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Comparison of Paired- and Multiple-Stimulus Preference Assessments using a Runway Task by Dogs

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Preference assessments identify foods that might be valued by an animal but do not capture differences in the magnitude of value. In combination with demand, the more effort required to acquire the commodity, the more valued and likely it is to function as an effective reinforcer for use in dog training. In the current experiment, two preference assessments' applicability was measured using a combination of choice assessment and an effortful runway task. Eight dogs experienced a paired-stimulus preference assessment and multiple stimulus without replacement preference assessments combined with a 3-m runway task. The preference assessments identified different most-preferred foods but the same least-preferred foods. The reinforcer assessment results showed that the dogs moved faster to obtain their most preferred food as identified by the multiple-stimulus-without-replacement-assessment compared to the most preferred foods identified in the paired stimulus assessment. The *paired*- or *multiple-stimulus-without-replacement* preference assessments identified highly valued foods; however, the applicability of that commodity as a reinforcer was not independent of the assessment method. To ensure accurate reinforcer identification and consistency, a preference assessment should be conducted under similar conditions to that experienced when the reinforcer is used in training. Overall, the multiple stimulus without replacement preference assessment would be more useful to trainers, owners or scientists wanting to identify high-value foods for their animals to function as effective reinforcers for the elicitation of behaviors in a training context.

Keywords: dog, food preference, MSWO, multiple stimulus, paired stimulus, reinforcer assessment, response latency, runway

Positive reinforcement involves delivering a reward following the production of a target behavior that subsequently increases the likelihood that this behavior will be repeated in the future (Skinner, 1987; Thorndike, 1911). When using positive reinforcement when training dogs (*Canis familiaris*), it is important to use a reinforcer that the animal highly values (e.g., Cameron et al., 2019; Vicars et al., 2014). For pet dogs, successful dog training results in good welfare with positive human-animal relationships (Deldalle & Gaunet 2014; Hiby et al., 2004; Payne et al., 2015) and decreases the likelihood of the dog developing negative or problematic behavior (Blackwell et al., 2008).

The present paper extends a previously published report by Cameron et al. (2019), who measured preference and demand for raw foods in dogs using a runway task and a paired-stimulus preference assessment. In combination with a preference assessment, effortful behavior provided reliable and accurate identification of high-value reinforcers in dogs. The current experiment aimed to compare the applicability of two commonly used preference assessments used with humans to assess dogs' reinforcer preferences. This included the paired-stimulus (PS; e.g., Cameron et al., 2019; Pace et al., 1985) and multiple-stimulus-without-replacement (MSWO; e.g., DeLeon & Iwata, 1996) preference assessments in combination with a runway task. The most and least-preferred foods identified by both the methods were then presented to dogs in a reinforcer assessment to confirm the utility of one of these methods for use by pet owners and trainers as an accurate and fast way of identifying reinforcers for use in animal training.

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Preference assessments have been used to identify items of value that might function as reinforcers to be used in teaching humans (e.g., DeLeon & Iwata, 1996; Fisher et al., 1992). They have also been used to inform training methods and potential reinforcers in dogs (e.g., Cameron et al., 2019; Feuerbacher & Wynne, 2014), horses (*Equus caballus*; Elia et al., 2010) and orangutans (*Pongo* spp.; Clay et al., 2009). In addition, preferred foods need to be identified to ensure prolonged responding in behavioral experiments (e.g., in brushtail possums [*Trichosurus Vulpecula],* Cameron et al., 2013; hens [*Gallus gallus],* Sumpter et al., 2002), or provide appropriate enrichment for cats (*Felis silvestris catus*; Vitale Shreve et al., 2017), lizards (*Plica plica;* Januszczak et al., 2016) and rabbits (*Oryctolagus* cuniculus; Seaman et al., 2008). It is common to observe idiosyncratic differences in preference for items among individuals and also to observe group-level differences that indicate demand for the item, such as responding on a lever many times or moving faster along a runway to gain their preferred food (Cameron et al., 2019).

