberlake, 2020; Staddon & Simmelhaag, 1971; Timberlake & Lucas, 1985).

In applied settings, response-independent schedules have often been described as “noncontingent reinforcement” (NCR). Although some researchers have raised concerns with attempting to describe reinforcement in the absence of a contingency (see Carr, 1996; Poling & Normand, 1999; Staddon, 1992; Vollmer, 1999), the use of the term NCR and of such schedules to reduce aberrant or undesired behaviors have become commonplace (for reviews, see Carr et al., 2000; Ingvarsson & Fernandez, 2023). During the last couple of decades, applied research efforts involving response-independent schedules with animals have emerged including with a black vulture (*Coragyps atratus*;

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Morris & Slocum, 2019), polar bears (*Ursus maritimus*; Fernandez, 2010; Fernandez, 2021), and domestic dogs (*Canis familiaris*; Hall et al., 2015; Pfaller-Sadovsky et al., 2022; Protopopova & Wynne, 2015). Additionally, response-independent schedules have been used as an experimental control procedure in applied animal behavior research, contrasting the effects of non-contingent food with food delivered contingent on specific approximation steps in a shaping program (Fernandez, 2020; Fernandez & Rosales-Ruiz, 2020).

One of the primary purposes of using response-independent schedules in applied settings is the ease with which such schedules can be delivered. Because items or events are dispensed independent of any response requirement, any intervention protocol is simplified, particularly if combined with some form of automation. Historically, some of the first automatic mechanical food delivery devices used for applied animal behavior purposes involved behaviorally engineering zoo enclosures to reinforce desired responses in the exhibited animals (e.g., gibbons swinging to pull levers that produced food rewards), later described as a form of behavioral enrichment (Markowitz, 1978; Markowitz, 1982; for reviews, see Fernandez, 2022; Fernandez & Martin, 2021; Fernandez & Martin, 2023). Additional research attempts that involved automation included pet dogs and using a differential reinforcement of other behavior schedule to reduce barking (Protopopova et al., 2016) as well as using a remote food delivery device to reduce problem behaviors, such as barking or jumping, when people arrive at a home (Yin et al., 2008). In addition, Andrews and Ha (2014) used automated scatter feeds (food delivered via a hanging feeder) to decrease stereotypic activity (e.g., pacing and head swaying) in two grizzly bears (*Ursus arctos horribilis*). However, although their study used six repeated feedings delivered throughout the day, these were not set to standard intervals as is typically observed in response-independent schedules (i.e., fixed- or variable-time schedules), and the researchers measured all-day activity in the bears rather than changes based on the times during which the schedules were delivered.

The current study examined the effects of an automated response-independent food schedule on the activity and noise levels of shelter dogs. Behavior was examined at times before, during, and after introduction of the response-independent schedule, as well as in comparison with a baseline condition, or similar days and times when the food delivery devices were introduced but not activated. We predicted that the response-independent schedule would produce several positive welfare-related effects, including (1) increased activity or other desired behaviors; (2) decreased inactivity or other undesired behaviors; (3) increased area use near the automated food delivery devices; and (4) decreased noise, as observed through decibel (dB) measurements.

MATERIALS AND METHODS

Subjects and enclosures

Table 1 details the eight dogs that were included in the analyses of this study. Dogs D1 and D6–D8 (four dogs) were present during the length of the study, whereas D2–D5 (four dogs) were only present during the last 2 weeks of the study. Other dogs were present in the areas occupied by D2–D5 during the first 4 weeks of the study, but their results were not included in any analyses. All dogs in the study resided at the San Diego Humane Society (SDHS) Behavior Center in San Diego, CA, USA. The SDHS houses approximately 500 dogs at any given time (~13,000 annually), with ~30 dogs daily residing in the Behavior Center portion of SDHS. The dogs in our study were housed separately for the duration of our experiment in side-by-side single-housed kennels (see Figure 1), which were $1.90 \times 1.21 \times 2.77$ m. The kennels were located on the other side of the staff area of the Behavior Center, which could be viewed through windows separating the kennels and the rest of the center (see Figure 1, Observation Area). Each kennel was furnished with bedding, 1–3 nonfood enrichment items, and water bowls. Dogs that were located at the SDHS's Behavior Center were typically enrolled in some type of behavior modification program and not viewable by the public, thus their selection for our study. The dogs were typically fed two times per day with a diet that consisted of Purina One SmartBlend chicken and rice formula (dry kibble; ~450 mL). All food delivered during the experimental conditions of the study was taken from their normal diet (~75 mL). Any leftover food was given to the dogs in their afternoon ration. The dogs were removed from their kennels approximately two to three times per day, during which time they received routine behavior modification (e.g., body handling, leash walking) and access to off-leash time in an adjacent yard; they were walked, had interactions with caretakers, and if appropriate, were provided social interactions with conspecifics.

Materials

The materials included a clipboard and data sheets to record observations as well as a notebook to record potential errors and additional observations and field notes that occurred during a session. A Pet Tutor (Smart Animal Training Systems, LLC, Indianapolis, IN, USA) automatic feeding device was placed in each dog's kennel prior to the start of each session (Area A; see Figure 1) and was used to deliver food during portions of the study (see Design and Procedure below). Two sound meters (overall and session sound intensity meters; see Figure 1 and descriptions below) were also placed in the study area. The sound data were uploaded to a local laptop, and the sound meters did not move throughout the length

of the study. This meant that the sound meters could pick up general levels of activity including barking, dog movement, people entering the kennel area, and some noise that occurred outside of the kennel area.

