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# On the generality of preference for contingent reinforcement

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Reinforcers can be delivered dependent on or independent of responding. Both human and nonhuman animals have shown a preference for contexts involving contingent reinforcement, but the generality of this phenomenon to humans and its implications have not yet been described. We present an integrative summary of studies evaluating preference for contingent versus noncontingent reinforcement, including (a) study participants, reinforcer types, response topographies, and contexts; (b) outcomes; (c) potential variables influencing preference outcomes; and (d) suggestions regarding research to expand behavior analysts' ability to design preferred contexts.

*Key words:* choice, contingent reinforcement, noncontingent reinforcement, preference

Reinforcers can be delivered dependent on or independent of responding. Whereas dependent (i.e., contingent) reinforcement implies that an individual must satisfy a prespecified response requirement in order to produce reinforcement, independent (i.e., noncontingent) reinforcement suggests that no such response requirement is in place; the individual receives reinforcers "for free." These relations occur naturally but can also be deliberately arranged in laboratories and therapeutic settings to influence behavior. The theory of least effort (Hull, 1943; Tolman, 1955) posits that animals will behave in a way that maximizes reinforcement while minimizing effort, which suggests that individuals are likely to prefer receiving reinforcement independent of their responding (i.e., freely) as opposed to contingent on some response requirement. Indeed, Skinner (1938, 1948) hypothesized that the availability of response-independent reinforcers should decrease responding for response-dependent reinforcers, a finding that has been demonstrated by other researchers (Nevin et al., 1990; Rescorla and Skucy, 1969).

However, the theory of least effort and research supporting it seem at odds with the phenomenon of contrafreeloading. Contrafreeloading is said to occur when an organism, in the presence of freely available reinforcers, continues to emit an operant response to obtain the same reinforcers (see Osborne, 1977, for a review). This has been demonstrated in studies in which an animal is taught an operant response (e.g., lever press) that results in the delivery of food. Freely available food is then placed inside the animal's chamber, but the chamber still contains the operant manipulandum and the food contingency. Across various experimental preparations (e.g., different reinforcers and reinforcement schedules), animals continued to obtain food via the lever press despite the availability of free food. This phenomenon has been studied in basic research with nonhuman animals.

Across the basic contrafreeloading literature, many variables appear to affect the generality of the phenomenon. These include, but are not limited to, motivating operations, training procedures, types of reinforcers, and length of preference testing. For example, in the original study on contrafreeloading, Jensen (1963) found that when rats experienced 40 reinforced responses prior to preference testing, they obtained 20% of their food

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via a lever press. When they experienced 1,280 reinforced responses, they subsequently obtained 75% of their food via a lever press. A longer history with response-dependent reinforcement may seemingly influence preference for that reinforcement contingency. Tarte and Snyder (1973) also found that pretesting history had an effect on preference in nonhuman animals. When rats were given equal histories with respect to response-independent and -dependent responding, they subsequently obtained 15%-20% of their food via a lever press. When the rats were given more experience with the response-dependent contingency, that is, exposed to three free-choice sessions and six sessions of lever pressing sessions, the rats subsequently obtained 72% of their food via lever press.

Singh (1970), Singh and Query (1971), and Tarte (1981) extended this line of research to humans and replicated findings by showing a preference for obtaining tangibles via lever pressing rather than independent of lever pressing. These early translational studies suggested that there may be generality to the contrafreeloading phenomenon across species. However, to our knowledge, no reviews have investigated the scope and generality of this phenomenon among humans. It is therefore unknown the extent to which there may or may not be a preference for contingent reinforcement among humans.

Given the fundamental reliance on arranging reinforcement contingencies by applied behavior analysts, general preference outcome information could be useful to practitioners. Behavior analysts are often tasked with treating the problem behavior of individuals. Following functional analyses, two common treatment options are differential reinforcement of alternative behavior and noncontingent reinforcement (Hagopian et al., 2013). These treatments are often found to be equally efficacious (e.g., Hanley et al., 1997). Thus, measures beyond efficacy, such as client preference for reinforcement schedules, may need to be considered for treatment selection.

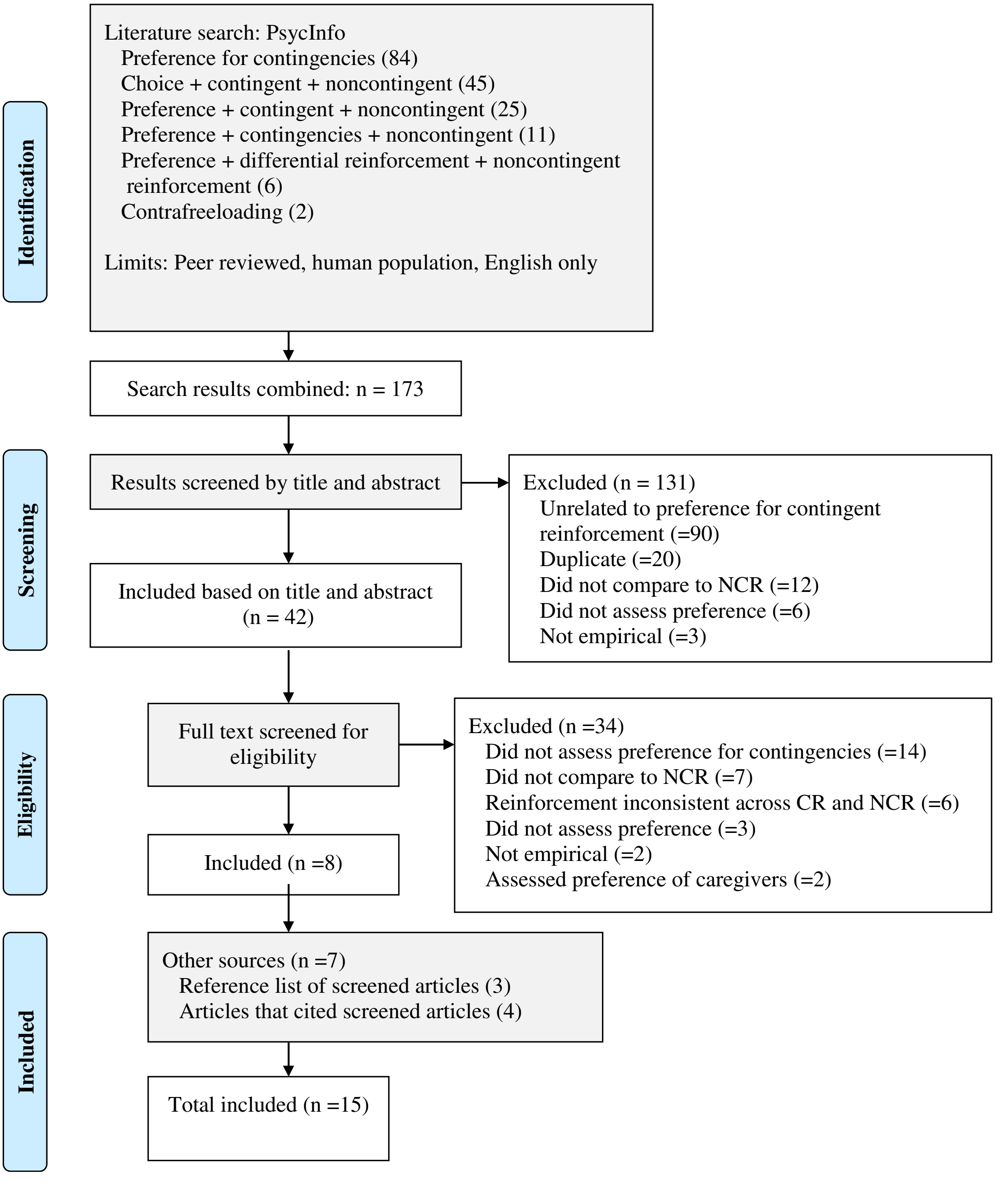
In addition to revealing preferences for contingent or noncontingent reinforcement among humans, the purpose of this review is to describe studies that have evaluated human preference for contingent and noncontingent reinforcement in order to provide an integrative summary of (a) study participants, reinforcer types, response topographies, and contexts included in these preference analyses; (b) outcomes; (c) potential variables affecting preference outcomes; and (d) suggestions regarding research to expand behavior analysts' ability to design preferred contexts.