The PS preference assessment is simple to execute. It requires small amounts of food (Riemer et al., 2018; Vicars et al., 2014) and has been reported to be reliable over short periods (Cameron et al., 2013; Clay et al., 2009). Pairs of food samples or items are offered systematically to the subject during a session, and their choice is recorded (Fisher et al., 1992), often repeated over time with randomised pairs of foods to measure stability over time, for example, over two weeks (Cameron et al., 2013). Once all possible pairs have been offered to the subject, the foods or items can be rank-ordered to determine preference. PS assessments were used by Vondran (2013) to investigate the novelty effect in dogs and cats and found that novel foods were preferred over a long-term staple diet by both species. This effect may only be present in adult animals; puppies showed a preference for the diet on which they were weaned when the diet was considered the more highly palatable option, compared to puppies fed a less palatable diet who then preferred a diet of novel foods (Ferrell, 1984). When both groups were fed a staple food made equal in palatability, puppies preferred a novel food (Ferrell, 1984). Similarly, Bremhorst et al. (2018) found that dogs offered either a constant or varied food award would tend to prefer the varied option, or were more likely to choose the varied option, by the end of the experiment, possibly habituating to the constant reward.

In contrast, the MSWO method is a more complex procedure than the PS preference assessment as several items are offered initially, followed by the relocation of each item in each subsequent trial. However, it has been reported as more efficient to conduct than the PS method, at least in humans (DeLeon & Iwata, 1996; Fisher & Mazur, 1997). The MSWO procedure is also less demanding on the animal than the PS assessment. It does not require the repetition of numerous trials measuring each potential food pair to procure a rank order of preference. Between one and three MSWO trials have been reported to identify a rank order of preference in humans (Carr et al., 2000; Richman et al., 2016). In addition, for humans, an abbreviated version of the MSWO is short enough to be repeated before each training session to ensure the most highly valued item is used in that session (Bremhorst et al., 2018; Fisher & Mazur, 1997; Martin et al., 2018).

Comparable results of PS and MSWO assessments have been reported in humans (e.g., DeLeon & Iwata, 1996; Ortiz & Carr, 2000; Roane et al., 1998). There are some reports of the PS and multiple stimulus methods identifying different most- or least preferred foods or rank orders of preference in humans (Call et al., 2012; Davies et al., 2013; Reed et al., 2009). Few researchers have utilized the MSWO method in animals. Martin et al. (2018) completed 66 sessions of the MSWO assessment with rhesus macaques and found that the five foods' median rank order remained stable over up to a year for most animals. They observed that the most preferred food used as a reinforcer for touching a target resulted in a higher response rate and breakpoint than when the least preferred food was offered. Fulgencio (2018) tested the efficiency of the PS and MSWO assessments in dogs. However, the PS method was considered more efficient as the MSWO required more effort on the part of the experimenter, including both their time and complexity of conducting the assessment. Completing this assessment for dogs, which required two experimenters, is impractical in a dog shelter environment (Fulgencio, 2018).

Following a preference assessment, a reinforcer assessment is used to confirm the identification of a high-value food that might function as a reinforcer (Cooper et al., 2007). Reinforcer assessments have been conducted in a range of animals using operant manipulanda such as a lever or key that, when pressed according to a schedule of reinforcement, measures the demand for a commodity. The more effort required based on the organism's ability to perform a task relevant to their ecology to acquire the commodity, the more valued or in demand the commodity. In the original experiments, rats and monkeys were required to respond under increasing fixed-ratio (FR) or progressive-ratio (PR) schedules of reinforcement to measure the demand for particular commodities, such as electrical brain stimulation (Hursh & Natelson, 1981), drugs (e.g., Hursh & Winger, 1995), or food (Hursh, 1978; Hursh et al., 2013). These demand experiments function as an analogue of human behavior when viewed from a behavioral economic perspective.

In more recent experiments, researchers have used similar methods of measuring animals' effort to improve welfare by providing commodities that the animals identify as highly valued. This is done by requiring the animals to respond more for a particular commodity over another, such as on FR schedules (e.g., Foster et al., 2009), assessing at what response requirement the animal switches from one commodity to the other (Cameron et al., 2015; Cameron et al., 2016). For example, a custom-built dual lever system was used to measure the preference and demand for a foraging substrate in pigs (Pedersen et al., 2005). The pigs responded more times for their preferred substrate even when another substrate was available for less effort. Dawkins (1988, 2004) argued that when animals work harder to obtain a particular commodity, as indicated by the pigs in the study by Pederson et al. (2005) the commodity should be made available to aid in good welfare for the animal, as long as the item is not detrimental to the animal.