Design and procedure

Prior to its implementation, the study was approved through San Diego Humane Society's Institutional Animal Care and Use Committee (IACUC #000009). An ethogram consisting of 11 total behaviors (see Table 2) was also developed prior to the implementation of the study. Ten of the behaviors were mutually exclusive, except for barking, which was coded as a possible addition

to another response. The inclusion of the “other” category also made the ethogram exhaustive. Four of the behaviors (eating/drinking, manipulating object, lying down, and standing/sitting) accounted for 94.29% to 97.62% of all observations. Therefore, they were the only behaviors examined in the latter results. In addition to behavioral observations, the dogs were coded for placement within their kennel (Area A or B; see Figure 1). A modified scan sampling procedure (Altmann, 1974) was used to record behaviors as pinpoint/momentary time samples every 1 min (Brereton et al., 2022). The dogs were observed in order, one at a time, from D1 to D8 and then in reverse, every minute and for the entire session (2 hr; see below). Thus, each dog was recorded once every 8 min, and a total of 120 samples was recorded per session (15 samples per dog).

Figure 2 details both the design (condition) and session (period) order. A single-case ABABAB reversal design was used for the following conditions:

Baseline (BL)—No food was delivered during the 2-hr observation session.

Fixed-Time 1 min (FT)—Food was delivered from the Pet Tutor every 1 min.

During the FT portion of the study, food was delivered automatically and independent of any response (it always occurred every 1 min). The BL and FT conditions ran as one session a day for 7 days (1 week) at a time, for a total of three presentations of each condition, back to back. Sessions typically began at 1200 hours and ran for 2 hr, with a Before, During, and After period of

TABLE 1 Details of all dogs included in the study

Dog ID	Name	Age	Intake date	Participation
D1	Luna Mae	11 Months	1/19/2022	Full 6 weeks
D2	Francisco	3.5 Years	4/05/2022	Last 2 weeks (sound only)
D3	Cooper	4.5 Years	11/04/21	Last 2 weeks (sound only)
D4	Tobi	1 Year 3 Months	11/14/2021	Last 2 weeks (sound only)
D5	Penelope	7 Months	3/29/2022	Last 2 weeks (sound only)
D6	Citrus	8 Months	12/26/2021	Full 6 weeks
D7	Soda	8 Months	12/26/2021	Full 6 weeks
D8	Lobo	1 Year 3 months	9/19/2021	Full 6 weeks

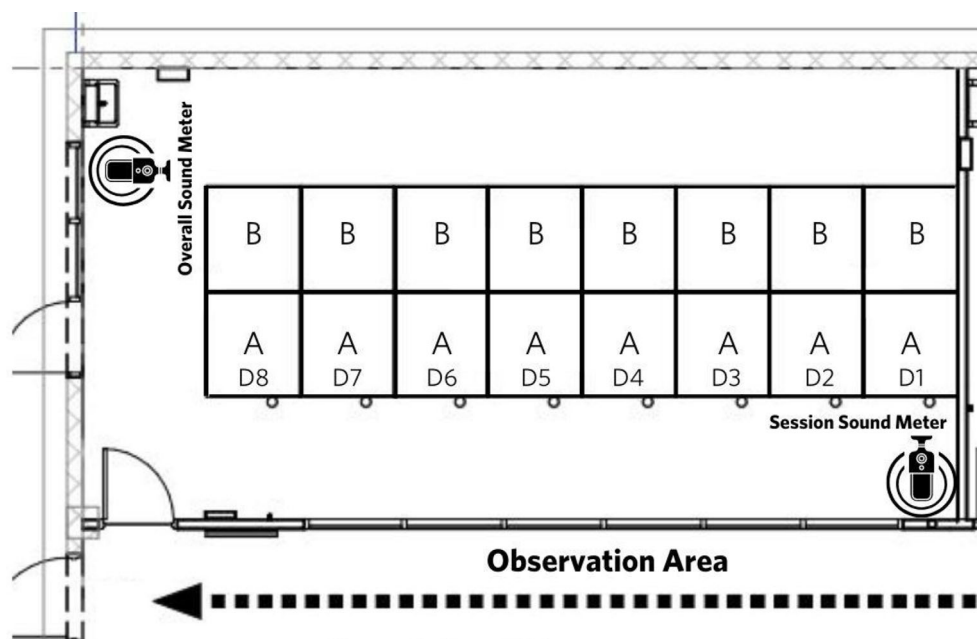


FIGURE 1 Diagram of the study area of the shelter; D1–D8 represent each kennel area. Letters A and B represent the two areas within each kennel where a dog could be coded during the study (Area A contained the Pet Tutor). Each fixed sound meter (overall and session) is noted.

TABLE 2 Behavioral ethogram

Behavior (Abbreviation)	Definitions
Locomoting (Lo)	Any movement that does not fall into another category (e.g., standing, jumping, or pacing).
Jumping/rearing (JR)	Vertical movement with at least two paws off the ground.
Eating/drinking (ED)	Mouth contact with an edible item (food or water).
Manipulating object (MO)	Mouth or paw contact with any nonedible object and with manipulation of the object (must occur without rearing).
Grooming (Gr)	Mouth or paw contact with own body.
Lying down (LD)	Most of the dog on the ground (no upright position) and with no movement.
Standing/sitting (SS)	Upright position with at least three paws and possible posterior on ground and with no movement.
Pacing (Pa)	Moving in a repetitive pattern, with at least one completion from one point to another and back.
Out of sight (OS)	Not visible to the observer.
Other (Ot)	Engaged in a behavior not listed above.
Barking (*)	Any vocalization. Must occur with other responses (is not mutually exclusive).