## Method

### Article Identification and Selection

To document our search process, we used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Liberati et al., 2009). This process is illustrated in Figure 1, which depicts the number of articles identified, the number of articles excluded and reasons for exclusion, and the final number of articles included. We began the search by using *PsycInfo* with the following search words: (a) preference for contingencies, (b) choice + contingent + noncontingent, (c) preference + contingent + noncontingent, preference + differential reinforcement + noncontingent reinforcement, and (d) contrafreeloading. All titles and abstracts were screened from this initial search for apparent inclusion. In addition, the reference sections of articles meeting the inclusion criteria were searched, and papers citing the included articles were reviewed for relevance. Articles that appeared to meet inclusion criteria were read in full to confirm inclusion. Articles were included that measured a preference for contingent and noncontingent reinforcement by humans experiencing those conditions, and that met the following criteria: (a) the two conditions were concurrently available, and (b) reinforcer quality was programmed to be similar across both conditions.

**Figure 1**
*PRISMA Flow Chart Documenting the Literature Search Process*




We excluded articles that were duplicates, did not compare contingent and noncontingent reinforcement conditions, did not assess preference for either contingency, or that were not empirical evaluations (e.g., discussion papers). We also excluded articles that measured caregiver preference only, that measured preference using qualitatively different reinforcers across conditions, or that evaluated preference after schedule thinning.

## Coding

Articles were read in full to code for the following variables: participant demographics, type of programmed reinforcers, type of response(s) required in contingent reinforcement, method for determining preference and number of selection opportunities for participants, control option and type, the reinforcer delivery schedule in the noncontingent condition, yoking procedures, and the percentage of responding allocated to contingent reinforcement.

We coded age and diagnoses for participant demographics. The type of programmed reinforcers, responses required in contingent reinforcement, number of selections, and control option type were obtained from the Method section of each article as the authors reported them. We coded the method for determining preference as either a concurrent chains or a concurrent operants arrangement based on the authors' description of their preparations. We coded the reinforcement delivery schedule in the noncontingent condition as either continuous or time-based; if time-based, we coded if the delivery was yoked to that of the contingent condition using frequency-, temporal-, or duration-based yoking procedures.

### *Evaluating Preference for Contingent Reinforcement*

A preference measure, in the form of percentage of responding allocated to contingent reinforcement, was calculated for each participant or group of participants. The calculation differed depending on the dependent variable, which included number of selections of a schedule, duration of time allocated to a schedule, and the number of reinforcers collected from a schedule. Studies either reported single-subject or aggregated participant data. If the study presented individual data sets, the measures from the last five trials or sessions (when available) were used to calculate a percentage allocation of responding to contingent reinforcement relative to noncontingent reinforcement. This data sampling method has precedent in the single-subject literature (Hagopian et al., 1998; Iwata et al., 1994) to allow time for the learner's behavior to conform to the contingencies in place. If the study presented responding as a percentage of allocation to contingent reinforcement, the percentages associated with the last five trials or sessions were averaged. If the study employed a concurrent-chains arrangement to assess preference and reported number of selections, the number of selections of contingent reinforcement in the last five trials was divided by five. If the value of the data points was not clear, data extraction software (GetData Graph Digitizer version 2.26.0.20) was used to obtain the exact value of the data points, and the percentage was calculated thereafter. When it was not possible to extract the data from the last five trials or sessions (e.g., one study reported overall selections for each condition per participant in a table), the overall average was calculated, or the percent of allocation provided by the authors was used. This was the case for one study that reported individual data (Stangeland et al., 2012) and all of the studies reporting aggregated data.

We considered a preference for contingent reinforcement to be shown if 60% of responding or more was allocated to contingent reinforcement. We considered no preference to be shown if responding was between 41% and 59%, and a preference for noncontingent reinforcement to be shown if 40% or less responding was allocated to contingent reinforcement (i.e., if 60% or more of responding was allocated to noncontingent reinforcement). Most basic studies on contrafreeloading determined preference if the proportion of food obtained from a given source exceeded 51% of total food obtained (Osborne, 1977). We took a more conservative route when determining preferences which also allowed us to examine potential cases in which participants' responding indicated indifference.

### Statistical Analyses

Point biserial correlations and independent sample *t*-tests were calculated between and reported for the percentage allocation to contingent reinforcement and (a) method of determining preference (i.e., concurrent-chains or concurrent operant arrangements), (b) type of reinforcer arrangement in the noncontingent condition (i.e., continuous or time-based), and (c) if the studies yoked the delivery of reinforcers during the noncontingent reinforcement condition to that of the contingent reinforcement condition. Given the heterogeneity of the experimental preparations used to evaluate preference in the current study, we do not believe this review can identify singular variables for preference. Thus, as an extra level of analysis, these correlation coefficients were conducted to highlight potential influences from the experimental preparations on preference.