For animals, such as dogs, that can be harnessed and easily handled, some methods allow for a relatively easy assessment of preference for different consequences. For example, methods such as performing a nose-touch to a touch screen (Vicars et al., 2014), the time spent holding the experimenter's gaze (Bentosela et al., 2009), or requiring dogs to travel a runway where the latency to travel the distance (e.g., Cameron et al., 2019) are taken as operational measures of preference for the different consequences subsequently offered for the target response on those tasks.

When demand procedures have been used that require effort on the part of the animal to acquire the commodity, they have resulted in lower rates of responding or larger latencies when their least-preferred or staple food is offered as a reinforcer compared with when a more highly valued commodity is available (e,g., Cameron et al., 2019; Thompson et al., 2016; Vicars et al., 2014) or a larger amount of food (Leonardi et al., 2012; Riemer et al., 2018). In other contexts, preference and demand procedures have been shown to discriminate familiar from novel foods (Vondran, 2013), a meat-based food from non-meat based (Bentosela et al., 2009; Thompson et al., 2016), and between different amounts of food (McGuire et al., 2018). A preference assessment can also be conducted in combination with an effortful response, such as that required on a runway task (Cameron et al., 2019). In a runway, the animal moves down the runway to where a highly-valued food has been placed. The faster the animal moves to acquire the food indicates the value of the food to the animal relative to lesser preferred foods.

The current study aimed to compare PS and MSWO preference assessment results when that assessment is combined with an effortful task. This involved identifying a rank order of preference for six types of food using both methods. A reinforcer assessment would then follow that preference assessment to assess if the foods identified as most- and least preferred in either method predicted faster latencies to complete a simple and otherwise uneventful 5-m runway task as used in Cameron et al. (2019). We predicted that both preference assessments would provide the same rank order of foods and that the dogs would approach their most-preferred food faster than their least-preferred food.

Method

Subjects

Eight companion dogs of various breeds participated in the experiment (see Table 1). Because owners were required to participate in the testing over multiple sessions, recruitment of dogs was opportunistic and resulted in various breeds and sizes of dogs participating. The University of Auckland Ethics committee approved this research (approval number 001769).

Table 1

Name, Sex, Breed and Order of Preference and Reinforcer Assessment for Each Dog

Dog (Sex)	Breed	Order of Assessments	
		First Preference Assessment	Reinforcer Assessment
Ellie (F)	Samoyed	MSWO	BABA
Foible (M)	Shih Tzu	PS	ABAB
Geordie (M)	Shih Tzu	PS	ABAB
Harry (M)	Labrador	MSWO	BABA
Hine (F)	Jack Russell	MSWO	-
Max (M)	Huntaway X	PS	ABAB
Mollie (F)	Pit Bull	MSWO	BABA
Zac (M)	Border Collie	PS	ABAB

Note. A = most preferred food, B = least preferred food. Hine did not complete the reinforcer assessment due to injury.

Apparatus

Experimental sessions were conducted in the same location each session and took place either in the owner's home or in a designated room on the Unitec campus of which the dogs were familiar. A virtual runway was created with a straight space approximately 3-m long. At the end of the runway was a screen hiding the experimenter. Identical food plates were placed in front of the screen so the experimenter could reach over and down to move or replace small identical plates of food samples.

In the three days before the first preference assessment sessions, owners were asked to familiarise their dog with the test foods (carrot, cheese, chicken, liver, and sausage) by feeding them a few samples in the days leading up to testing. The sixth food was each dog's staple biscuit. During preliminary testing with thirteen dogs, the test foods were chosen, and those represented the range of foods that elicited differential responding. Owners were also asked not to feed their dogs on the morning of each session.