Note. Detailed behavioral inventory of the possible shelter dog responses including abbreviations used to code the response and the operational definitions for each behavior. The ethogram was exhaustive, and all behaviors were mutually exclusive, except for Barking (*), which had to occur with one of the other responses.

40 min each. Each 2-hr session consisted of three periods of observation:

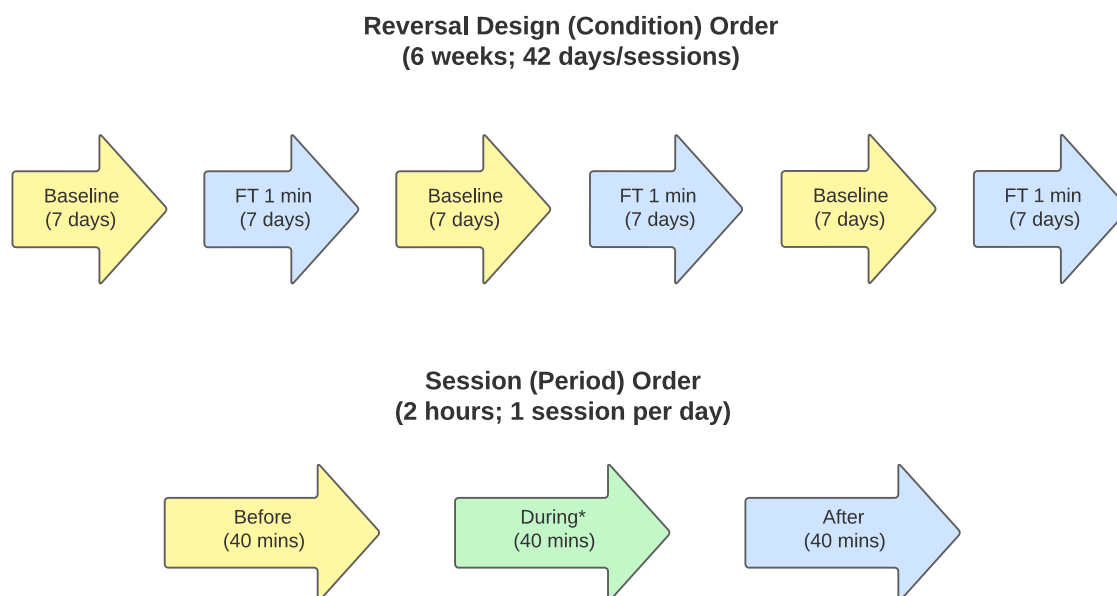
Before—40 min of observation prior to the food schedule (~1200–1240 hours).

During—40 min of observation during the food schedule (~1241–1320 hours).

After—40 min of observation after the food schedule (~1321–1400 hours).

The same periods of observation were used for comparison purposes between the BL and FT conditions. Thus, in the “During” period of the BL condition, no food was delivered, but still matched the same times of the FT condition when food was dispensed. A total of 40 food deliveries were dispensed in the During period of the FT condition (one delivery every minute).

To start a session, a researcher entered the kennel area and started the session sound intensity meter ~30 min prior to the start of the study. The same researcher would place one Pet Tutor in each of the kennels (Area A; eight total devices) and, for the FT condition, activate the Pet Tutor via cell phone to start at 1240 hours (start of During period). One to two observers were stationed outside the kennel area, where all eight dogs could be viewed. Sessions then began at 1200 hours and terminated at 1400 hours. The same procedure occurred regardless of condition, with the only distinction between BL and FT being the delivery of food in the FT conditions (the BL condition still received a Pet Tutor in the kennel prior to the start of the session).



*In the baseline condition's During period, no food is delivered (it is matched in time to the FT During period).

FIGURE 2 Design (condition) and session (period) order for the duration of the study. One session was run per day, and each session was 2 hr in duration. A total of 6 weeks (42 days) were run, with three introductions of each condition (ABABAB reversal design).

The entire study ran 7 days a week, from March 28, 2022, to May 8, 2022 (42 days). A total of 14 volunteers conducted all the observations. Only four of the dogs remained in the study area for the entire 6 weeks (D1 and D6–D8). Therefore, only their behavior and area use results were used in all behavioral analyses reported below.

Sound meter data were also recorded and analyzed for the final 2 weeks of the study (1 week of each condition), when the same eight dogs were present. Sound meter data were recorded based on two types of observations: overall sound intensity (dB), which recorded samples every 2 min for a 24-hr period (the last 2 weeks of the study; ~10,000 samples), and session sound intensity (dB), which recorded samples every 1 s for the 2-hr session time (~94,000 samples). The overall sound intensity recordings were used to compare overall differences in sound as well as the hour-to-hour comparisons. No comparisons were made between the overall and session meter data.

Statistical analysis and interobserver agreement

SigmaPlot, version 12.5 (Systat Software Inc., San Jose, CA, USA) was used to create all graphs and run all the statistical analyses. Because Shapiro–Wilk tests for normality or Levene’s test for homogeneity of variance failed, behavior and area use differences in the During period between the BL and FT conditions were conducted using Mann–Whitney *U* tests. Bonferroni corrections were applied to the behaviors (.05/4; $\alpha = .0125$) and area use (.05/2; $\alpha = .025$) separately, and only comparisons in the During period were made to minimize the number of corrections required. A *U* test was also used to compare the difference between the BL and FT conditions for overall sound intensity. Finally, a factorial (two-way) ANOVA was used to compare differences in the session sound intensity between the two conditions (BL and FT) and the three periods (Before, During, and After). Although the data failed a Komogorov–Smirnov test for normality and because of the large size of the data (>94,000 data points), we implemented a parametric test (Ghasemi & Zahediasl, 2012). When significant differences were observed, post hoc tests (Holm–Sidak method) and difference of means comparisons were made.