A point biserial correlation is a statistic used to determine the correlation between a continuous measure (e.g., percentage of responding allocated to contingent reinforcement) and a dichotomous measure (e.g., concurrent-chain vs. concurrent-operants arrangement). Point biserial correlation coefficients were calculated by entering the percent of responding allocated to contingent reinforcement, assigning a binary number (0 or 1) to each of the variables listed above, and calculating the coefficient using a formula through Excel.

A *t*-test is used to determine whether it is likely that between-group differences could have happened by chance. We calculated *t*-tests by entering the percent of responding allocated to contingent reinforcement, grouping these percentages by the variables listed above, and calculated using a formula through Excel.

### Interrater Agreement

Interrater agreement was measured by having a second, independent rater code 20% of the articles (Hausman et al., 2021; Kratochwill et al., 2010) meeting the inclusion criteria for the variables described above; these articles were selected at random. An agreement was scored if both raters coded an item identically (e.g., both coded "concurrent-chains" as the method for determining preference). The coder recorded the exact variable for participant demographics (i.e., age and diagnosis) and was provided with categories to select from for the following variables: reinforcer type, response required in contingent reinforcement, and method for determining preference. Some variables were coded in a binary fashion (i.e., concurrent chains vs. concurrent operants) and others had more selections; for example, with reinforcer type, the coder selected among access to a location, completion of task, edibles, stereotypy, social attention, tangibles, and visual stimulation.

Interrater agreement was calculated by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100. Interrater agreement across all variables was 100%.

## Results

We identified 15 articles for inclusion. Eight articles reported data for individual participants and seven articles reported aggregated data across participants, which resulted in 32 individual data sets and 15 aggregated data sets comprised of 694 participants, for a total of 726 participants.

The experimental question of whether individuals prefer to receive reinforcers contingent on some response appeared across the applied to translational continuum (Moore & Cooper, 2003). Some authors aimed to specifically study the contrafreeloading phenomenon with humans within translational models. For example, Singh (1970) measured the amount of marbles children received on a time-based schedule or via a lever press. For others, understanding the phenomenon of the preference for contingent reinforcement was often not the primary goal; instead, preference analyses including contingent and noncontingent reinforcement schedules were conducted while attempting to answer other experimental questions. For example, Lepper et al. (2013) evaluated children's preferences for their own treatments aimed to increase vocalizations, stimulus–stimulus pairing, and operant discrimination training.

## Preference Outcomes

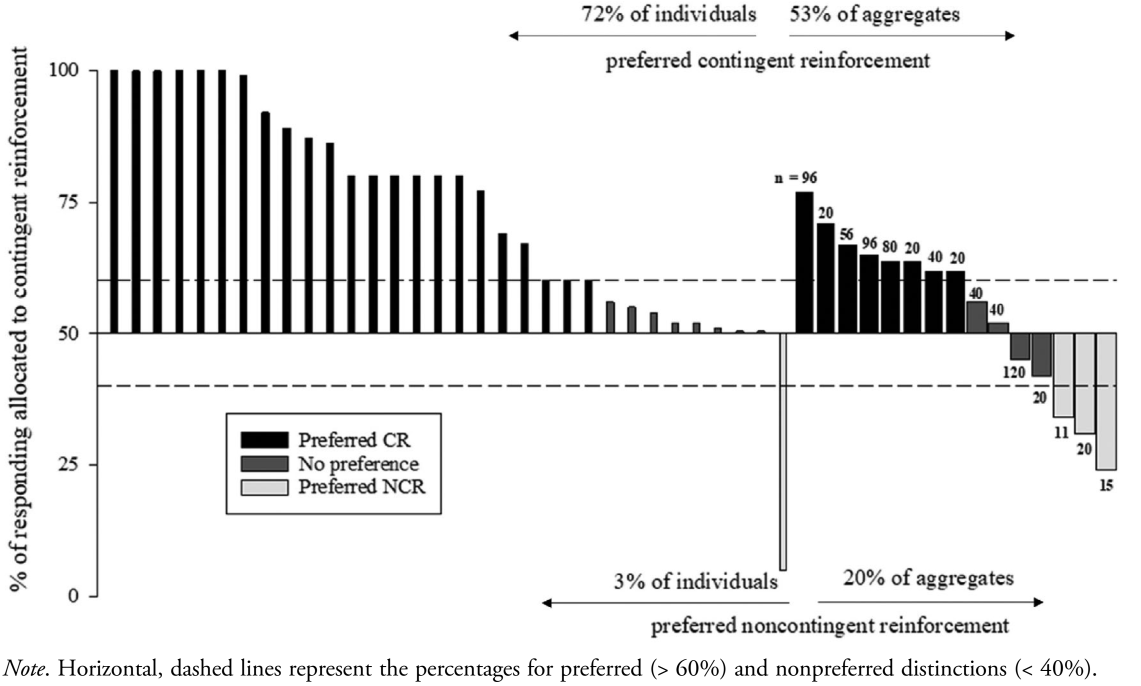
A summary of the percentage of response allocation to contingent reinforcement across individual and aggregated data sets is depicted in Figure 2. Each bar represents either the responding of an individual participant, represented by the thin bars, or the average responding across a group of participants, represented by the thicker bars. Overall, these studies reveal a general tendency for individuals to prefer contingent reinforcement relative to noncontingent reinforcement. Of the 32 individual and 15 aggregated data sets, 72% (23/32) and 53% (8/15) indicated a preference for contingent reinforcement. By contrast, 3% (1/32) and 20% (3/15) indicated a preference for noncontingent reinforcement.

## Participant Demographics

Participant characteristics and experimental preparations are listed in Tables 1 and 2. Most of the individual data sets were produced with children (74%) who had a diagnosis of a developmental or intellectual disability (75%). By contrast, of the aggregated data sets, 40% of

**Figure 2**

*Percentage of Responding Allocated to Contingent Reinforcement Across Individual and Aggregated Data Sets*




*Note*. Horizontal, dashed lines represent the percentages for preferred (> 60%) and nonpreferred distinctions (< 40%).