Procedure

At the beginning of each trial, the dog would be held on a loose lead by the owner in a sit position at the beginning of the route. The owner would instruct the dog to move and then walk behind the dog to avoid developing an owner-induced side bias to the food samples. Half of the dogs first experienced three PS method sessions, followed by three sessions of the MSWO method, and the other half experienced the reverse order. At the beginning of each session, each food was presented singly on either the left or right side in the PS and on one of the six plates in the MSWO to familiarise the dog with the procedure and train the dog to search for food. Once a food was selected, operationalised as the dog picking the food up in their mouth and not expelling it, the dog subsequently ate it. The owner then led the dog in the same direction as the dog's selection (left or right) in a circular motion back to the starting point to await the next trial. There was minimal wait time between trials (less than 30 s). The experimenter would prepare the test foods behind the large screen according to the pre-determined order of presentation and replace the plate as the dog was walked back to the start point.

PS Preference Assessment

The PS preference assessment consisted of 30 trials, in which food presentation was counterbalanced across sides. Each food was offered on the left and right plate in separate trials and paired with every other food. The food pairs were presented in a pseudorandom order such that the same foods were not offered on successive trials. The number of times each food type was chosen determined the rank order of preference (see Cameron et al., 2013).

MSWO Preference Assessment

The MSWO preference assessment consisted of five assessment sessions, each of six trials, each making 30 trials in total, which varied in length but was no more than half an hour. During the first trial of each block, the food samples were placed in a pre-determined pattern on the food plates that formed a semicircle at the end of the runway. The RAND function in Excel provided the random starting order for each trial. Within each block of trials, the dog would walk down the runway, choose one food sample and walk back to the start line. This food was not replaced, and, for each subsequent trial, each food or empty plate's position was moved one position to the left to aid the experimenter in keeping track of the experiment out of sight of the dog. Each food was placed on the same plate across trials/sessions. The order in which the food was chosen in each assessment was summed and the Excel RANK.AVG function was used to calculate a rank order for each session based on the five assessments (the first being ignored). This method is based on that reported by DeLeon et al. (1997), where the number of times the food was chosen was divided by the number of trials when the food was available and was used to determine a rank order of preference.

Reinforcer Assessment

The method used in the present experiment was the same as that used by Cameron et al. (2019). The dogs were required to move from a sitting position down an extended runway to a point 5-m distant for a food sample of either their most or least preferred foods identified from the PS and MSWO methods for a total of two sessions of reinforcer assessments. The distance was chosen to differentiate it from the preference assessments and be a distance most homes could accommodate as most assessments were conducted in the owner's home. The most and least preferred foods from each method were identified by calculating the average rank from the sum of the ranks for each food across the three sessions for the PS method and each trial of the MSWO over the three sessions. Owners would hold their dogs in place by the collar then release the dog to move toward the food, saying "go". The latency from the start to the dog picking up the food was measured using a stopwatch by the experimenter. The owner would then attach a lead and return the dog to the start position. Order effects were minimized by having half the dogs experience the test according to an ABAB design and the other half experiencing a BABA design (Table 1): There were five trials per block with A = most preferred food and B = least preferred food. One dog, Hine, hurt her leg before the reinforcer assessment and did not participate.

Results

All food types were selected at least once by all dogs in the paired stimulus preference assessments. Friedman tests revealed no differences between the rank orders of food for the three PS assessments [Ellie, $F(2) = 0.78$, $p = .678$; Foible, $F(2) = 0.33$, $p = .846$; Geordie, $F(2) = 0.10$, $p = .951$; Harry, $F(2) = 0.11$, $p = .946$; Hine, $F(2) = 1.08$, $p = .584$; Max, $F(2) = 0.67$, $p = .717$; Mollie, $F(2) = 0.44$, $p = .801$; and, Zac, $F(2) = 0.10$, $p = .951$]. Table 2 shows the rank order of preference for the foods for each dog averaged over the three sessions. Overall, sausage was the most-preferred food for four of the eight dogs, with two dogs indicating their most-preferred food was chicken or their staple food. Carrot was the least-preferred food for six dogs, with the remaining dogs indicating their staple and cheese as their least-preferred foods.