Interobserver agreement (IOA) was calculated live based on exact agreement (Poling et al., 1995) for 31% (13 of 42) of all sessions. Observers were randomly assigned to primary or IOA measurement based on availability of observers during that session (two observers max). The average IOA across all sessions was (97.37%), with a range of 92.5%–100%.

RESULTS

Figure 3 displays the session-to-session data in the During period for the four dogs (D1 and D6–D8) that were

present for the entire 6 weeks of the study (42 total sessions). Each graph represents the percentage of occurrence for the four analyzed behaviors (eating/drinking, manipulating object, lying down, and standing/sitting) for each of the dogs (from top to bottom: D1, D6, D7, and D8). The dogs showed similar trends in that lying down and manipulating object were more frequent in the BL conditions, whereas eating/drinking and standing/sitting were more frequent in the FT conditions. There appeared to be greater variability in the behaviors during the FT condition as well, particularly for dogs such as D7 that engaged almost exclusively in lying down during the BL condition.

Table 3 lists the individual average percentage of occurrence (with standard error of the mean) for the four dogs in the During period and for the entire 6 weeks of the study. Individual responses for the four behaviors analyzed are averaged across each of the BL and FT conditions. Both eating/drinking (ED) and standing/sitting (SS) increased for all four dogs (increased range: ED, 3.8%–19.1%; SS, 5.7%–19.1%) in the FT condition compared with the BL condition. Lying down (LD) decreased for three of the dogs (D1, D7, and D8; decreased range: 20.9%–38.1%) in the FT condition compared with the BL condition, and manipulating object (MO) decreased for two of the dogs (D1 and D6; decreased range: 7.6%–8.6%) in the FT condition compared with the BL condition.

Figure 4 shows the average occurrence (with standard error of the mean) of each of the four behaviors analyzed (eating/drinking, manipulating object, lying down, and standing/sitting) for all four dogs combined and across the entire study. The graphs compare differences between the two conditions (BL and FT) across the three session periods (Before, During, and After). eating/drinking was significantly greater in the During period for FT ($M = 13.57$, $SE = 2.04$) compared with BL ($M = 1.67$, $SE = 0.61$; $U = 2145.5$, $n_1 = n_2 = 84$, $p < .001$). Whereas manipulating object was greater in the During period of BL ($M = 8.57$, $SE = 2.12$) compared with FT ($M = 4.76$, $SE = 1.30$), this was not a significant difference ($U = 3353.5$, $n_1 = n_2 = 84$, $p = .425$). Lying down was significantly lower in the During period for FT ($M = 56.67$, $SE = 3.23$) compared with BL ($M = 76.67$, $SE = 3.25$; $U = 2163$, $n_1 = n_2 = 84$, $p < .001$). Finally, standing/sitting was significantly greater in the During period of FT ($M = 20.95$, $SE = 2.51$) compared with BL ($M = 10.48$, $SE = 2.10$; $U = 2513.5$, $n_1 = n_2 = 84$, $p < .001$).

Figure 5 displays the average occurrence (with standard error of the mean) of Area A and Area B use for all four dogs combined and across the entire study. Area A use was significantly greater in the During period of FT ($M = 92.86$, $SE = 2.02$) compared with BL ($M = 71.43$, $SE = 4.33$; $U = 2516$, $n_1 = n_2 = 84$, $p < .001$). As Area A increased in use in the During period of FT, use of Area B significantly decreased in the During period of