**Table 1**

*Summary of Variables Coded Across Individuals*

| Variable | Number (%) of participants |
|---|---|
| Diagnosis ($n$ = 32) | |
| Autism | 11 (34) |
| Intellectual disability (ID) | 9 (28) |
| Typically Developing | 8 (25) |
| Autism and seizure disorder | 1 (3) |
| Cerebral palsy and seizure disorder | 1 (3) |
| ID, CP, epilepsy | 1 (3) |
| Mild ID, ADD, ODD, Seizure Disorder | 1 (3) |
| Age ($n$ = 23)[a] | |
| Child (1 to 12 years old) | 17 (74) |
| Adolescent (13 to 17 years old) | 4 (17) |
| Adult (> 18 years old) | 2 (9) |
| Reinforcer Type ($n$ = 32) | |
| Stereotypy | 18 (56) |
| Social attention | 10 (31) |
| Edibles | 2 (6) |
| Tangibles (toys) | 1 (3) |
| Access to a location | 1 (3) |
| Response required in CR ($n$ = 32) | |
| Participant's own stereotypy | 13 (41) |
| Functional Communication Response | 10 (31) |
| Leisure skills | 4 (13) |
| Raise arms | 3 (9) |
| Using walker | 1 (3) |
| Vocational skills | 1 (3) |
| Method for determining preference ($n$ = 32) | |
| Concurrent-chains arrangement | 19 (59) |
| Concurrent operant arrangement | 13 (41) |

[a] $n$ = 23 for individual data sets, Buyer et al. only reported a range of ages across groups.

**Table 2**

*Summary of Variables Coded Across Aggregated Data Sets*

| Variable | Number (%) of participants ($n$ = 694) |
|---|---|
| Diagnosis | |
| Not reported | 694 (100) |
| Age | |
| Infant (< 1 year old) | 26 (4) |
| Child (1 to 12 years old) | 272 (39) |
| Adolescent (13 to 17 years old) | 120 (17) |
| Adult (> 18 years old) | 276 (40) |
| Reinforcer | |
| Tangibles | 432 (62) |
| Completion of task | 196 (28) |
| Edibles | 40 (6) |
| Visual Stimulation | 26 (4) |
| Response required in CR | |
| Lever press | 652 (94) |
| Academic task | 20 (3) |
| Leisure skills | 20 (3) |
| Method for determining preference | |
| Concurrent-chains arrangement | 236 (34) |
| Concurrent operant arrangement | 458 (66) |

*Note*. CR = contingent reinforcement.

participants were over the age of 18 and a diagnosis was never reported for any participant.

## Procedural Details

Although all studies included in this review evaluated preference for contingent or noncontingent reinforcement, the way the question was asked varied considerably.

### *Type of Preference Analysis*

The reviewed studies employed either a concurrent-chains or concurrent-operant arrangement to evaluate preference for the reinforcement schedules. In a concurrent-chains arrangement (Catania, 1963; Herrnstein, 1961), an individual first responds to a stimulus—an *initial link*—from among two or more stimuli associated with concurrently available schedules of reinforcement. The individual then experiences only the selected schedule called the *terminal link*, which serves as the reinforcer for responses in the initial link. Responding on the initial link is considered indicative of preference for that schedule. For example, in Slaton and Hanley (2016), children first selected a schedule-correlated stimulus (different colored pieces of paper). After selecting, the child then experienced the selected schedule. In a concurrent-operants arrangement, two schedules of reinforcement are continuously and concurrently available. This arrangement does not include an initial link selection. An individual can typically switch back and forth among the schedules at any time and response allocation to a schedule is considered indicative of a preference. For example, in Stangeland et al. (2012), a room was divided into two halves using tape on the floor. On one side, a child could experience a contingent schedule of reinforcement and on the other a noncontingent schedule, and the child was free to move back and forth between the halves of the room.

There is a greater degree of inference required with a concurrent-operants arrangement, because the unit of measurement for preference is responding on a particular schedule and responding among two different schedules can be confounded by the rate of responding associated with each schedule of reinforcement (Herrnstein & Heyman, 1979). That is, responding on a schedule may not be indicative of a preference but rather indicative of the pattern of responding that that schedule selects. In a concurrent-chains arrangement, by contrast, the response with which preference is measured is separate from the schedule itself. Thus, the preference outcomes yielded from a concurrent-chains arrangement may be a stronger indicator of schedule preferences (Catania, 1992; Hanley et al., 1997).

Six of eight studies depicting individual data sets and three of seven studies depicting aggregated data sets employed a concurrent-chains arrangement, with the remaining six studies employing a concurrent-operant arrangement. A point biserial correlation was computed with the individual data sets to assess the relationship between a preference for contingent reinforcement and the type of preference analysis employed. Overall, there was a moderate positive correlation between the two variables ($r = .527$, $p < .001$). An independent samples *t*-test was also conducted with the individual data sets. There was a significant difference in the scores for concurrent chains ($M = 83.5$, $SD = 16.2$) compared to concurrent operant ($M = 60.5$, $SD = 21.9$), $t\ (30) = 3.4$, $p = .001$; $d = 1.2$. Individuals were more likely to select and then experience contingent reinforcement when a concurrent-chains schedule, rather than a concurrent-operants arrangement, was employed.

***Programmed Reinforcers***

Across the individual data sets, reinforcers included access to the participants' own stereotypy, social attention, food items, toys, and access to a location. Across the aggregated data sets, reinforcers included tangibles (i.e., coins and marbles), the opportunity to complete a task, food items, and visual stimulation in the form of cartoon pictures. Because these studies spanned the continuum of translational to applied, some of the reinforcers could be considered arbitrary in that there was little social significance in the selection of the reinforcers. That is, it is unclear how valuable the stimuli used as reinforcers were to the participants across studies. For example, in Singh (1970), Singh and Tarte (1971), and Tarte (1981) students received marbles or coins contingent on a lever press, and it was never reported if these items were preferred by the children. This type of reinforcement arrangement contrasts with Hanley et al. (1997), in which adult attention was first identified as a reinforcer for severe problem behavior and subsequently delivered contingent on a functional communication response. Given that the reinforcing efficacy of a stimulus may affect schedule selection (Osborne, 1977), there were likely different motivational variables influencing outcomes across the studies.

Reinforcer availability in the noncontingent condition was not consistent across studies, and the varying arrangements could have affected preference for either schedule. Reinforcers in the noncontingent condition were either continuously available or provided intermittently via a time-based schedule. Three studies depicting individual data sets provided continuous access to the reinforcer in the noncontingent condition. Buyer et al. (1987), Stangeland et al. (2012), and Potter et al. (2013) allowed the participants to engage freely in stereotypy during the noncontingent condition without interference from the experimenter. Three sets of authors provided the reinforcer on a time-based schedule that was yoked to the schedule in the contingent condition. Hanley et al. (1999) and Luczynksi and Hanley (2009) yoked both the frequency, quality, and the temporal distribution of the delivery of adult attention to that of the schedule in the contingent reinforcement condition. In Slaton et al. (2016), in the multiple schedule, the reinforcer was delivered after a period of time that was yoked to the duration of the response requirement in the chained schedule, and the set durations were presented in the same order as in the chained schedule (durations varied depending how long it took the participant to complete the required chain).