Table 2

The Rank Order of Preference in the PS and MSWO Assessments for Each Dog

Dog	Order of Preference PS						Order of Preference MSWO					
	Most preferred	2nd	3rd	4th	5th	Least preferred	Most preferred	2nd	3rd	4th	5th	Least preferred
Ellie	Sausage	Chicken/ Staple		Cheese/ Liver		Carrot*	Staple[3]/ Liver		Sausage	Chicken	Cheese	Carrot
Foible	Sausage	Liver	Chicken/ Cheese		Staple[1]	Carrot*	Cheese	Sausage	Chicken	Liver	Staple[1]	Carrot*
Geordie	Sausage	Staple	Chicken	Liver	Cheese[2]	Carrot	Cheese	Chicken	Sausage	Staple	Liver[1]	Carrot*
Harry	Chicken	Cheese	Sausage	Carrot	Liver	Staple	Sausage[4]	Chicken	Carrot	Staple	Cheese	Liver
Hine	Chicken	Cheese	Sausage	Liver	Staple[1]	Carrot*	Sausage	Liver	Chicken	Cheese	Staple	Carrot*
Max	Staple	Liver/ Sausage		Carrot	Chicken	Cheese	Sausage	Staple	Cheese	Chicken	Liver	Carrot*
Mollie	Staple	Sausage	Cheese/ Liver		Chicken[1]	Carrot*	Chicken	Staple	Sausage	Liver/ Cheese		Carrot
Zac	Sausage	Cheese	Liver	Chicken	Staple[2]	Carrot	Cheese	Chicken	Liver	Sausage[1]	Staple	Carrot

Note. * = no trials where this food was eaten in the preference assessment. In most cases, the 5th most preferred food was used instead to maintain movement behavior on the runway. 1 = the 5th preferred food replaced the 'least-preferred' food in the reinforcer assessment as no actual consumption of carrot occurred in the preference assessment trials. 2 = the 5th preferred food replaced the 'least-preferred' food in the reinforcer assessment as no consumption of carrot occurred in initial trials. 3 = the most-available food ranked most preferred was used as the most preferred food in the reinforcer assessment. 4 = error in use of 'most-preferred' food in reinforcer assessment – cheese was used.

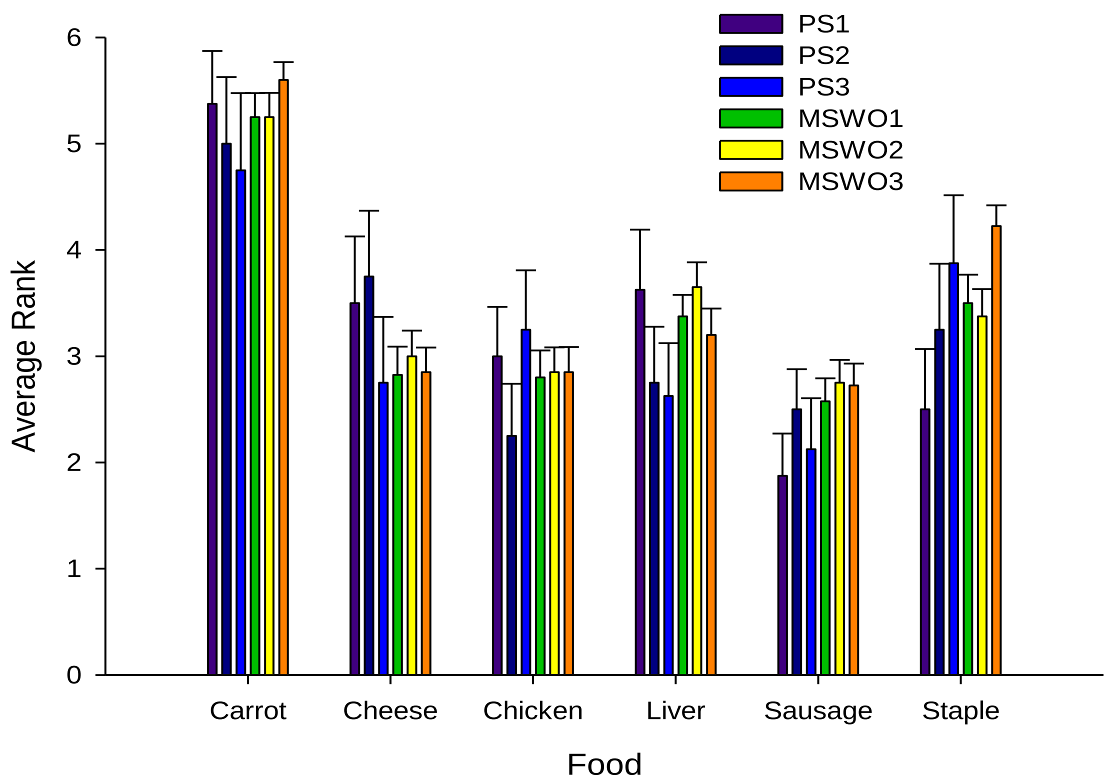
Friedman tests revealed no differences between the rank orders of food for the three MSWO assessments [Ellie, $F(2) = 0.74$, $p = .692$; Foible, $F(2) = 0.13$, $p = .939$; Geordie, $F(2) = 0.00$, $p = 1.00$; Harry, $F(2) = 1.14$, $p = .565$; Hine, $F(2) = 0.15$, $p = .926$; Max, $F(2) = 0.61$, $p = .738$; Mollie, $F(2) = 0.00$, $p = 1.00$; and, Zac, $F(2) = 0.00$, $p = 1.00$]. Table 2 shows the rank order of preference for the foods for each dog averaged over the three sessions. Cheese (three dogs) and sausage (three dogs) were the most-preferred foods for six of the eight dogs, with one dog indicating a preference for their staple food or liver and the remaining dog preferring chicken. Carrot was the least-preferred food for seven dogs with four of these dogs never selecting it. The remaining dog indicated liver was their least-preferred food.