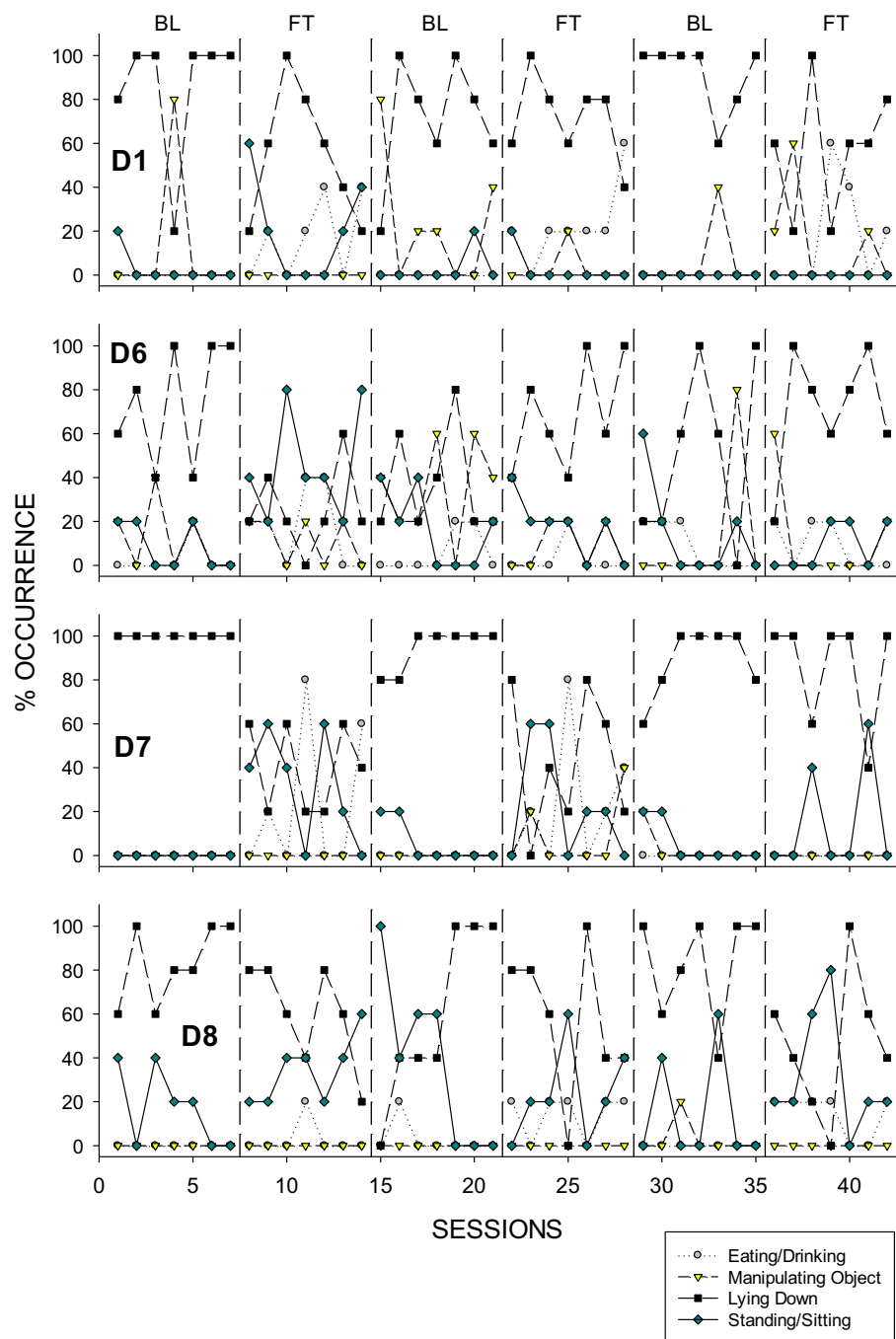


FIGURE 3 Session-to-session graphs for the individual four dogs (D1 and D6–D8) in the During period who experienced all 6 weeks of the reversal study. The four most frequent behaviors (eating/drinking; manipulating object; lying down; standing/sitting) are presented for the four dogs across the two conditions: baseline (BL) and fixed-time 1 min (FT).

FT ($M = 7.14$, $SE = 2.02$) compared with BL ($M = 28.33$, $SE = 4.34$; $U = 2554.5$, $n_1 = n_2 = 84$, $p < .001$).

Figure 6 shows the average (with standard error of the mean) overall and session sound intensity for the last 2 weeks of the study. The left figure shows the average decibel (dB) readings for the overall (24 hr) sound of BL compared with FT, whereas the right graph shows the session (2 hr) sound for all three session periods (Before, During, and After) across the two conditions (BL and

FT). There was a significant decrease in the overall sound intensity for FT ($M = 45.66$, $SE = 0.13$) when compared with BL ($M = 45.93$, $SE = 0.12$; $U = 10,699,803$, $n_{BL} = 5052$, $n_{FT} = 5040$, $p < .001$). For session sound intensity, there were significant differences observed for condition ($F_{1, 94314} = 4.562$, $p = .033$). There were also significant differences observed for the period of observation ($F_{2, 94314} = 525.658$, $p < .001$), as well as the interaction between condition and period ($F_{2, 94314} = 35.399$, $p < .001$).

TABLE 3 Mean percentage of occurrence (with standard error of the mean) for the four individual dogs (D1 and D6–D8) in the During period who experienced all 6 weeks of the reversal study

Dog	Condition	ED	MO	LD	SS
D1	BL	0 (0)	13.33 (5.58)	82.86 (5.57)	1.90 (1.31)
	FT	19.05 (4.25)	5.71 (3.13)	60.95 (5.77)	7.62 (3.51)
D6	BL	5.71 (19.05)	19.05 (5.43)	54.29 (7.32)	13.33 (3.74)
	FT	9.52 (2.97)	10.48 (3.27)	55.24 (6.89)	23.81 (5.09)
D7	BL	0 (0)	0.95 (0.95)	94.29 (3.81)	3.81 (1.76)
	FT	15.24 (5.84)	2.86 (2.09)	56.19 (7.12)	22.86 (5.57)
D8	BL	0.95 (0.95)	0.95 (0.95)	75.24 (6.46)	22.86 (6.37)
	FT	10.48 (2.23)	0 (0)	54.29 (6.35)	29.52 (4.70)

Note. Results are averaged for each dog across the two conditions—baseline (BL) and fixed-time 1 min (FT)—and for the four most frequent behaviors—eating/drinking (ED), manipulating object (MO), lying down (LD), and standing/sitting (SS) measured.