Two studies delivered the reinforcer in the noncontingent condition on a time-based schedule that was not yoked to that of the contingent condition. In Lepper et al. (2013), during the noncontingent condition, the experimenters provided a tangible item after the therapist emitted the target speech sound three times (e.g., "goo, goo, goo"). During the contingent condition, the item was delivered after the child raised their arms in response to the target speech sound (e.g., "goo"). Therefore, there likely was a longer delay to reinforcement during the contingent condition if the child took longer to emit the response. As an example, in Hanley et al. (1999), a participant had the choice between a staff member pushing him in a wheelchair to a location or reaching the location by self-propelling using a walker. There was a longer delay to reinforcement during the contingent condition in which the participant self-propelled using the walker.

A point biserial correlation was calculated with the individual data sets to assess the relation between a preference for contingent reinforcement and manner of reinforcer delivery in the noncontingent condition. Overall, there was a moderate positive correlation between the two variables ($r = .473$, $p = .006$). An independent samples $t$-test was also conducted with individual data sets. There was a significant difference in the scores for studies that employed time-based reinforcement delivery ($M = 83.1$, $SD = 15.2$) compared to continuous reinforcement delivery ($M = 62.6$, $SD = 23.7$), $t(30) = 2.939$, $p = .006$; $d = 1$. When the reinforcer was delivered on an intermittent time-based schedule during the noncontingent condition, the individual was more likely to prefer contingent reinforcement.

### *Response Requirement*

There was a greater variety of responses required in the contingent reinforcement conditions across the individual data set studies than the aggregated data studies. The individual data set studies included the participants' own stereotypy, functional communication, leisure skills, raising arms, using a walker, and vocational skills. The two most prevalent responses were stereotypy, 41% of participants, and functional communication, 31% of participants. With the aggregated data sets, most of the responses were lever presses (94%). This is not surprising, as the aggregated data sets were all part of translational studies. Thus, a socially significant response was not necessary.

### *Scientific Rigor of Studies*

All studies included the necessary experimental procedures for valid inferences about preferences to be made; these procedures included, but were not limited to, direct measures of behavior, the use of appropriate experimental designs, and reliability of dependent variables (Kazdin, 2011; Kratochwill et al. 2010). Tables 3 and 4 summarize additional experimental design features and control tactics the studies employed. For example, seven of the 15 studies controlled for potential side biases by randomizing the position of initial links. Nevertheless, the strength of evidence for the inferences regarding preference for contingency varied across the studies, and studies utilizing fewer control tactics should be interpreted with caution. As an example, Stangeland et al. (2012), found that one participant preferred

**Table 3**

*Details of Studies Included in Review Reporting Individuals' Results*

| First Author (Year) | Reinforcer *Contingent condition label* Noncontingent condition label | DV | Exp design | Stability achieved | Control condition | Sufficient measurement | Yoking procedures | Additional control tactics |
|---|---|---|---|---|---|---|---|---|
| Buyer (1987)* | **Stereotypy**<br>*Child controlled rocking chair*<br>Experimenter controlled rocking chair | Frequency of choices for a chair (by sitting) | Concurrent operant | Unknown | EXT | Yes | Frequency and temporal | Prior exposure to conditions<br>Controlled for side biases<br>Randomization of experimenter to each session |
| Hanley (1997) | **Social attention**<br>*Functional communication*<br>Time-based delivery | Number of initial link selections | Concurrent chains | Yes | EXT | Yes | Frequency and temporal | Prior exposure to conditions<br>Experimenter positioned behind client during selections<br>Integrity of IVs monitored<br>Controlled for side biases |
| Hanley (1999) | **Access to location**<br>*Self-manipulated walker*<br>Wheelchair pushed by staff | Number of initial link selections | Concurrent chains* | Yes | Alone | Yes | None | Prior exposure<br>Controlled for side biases |
| Lepper (2013) | **Praise/edibles**<br>*Operant discrimination training*<br>Stimulus–stimulus pairing | Number of initial link selections | Concurrent chains | Yes | Play | Yes | None | Initial links confirmed to not be preferred |
| Luczynski (2009) | **Social attention**<br>*Functional communication*<br>Time-based delivery | Number of initial link selections | Concurrent chains | Yes | EXT | Yes | Frequency and temporal | Attention confirmed to be a reinforcer<br>Initial links confirmed to not be preferred<br>Integrity of IV evaluated |
| Potter (2013) | **Stereotypy**<br>*Leisure skills*<br>Free access to stereotypy | Number of initial link selections | Concurrent chains | Yes | EXT | Yes | None | Reversal design for 3/3 participants<br>Colors of initial links confirmed to not be preferred<br>Controlled for color bias<br>Side bias controlled for |
| Slaton (2016) | **Stereotypy**<br>*Leisure and vocational skills*<br>Free access to stereotypy | Number of initial link selections | Concurrent chains | Yes | EXT | Yes | Duration | Reversal design for 1/2 participants |
| Stangeland (2012) | **Object stereotypy**<br>*Child manipulated objects*<br>Experimenter manipulated objects | Percentage of time | Concurrent operant | No | None | Yes | None | Side bias controlled for |

*Note*. Asterisk denotes studies in which the overall average was used to calculate the percent of allocation to contingent reinforcement.