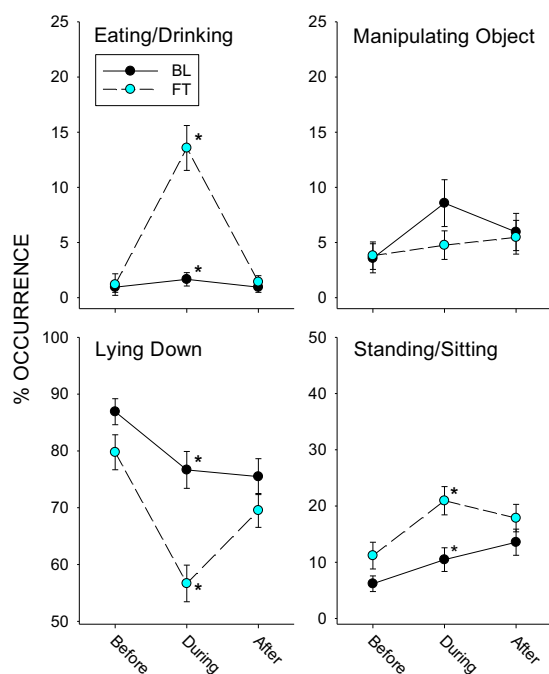


FIGURE 4 Combined averages (with standard error of the mean bars) for the four dogs (D1, D6, D7, and D8) across both conditions: baseline (BL) and fixed-time 1 min (FT). The four most frequent behaviors (eating/drinking; manipulating object; lying down; standing/sitting) are presented across all three periods (Before, During, and After). Significant differences in the During period ($p < .0125$) are represented by an asterisk (*).

Post hoc tests revealed significant differences between BL's Before and After periods ($t = 23.772$, $p < .001$), BL's During and After periods ($t = 23.782$, $p < .001$), FT's Before and During period ($t = 3.927$, $p < .001$), FT's Before and After period ($t = 17.556$, $p < .001$), and FT's During and After period ($t = 13.545$, $p < .001$). Post hoc tests also revealed that session sound intensity was significantly higher for FT compared with BL in the Before period

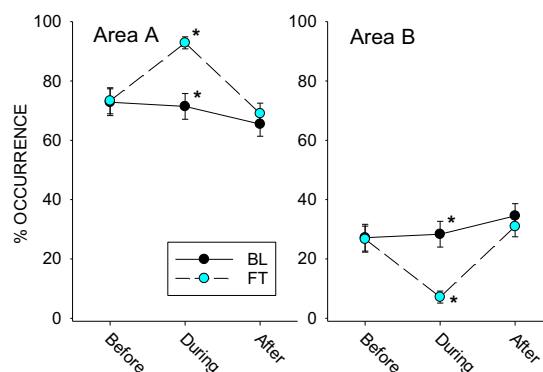


FIGURE 5 Combined averages (with standard error of the mean bars) for the four dogs (D1, D6, D7, and D8) across both conditions: baseline (BL) and fixed-time 1 min (FT). The two areas (Area A and Area B) are presented across all three periods (Before, During, and After). Significant differences in the During period ($p < .025$) are represented by an asterisk (*).

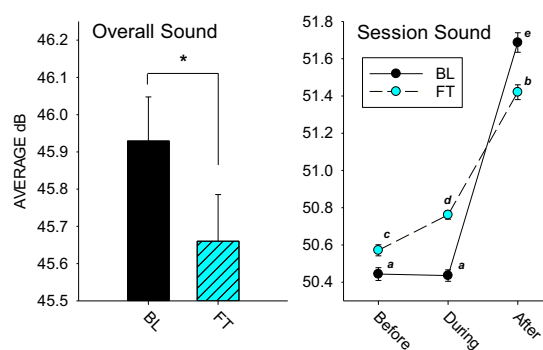


FIGURE 6 Average sound intensity (dB) recorded from two separate meters placed in the study area of the shelter: Overall sound intensity (2-min samples for 24 hr) and session sound intensity (1-s samples for the 2-hr observation period). The left graph shows the overall sound intensity difference averages (with standard error of the mean bars) across both conditions—baseline (BL) and fixed-time 1 min (FT)—for the last 2 weeks of the study. Significant differences ($p < .05$) are represented by the line and *. The right graph shows the average session sound intensity (with standard error of the mean bars) across all three periods (Before, During, and After) for the last 2 weeks of the study. Significant differences ($p < .05$) are represented by different letters (e.g., a to a = nonsignificant; a to b = significant).

($t = 2.55$, $p = .011$), During period ($t = 6.43$, $p < .001$), and After period ($t = 5.257$, $p < .001$). To better understand these differences, the means and difference of means were compared across the different conditions, periods, and their combinations (see Table 4). Table 4 also shows the means (with standard error of the mean) for the two conditions and three periods (six total scores) shown in Figure 5. Overall, the greatest differences occurred between the After period regardless of condition (BL and FT combined) and the Before period regardless of condition (difference of means = 1.05), followed closely by the difference of means between the After period regardless of condition

and the During period regardless of condition (difference of means = 0.96).

Finally, Figure 7 displays the average (with standard error of the mean) hour-to-hour sound intensity (dB) during the last 2 weeks for BL and FT. Overall

TABLE 4 Mean (with standard error of the mean) and difference of means for the session sound intensity (dB) conditions and periods

Mean	Mean	Difference of means
BL–Before	FT–Before	
50.44 (0.03)	50.57 (0.03)	0.13
BL–During	FT–During	
50.44 (0.03)	50.76 (0.02)	0.32
BL–After	FT–After	
51.69 (0.05)	51.42 (0.04)	0.27
BL (overall)	FT (overall)	
50.86	50.92	0.06
Before (BL & FT combined)	During (BL & FT combined)	
50.51	50.60	0.09
Before (BL & FT combined)	After (BL & FT combined)	
50.51	51.56	1.05
During (BL & FT combined)	After (BL & FT combined)	
50.60	51.56	0.96

sound intensities for both conditions were generally similar for each hour, with the overall trend showing the lowest recordings in sound intensity in the hours when people were typically not present (0000–0600 hours and 1800–2400 hours; average range = 42.25–44.68). Sound levels peaked in the morning at 0700–08:00 hours (BL: $M = 54.87$, $SE = 1.08$; FT: $M = 55.62$, $SE = 1.17$), which gradually declined to 1200–13:00 hours (BL: $M = 43.76$, $SE = 0.26$; FT: $M = 43.97$, $SE = 0.39$). The times of the study (1200–14:00 hours) showed lower sound intensity recordings (average range = 43.76–44.49), similar to the late evening/early morning hours when people were not present. Overall sound levels increased following the study periods for the final four hours of the typical workday at SDHS (1400–1800 hours; average range = 47.46–48.69).

DISCUSSION

Positive and negative behavioral welfare in shelters

All the dogs observed in the study exhibited increased standing/sitting, as well as increased eating/drinking in the During period of the FT condition compared with the BL condition. In contrast, lying down significantly decreased in the During period of the FT condition compared with the BL condition. Taken together, the increases in standing/sitting and eating/drinking and the

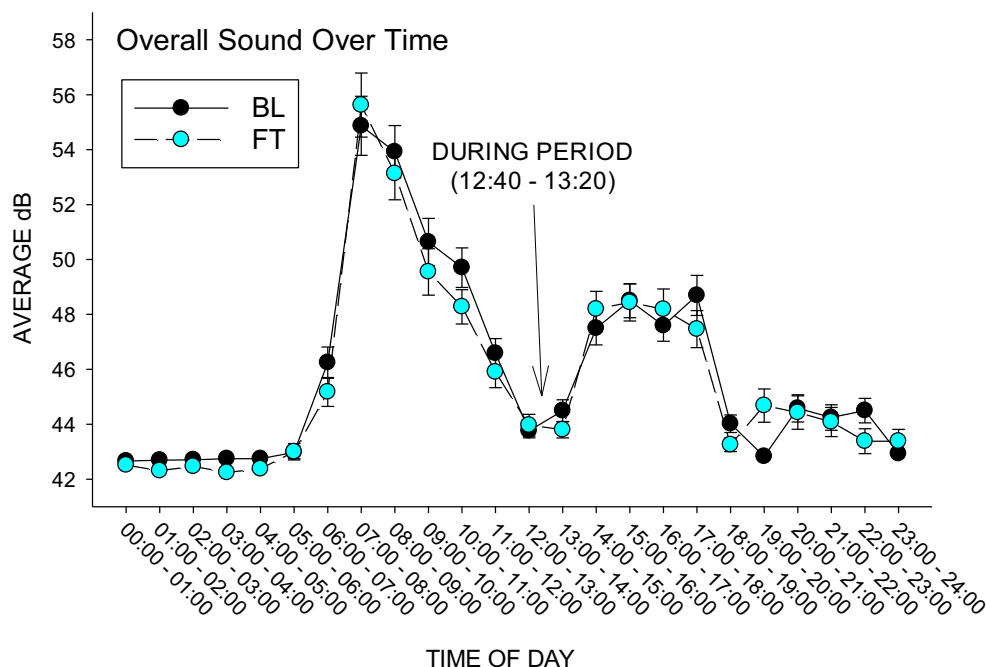


FIGURE 7 Average hour-to-hour sound intensity (dB, with standard error of the mean bars) recorded from the overall sound meter. Hour-to-hour samples (x-axis) are compared across both conditions—baseline (BL) and fixed-time 1 min (FT)—for the last 2 weeks of the study. Time of the During period (when the FT schedule was active and its equivalent BL time) is noted in the graph.

decrease in lying down can be viewed as an indication of positive welfare, as activity and inactivity represent positive and negative welfare, respectively (Yeates & Main, 2008). Greater variability in behaviors in the During period of the FT condition was also observed for most of the individually analyzed dogs. Although not directly assessed, this may indicate positive welfare commonly associated with increased behavioral diversity (Brereton & Fernandez, 2022; Miller et al., 2020). In short, increased desired behaviors and a greater display of a behavioral repertoire should identify as positive welfare for most companion animals, which is essential to directly evaluate in shelters.

The increased standing/sitting in the During period of the FT condition, as well as the increased Area A use can be viewed as a form of anticipatory behavior to feeding (Timberlake, 1993; White & Timberlake, 1995). The anticipatory behavior directed toward the feeding devices themselves can also be viewed as a type of sign- or goal-tracking, as they represent behavior directed toward stimuli associated with the feeding event (e.g., the Pet Tutor) or the food itself (Boakes, 1977; Nilsson et al., 2008). Anticipatory behavior has been discussed as a form of positive welfare for captive animals, often associated with an enriched environment (Watters, 2014). Thus, increasing opportunities for animals to forage can indicate a potential improved welfare experience (Bracke & Hopster, 2006; Johnson et al., 2004).