**Table 4**

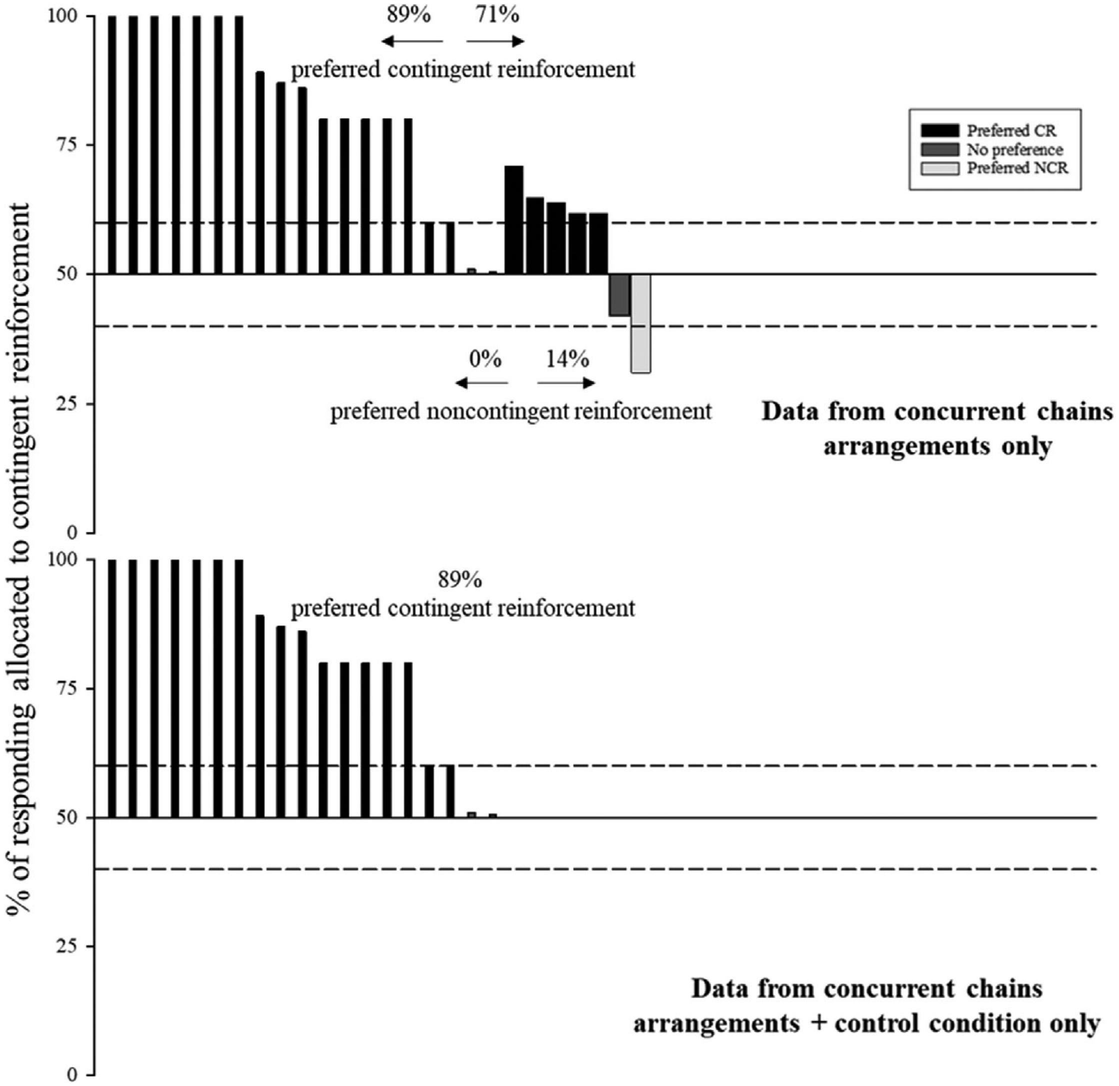
*Details of Studies Included in Review Reporting Aggregated Results*

| First Author (Year) | Reinforcer<br>*Contingent condition label*<br>Noncontingent condition label | DV | Exp Design | Stability achieved | Control condition | Sufficient measurement | Yoking procedures | Additional control tactic |
|---|---|---|---|---|---|---|---|---|
| Makin (1982)* | **Visual stimulation**<br>*Lever press*<br>Time-based delivery | Time in front of screens | Concurrent operant | - | None | No, 1 opportunity | None | - |
| Navarro (2015)* | **Not reported**<br>*Manual task completion*<br>Automatic task completion | Frequency of selections | Concurrent chains | - | None | Yes | Duration | Side bias controlled for |
| Osiurak (2013)* | **Not reported**<br>*Manual task completion*<br>Automatic task completion | Frequency of selections | Concurrent chains | - | None | Yes | Duration | Side bias controlled for |
| Singh (1970)* | **Tangibles**<br>*Lever press*<br>Time-based delivery | % of tangibles obtained via lever press | Concurrent operant | - | None | No, 2 opportunities | Frequency | Prior exposure to conditions |
| Singh (1971)* | **Tangibles**<br>*Lever press*<br>Time-based delivery | % of tangibles obtained via working | Concurrent operant | - | None | No, 2 opportunities | Frequency | Prior exposure to conditions |
| Tarte (1981)* | **Tangibles**<br>*Lever press*<br>Time-based delivery | % of reward obtained via lever press | Concurrent operant | - | None | Yes | Frequency | - |
| Winefield (1980)* | **Tangibles**<br>*Accuracy of math problems/ different Lego forms required*<br>Accuracy or different forms not required | Mean # of choices, mean number of SR received | Concurrent chains | - | None | Yes | Duration | - |

*Note*. Asterisk denotes studies in which the overall average was used to calculate the percent of allocation to contingent reinforcement.

**Figure 3**

*Percentage of Responding Allocated to Contingent Reinforcement with Concurrent Chains Arrangement Only (top panel) and Concurrent Chains Arrangements Plus the Use of a Control Condition (bottom panel)*




*Note*. Horizontal, dashed lines represent the percentages for preferred (> 60%) and nonpreferred distinctions (< 40%).

contingent reinforcement and the other preferred noncontingent reinforcement. Although the authors controlled for a side bias by counter-balancing, they did not employ a concurrent -chains arrangement, a control condition, nor did they run their analyses until stability was achieved.

Nine studies employed a concurrent-chains arrangement, perhaps one of the most important control tactics when studying preference for schedules of reinforcement, because the unit of measurement for preference (i.e., the initial link selection) is separate from the schedule itself. The top panel of Figure 3 depicts data sets from only those studies employing a concurrent-chains arrangement. Under this more conservative lens, preference for contingent reinforcement increased to 85% across all data sets (89% and 71% for individual and aggregated data sets, respectively).

The number of opportunities to express a preference provided to participants differed considerably across studies, and this procedural aspect of preference testing may have also affected outcomes (Taylor, 1972). In behavior analysis, to determine experimental control, data are visually analyzed using three characteristics: (a) level, (b) trend, and (c) variability. However, this information was not always available in reviewed studies. We extracted the number of points at which individuals were given the option to choose among the schedules across studies. If the study employed a concurrent-chains arrangement, the choice points were the number of initial link selections the individual made. If the study employed a concurrent-operants arrangement, the choice points were the number of times an individual was given to initially select among the options. If three or more choice points were provided, this was categorized as sufficient as three data points are considered the minimal requirement to indicate a trend or effect (Kratochwill et al., 2010). All studies reporting individual data provided sufficient measurement, while three of seven studies (43%) reporting aggregated data sets did not.