Behavioral measurement

One of the difficulties we encountered during the study was the few behaviors listed in our ethogram that were regularly observed. For instance, only four of the 11 behaviors defined (see Table 2) accounted for greater than ~95% of all responses recorded, as previously noted. Likewise, of over 2,000 intervals observed, barking was only recorded 13 times, or 0.51% of all recording intervals. This may in part be due to the pinpoint/momentary time-sampling procedure used, where responses were only recorded if they occurred at the exact 1 min recording point. An alternative could have been to use an interval recording method, such as all-occurrence interval sampling (Bailey & Burch, 2017), which has been a popular behavioral recording method within applied behavior analytic research. However, in computer simulations of pinpoint and interval sampling methods, pinpoint sampling generally outperformed interval sampling as a behavioral recording method (Brereton et al., 2022; Wirth et al., 2014). Similarly, other researchers have recommended against the use of interval sampling methods when attempting to assess the occurrence of some event (i.e., percentage of time), as interval sampling produces results biased to the length of the recording interval rather than the frequency/duration of occurrence (Altmann, 1974). The end result was that we could not

rely on direct observation to assess changes in barking and instead relied on changes in frequently measured sound levels (dB) to assess such potential changes.

Overall and session sound

One of the difficulties we encountered with measuring sound during the study was how effective they were at directly measuring changes in barking. As noted previously, barking was rarely directly observed, and the sound meters themselves could pick up multiple sources of sound, including general dog activity (e.g., movement), people entering the kennels or other nondog activity inside the kennel area (e.g., staff cleaning), and at least some sound occurring outside of the kennel area. Nonetheless, because these sounds were expected to remain relatively constant throughout the course of the study, they were treated as extraneous or background “noise,” with any systematic changes treated as a result of the experiment itself.

There was a significant decrease in the overall (24 hr) sound measured in the FT condition compared with BL. However, the decrease equated to a change of less than 1/3 a decibel. This is further complicated by examining the changes in the session sound intensity, which showed the greatest differences happening between the Before and During periods compared with the After period but fewer differences between the two conditions, as well as the similarities observed in the hour-to-hour changes between the FT and BL conditions.

Statistical versus clinical significance

With respect to the small yet statistically significant effect observed in overall sound intensity, what remains less clear is whether such a change could be viewed as clinically significant (Ranganathan et al., 2015). Certainly, there has been increased support for the use of inferential statistics in assessing the effects of interventions within applied behavior analytic research (Costello et al., 2022; Fisher & Lerman, 2014; Kazdin, 2021). In addition, past research has documented the noise levels observed in canine shelter environments, which can regularly exceed 100 dB (Coppola et al., 2006; Sales et al., 1997) and result in measurable hearing loss for dogs (Scheifele et al., 2012). The Occupational Safety and Health Administration (OSHA, 2022) recommends that humans wear protective gear when exposed to noise levels that exceed 100 dB for more than 2 hr a day, which would include any individuals working in a shelter environment like the ones studied in the above studies. Although both our sound meters rarely recorded decibels louder than 60 dB, these were measures taken in a study area removed from the hundreds of other dogs kennelled at SDHS. Therefore, it is possible that small yet statistically significant reductions in overall sound intensity like those observed in our study would have clinical significance

when applied to potentially hundreds of dogs in a shelter environment or over an extended period.

Context, conditions, and methodological concerns

As noted above, another difficulty in assessing the effects of the FT condition on the sound measures are the few differences that exist between the conditions. Although we observed hour-to-hour changes that resulted in some of the lowest sound recordings measured during the times when the study was conducted (between 1200–14:00 hours), these lowered sound measurements were similar for both the FT and BL conditions. It is possible that the dogs were responding to the introduction of the automated feeding devices at the beginning of each session, including when they were introduced but not activated prior to each BL session. Past research has noted the importance of contextually conditioned stimuli, particularly ones that may produce sign-tracked responses (Bouton, 1993; Rescorla, 2008). Anecdotally, the shelter staff noted that the dogs appeared considerably quieter during the study. Nonetheless, the above demonstrates a lack of proper experimental control for measuring sound effects in this study and one potentially related to the use of a reversal design. Future research on the effects of response-independent schedules in shelters or elsewhere might be better suited to use a pre-/posttest method such as a multiple-baseline design across settings or subjects (Cooper et al., 2019). This would negate the potential confound of a conditioning effect that might occur.

Response-independent schedule functions

Although this study focused on the applied implications of using automated response-independent schedules to benefit the welfare of shelter dogs, it is worth considering how such schedules might function. As mentioned in the introduction, much of the past research on response-independent schedules has contrasted differences between operant and nonoperant effects of time-based deliveries, with a recent review considering the influence that antecedent effects might have (Ingvarsson & Fernandez, 2023). Future research in shelters or similar applied animal environments could provide ideal translational research opportunities to help better understand the function of response-independent schedules while simultaneously expanding the readily available tools we can use to benefit the animals existing in those environments.

CONCLUSION

Overall, the automated response-independent schedules appeared to have positive behavioral welfare benefits for

the shelter dogs in this study. The sound results also show promise for a potentially clinically significant result, with the caveat that future research should implement modified methods to examine such possibilities. One of the primary benefits of continuing this line of research is the time and cost efficiency possible using automated devices delivering time-dependent, response-independent food. Little effort or financial resources would be required to adapt a shelter environment with dozens of automatic feeding devices, all of which could be set to deliver most of a shelter dog's diet over the course of the day. The key would be measuring the effects of such larger scale deliveries in terms of all the possible benefits (e.g., animal and staff well-being; effects on adoption rates). Our hope is that this study offers future shelter management practitioners and researchers a plethora of empirical questions to explore.

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CONFLICT OF INTEREST STATEMENT

We have no conflicts of interest to disclose.

ETHICS APPROVAL

We confirm that this study was approved through the San Diego Humane Society's Institutional Animal Care and Use Committee (IACUC #000009).

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