The interpretation of preference outcomes may be affected by the stability of data. If data are variable, evaluations are typically extended until stability is achieved. Each study either had their own criterion for determining preference by way of the stability of the data (e.g., three consecutive selections of the same initial link) or they did not report their criterion; therefore, we employed the What Works Clearinghouse guidelines for visual inspection of single-case designs to determine if the current evaluations, among the individual data sets, were extended until stability was achieved. Primarily, we looked to see if the researchers ended their preference analyses on a trend that indicated a clear preference or clear indifference. This typically looked like the participant selected the same choice option for the last 3-5 trials or sessions. Six of eight studies reporting individual data achieved stability within their preference analyses; one did not (Stangeland et al., 2012) and the data remained variable across the entire analysis (for three out of four participants). The remaining study (Buyer et al., 1987) only reported the preference outcomes summarized in a table; thus, visual inspection was not possible. For all aggregated data sets, preference outcomes were averaged across all participants. Thus, it is unknown if stability was achieved on an individual basis.

A control option is necessary to distinguish between indiscriminate responding and indifferent responding. That is, if a participant's selections are split equally among choices, a control elucidates whether those choices represent unsystematic responding, in which they also equally select the control condition, or represents indifference in which their responding is spread across the available choices but not the control. Seven out of eight studies (89%) reporting individual data and zero studies reporting aggregated data employed a control condition. Of the studies in which the data sets that indicated no preference, two studies did not include a control condition (i.e., Tarte, 1981; Winefield & Manglaras, 1980). Control conditions included variations of extinction, including one in which the participant could engage in the response, but no reinforcer was delivered, an alone condition, in which there was no opportunity to engage in the response or access the reinforcer, and a condition in which the delivery of the reinforcer was delayed up to 20 s. Narrowing the lens further to the inclusion of a control condition in addition to the use of a concurrent-chains arrangement (Figure 3, bottom panel), the preference for contingent reinforcement increased from 85% to 89%.

Yoking procedures are employed in studies to control for the confound of reinforcer quantity being dissimilar across conditions. Yoking procedures can include equating both the frequency of reinforcement, as well as the temporal distribution of the reinforcers. Some studies yoked the noncontingent condition duration to that of the contingent condition. Of the studies reporting individual data, three of eight studies (36%) yoked both the frequency and temporal distribution, one (13%) yoked the duration of the conditions, and four (50%) did not employ any yoking procedures or did not describe them. Of the studies reporting aggregated data, three of seven (43%) yoked the duration of the conditions, three (43%) yoked the frequency of reinforcers, and one did not employ any yoking procedures or did not describe them.

A point biserial correlation was calculated with the individual data sets to assess the relation between a preference for contingent reinforcement and if yoking procedures were used or not. Overall, there was a small and nonsignificant negative correlation between the two variables ($r = -.153$, $p = .403$). An independent samples *t*-test was conducted as well. There was no significant difference in the scores for studies that used yoking procedures ($M = 70.6$, $SD = 17.2$) compared to those that did not ($M = 77.2$, $SD = 27$), $t\ (30) = -0.847$, $p = .403$; $d = .3$.

Interpretation of the outcomes may prove challenging given that some studies did not yoke the frequency and the temporal distribution of reinforcer deliveries between conditions (see Tables 3 and 4) and thus, reinforcement rate may not be equal across conditions. This challenge is rendered somewhat moot, however, when one looks at the contingency arrangement employed in the studies that did not yoke. For example, in Lepper et al. (2013), an edible item was delivered to the child following an adult emitting a sound (NCR) or following an adult emitting a sound and the child emitting an operant response of raising their arms (contingent reinforcement). Thus, the rate of reinforcement was equal per trial, but the delay to the reinforcer differed. As another example, in Slaton and Hanley (2016), the reinforcer was delivered following a period of time in which the child simply waited or in which they engaged in some behavior and these durations were equated; sessions ended after three reinforcement components were experienced. Thus, the rate was the same across conditions given this trial-like format.

An array of additional control tactics was used beyond those mentioned above. Each study's control procedures are highlighted in Tables 3 and 4 and included tactics such as controlling for side biases by randomizing the order of initial links or schedule locations, monitoring the integrity of the reinforcement across the two conditions to ensure they were equal, and ensuring that initial links were neither preferred nor nonpreferred to control for any visual or color preference influence over selections.

## Discussion

We found that across a variety of experimental preparations and participant demographics, most participants indicated a preference for receiving reinforcers contingent on responding rather than receive the same reinforcers for free. In fact, when a preference was shown, that is, excluding the no-preference data sets, and the data were presented for individual participants, preference for contingent reinforcement was evident 96% of the time. Further, the evidence for a general preference for contingent reinforcement becomes more robust when additional control tactics are added to evaluations. Despite some ambiguity imposed when participant data were aggregated and opportunities to express a preference were often limited, preference for contingent reinforcement was revealed 73% of the time when a preference for either was evident. In sum, there appears to be a strong and general preference for contingent reinforcement. However, our understanding of the boundary conditions of this phenomenon remains cursory, and more research is needed.

Although phylogenetic influences should not be overlooked (indeed, Catania, 1980, hypothesized there may be evolutionary advantages influencing animals' preference for free-choice), additional factors may contribute to a preference for contingent reinforcement. For instance, some reinforcers may be more sensitive to fluctuations in satiation and deprivation, and a contingent relation may directly serve these flexible motivational states (Hanley et al., 1997). Luczynski and Hanley (2009) evaluated preference for contingent social attention among eight typically developing children. Seven of eight children preferred to receive attention contingent on a social bid and allocated most of their selections to contingent reinforcement. The value of social attention may vary across time. Thus, a condition in which attention can be obtained when it is at its highest value, through a functional communication response, may be preferred to a condition in which attention is delivered on a time-based schedule irrespective of the child's motivation. The preference for contingent reinforcement may come from the ability to influence the timing of the reinforcer delivery, thus allowing the individual to access the reinforcer when it is most valued (Hanley et al., 1997).

Another factor influencing preference could be that, in some preparations, the reinforcer value may be greater in the contingent reinforcement condition because the reinforcer is delivered following a state of deprivation. This would be the case if the reinforcer was freely available in the noncontingent condition, but unavailable during the response requirement in the contingent reinforcement condition. This was exemplified when the reinforcer was the individual's own stereotypy (Potter et al., 2013, Slaton & Hanley, 2016). The participants gained access following the response requirement in which stereotypy was blocked in the contingent reinforcement condition, and the participants were able to engage in stereotypy for the entirety of the noncontingent condition. Stereotypy being restricted during the contingent condition may have functioned as an establishing operation; its availability thereafter may have been more valuable. If reinforcer delivery following periods of deprivation indeed is a relevant factor in the preference for contingent reinforcement, future research could compare a time-based delivery condition in which the reinforcer is absent during the delays, to a condition in which continuous access is available (e.g., Rajaraman et al., 2021). Presumably, preference for contingency would erode given the choice of continuous noncontingent reinforcer access verses limited contingent reinforcer access following periods of deprivation, if differential *value* was not driving preference for contingent reinforcement.

Other potential factors influencing outcomes could include preference for receiving reinforcers spaced over time, the increased value of a reinforcer following the effort of completing a response requirement (Hackenberg, 2009), or the density of reinforcement in a given condition if proper yoking procedures were not employed (Briggs et al., 2018; Herrnstein, 1961). Although the outcomes from the statistical analyses did not suggest that yoking procedures made a significant difference in preference outcomes, this inclusion of studies that used no yoking procedures likely affected this. Future studies should still employ yoking procedures to ensure differences between reinforcer rates across conditions are minimized.

Despite generally consistent outcomes revealing preference for contingency, eight individual and four aggregated data sets indicated no preference and one individual and three aggregated data sets indicated a preference for noncontingent reinforcement arrangements. These outcomes may have occurred for several reasons. First, the participants responding may simply have been indicative of indifference or preference for noncontingent reinforcement. To illustrate, the participant Jon in Potter et al. (2013) selected almost equally the condition that allowed him to freely engage in stereotypy and the condition in which he was given access to his own stereotypy contingent on engagement with leisure items. He rarely selected the restriction-only condition, the control. Thus, his selections were likely indicative of indifference. For the aggregated data sets, the lack of preference outcome could be an artifact of the data aggregation. All aggregated data sets reported preference outcomes as a percentage allocation to contingent reinforcement averaged across participants. Presumably an average was first calculated for each participant's responding, and as a result, these data likely went through two levels of aggregation. Aggregation masks variability, and it is possible that participants demonstrating a preference for contingent or noncontingent reinforcement were obscured.

Second, the participants' responding may have been indiscriminate, meaning it did not come under control of the terminal links, or the associations between the initial and terminal links were not learned. As another possible reason, there may have been contingent properties of reinforcement in both conditions (i.e., noncontingent reinforcement was programmed but not experienced). For example, one participant in Luczynski and Hanley (2009), Lou, allocated responding equally to contingent reinforcement and noncontingent reinforcement while not selecting the extinction control. Interestingly, he emitted high rates of a functional communication response during both the contingent and noncontingent reinforcement conditions, despite there being no programmed contingency in the latter. However, because of the high rate of Lou's responses in the noncontingent reinforcement, the time-based delivery of the reinforcer often followed the response. The authors conducted post-hoc conditional probability measures quantifying the response and reinforcer occurrences during the noncontingent reinforcement conditions. Lou experienced many response–reinforcer occurrences during the noncontingent reinforcement condition. Therefore, the apparent indifference may have resulted because the programmed differences between the two conditions were not necessarily experienced. In other words, although there was not a contingent, programmed response–reinforcer relation in the noncontingent condition, it may have appeared this way for Lou and thus led to no preference being shown between contingent and noncontingent reinforcement.

Finally, despite the fact that studies in the current analyses programmed for reinforcer quality to be the same between contingent and noncontingent conditions, differences between conditions may have introduced nonprogrammed differences in reinforcer quality. These differences may have contributed to preference for noncontingent reinforcement. As an example, Makin and Deni (1982) measured preference for contingent or noncontingent visual stimulation across two different groups of infants. The two groups of infants allocated 34% and 24% of their responding to contingent reinforcement. The authors discussed that the unpredictability of the noncontingent condition may have been attractive, and because of the uncertainty, the infants attended to this condition more. However, as noted above, the participants also engaged in lever pressing at a higher rate in the noncontingent condition, which may have influenced this outcome. Nevertheless, using an intermittent contingent-reinforcement schedule would be important in future research in this area.

There are several areas for future research that may help to inform behavior analysts' ability to design preferred environments using programmed reinforcers. First, all studies in the current review evaluated preference the way positive reinforcers are arranged. To our knowledge, no studies have evaluated preference for contingent and noncontingent negative reinforcement schedules (e.g., breaks from academic work), although preference studies have been conducted that evaluate preference for positive versus negative reinforcement contingencies (DeLeon et al., 2001). Second, future research could evaluate durability of preference when the initial link requirement is increased. The current study was limited to a comparison of preference for contingent reinforcement when the response requirements were similar and of relatively low effort. Some studies, which were outside the scope of the current paper, have evaluated preferences when the response requirement was increased, and reinforcer schedule thinned. Luczynski and Hanley (2010) evaluated preference for contingent reinforcement when the response requirement was increased along a progressive ratio. Preference for contingent reinforcement initially persisted. Preference switched once the response requirement reached an FR 8 and 10 for the two participants, respectively. In addition, Osiurak et al. (2013) evaluated preference for a contingent condition when the noncontingent condition duration was decreased by increasing the speed of the computerized task. Once the computerized task in the noncontingent condition was completed in a speed at least three times as quickly as the contingent condition, preferences switched from contingent to noncontingent reinforcement. The Osiurak et al. results in this example, however, could be described by the matching law given that reinforcement rates were not yoked across the conditions, and there was a shorter delay to reinforcement in the noncontingent condition. It would be interesting and useful to understand the type of learning histories that influence the point at which individuals' preference for certain reinforcement schedules change and if these experiences could be arranged to deliberately affect preference for therapeutic teaching contexts.

Third, preference analyses could be extended to those implementing treatments. Do caregivers prefer to deliver contingent reinforcers? There is some evidence that they do. Gabor et al. (2016) evaluated caregiver preference for interventions to treat socially maintained problem behavior and found that four of five caregivers preferred differential reinforcement procedures. One did not exhibit a preference and no caregiver preferred noncontingent reinforcement. This question is important as the adoptability of treatments likely influences the maintenance and generalization of treatment use and effects. Further, additional conditions could be evaluated such as the combination of contingent and noncontingent reinforcement, which may be more practical for settings in which a caregiver's attention is divided among multiple individuals (e.g., a classroom).

To conclude, researchers interested in studying preference for reinforcement schedules with humans should consider employing a combination of control tactics previously discussed. Most notably, a concurrent-chains arrangement should be employed, as this design may be a stronger indicator of preference between different schedules of reinforcement because it controls for many potential confounds present in other designs. When using this arrangement, researchers should counterbalance initial links to control for side biases and ensure other variables (e.g., color) are not driving initial link selections. In addition, a control condition should be included to identify potential indiscriminate responding, participants should be given sufficient opportunities to express a preference by running analyses until stability is achieved, reinforcer quality should be equal across conditions, and if necessary, yoking procedures should be included.

It is important to know that individuals generally prefer contingent reinforcement, but now we need more research to know the boundaries of this preference, as well as the conditions that give rise to this preference in order to optimize preferred environments that promote adaptive behavior.

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