A comparison of rank orders of foods identified in the PS and MSWO assessments indicated consistency across sessions within each assessment, and Friedman tests revealed no differences between the rank orders of food identified in the PS and MSWO assessments for individual dogs [Ellie, $F(2) = 1.71$, $p = .888$; Foible, $F(2) = 2.50$, $p = .776$; Geordie, $F(2) = 1.71$, $p = .888$; Harry, $F(2) = 0.87$, $p = .973$; Hine, $F(2) = 1.56$, $p = .907$; Max, $F(2) = 0.87$, $p = .973$; Mollie, $F(2) = 0.16$, $p = 1.00$; and, Zac, $F(2) = 0.78$, $p = .979$]. Between the two assessments, however, a different most preferred food was identified for all dogs. The same food, namely carrot, was identified as least preferred for six out of eight dogs.

When aggregated across dogs, the average rank orders for the foods were more stable and similar across foods in the MSWO assessment with smaller standard errors of the mean compared to the PS assessment (Figure 1).

Figure 1

The Average Rank of Each Food in Each Session of the PS and MSWO Preference Assessments Aggregated across Dogs



Note. The error bars indicate the standard error of the mean.

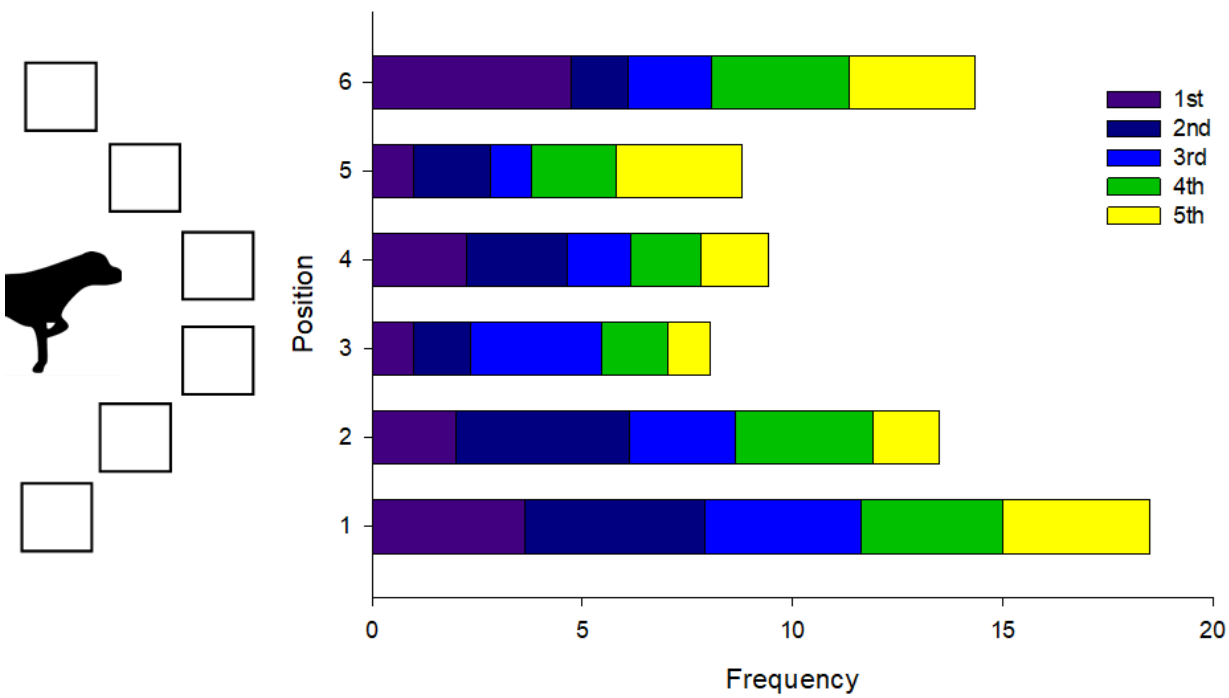
The PS session consisted of one assessment of 30 trials, and an MSWO session consisted of five assessments of six trials, each totalling 30 trials. The average rank order obtained on Day 1 was correlated with the final averaged rank order across all sessions. For all dogs, there was a strong positive correlation between the rank orders on Day 1 (30 trials) and the final averaged rank order over three sessions (Ellie, $r_{sp} = .91$, $p = .013$; Foible, $r_{sp} = .66$, $p = .156$; Geordie, $r_{sp} = .99$, $p < .001$; Harry, $r_{sp} = .84$, $p = .036$; Hine, $r_{sp} = .94$, $p = .005$; Max, $r_{sp} =.80$, $p = .051$; Mollie, $r_{sp} = .81$, $p = .05$; and, Zac, $r_{sp} = .64$, $p = .173$). For the MSWO assessment, a single session, made up of four assessments (the first assessment being excluded), provided a reliable rank order of preference compared to the averaged rank order across all sessions for five dogs (Ellie, $r_{sp} =.81$, $p = .050$; Foible, $r_{sp} =1.0$; Geordie, $r_{sp} = .93$, $p = .008$; Hine, $r_{sp} = .88$, $p = .020$; Max, $r_{sp} =.93$, $p = .008$; and, Zac, $r_{sp} =.77$, $p = .072$). Additional sessions were required to obtain a reliable rank order for Harry ($r_{sp} = .09$, $p = .860$) and Mollie ($r_{sp} =.41$, $p = .425$). For Harry, a stronger correlation was established in assessments by the end of Day 2 ($r_{sp} = .93$, $p = .008$) and for Mollie, by the end of Day 3 ($r_{sp} = .71$, $p = .111$).

It was of interest whether the position of the foods in the MSWO affected food choice. Figure 2 shows the pattern of food choices across dogs based on the rank order of food choice. The graphic shows that foods ranked 1st and 2nd are chosen from the outer food plates and that the dogs alternate their choices, choosing from the far left, then the far right moving inwards as trials progress. When aggregated across dogs, a Friedman analysis revealed no significant effects of rank or position for particular food choices [$F(2) = 2.17$, $p = .337$]. However, Wilcoxon Signs rank tests revealed that foods were selected preferentially while in positions 1, 2, and 6, compared to positions 3, 4, and 5 (all *p*s < .001), but this did not impact the overall rank order of preference.

For individual dogs, there were differences in the effects of the position of the food. Kruskil-Wallis tests revealed that the food choices were higher in position 1 by Ellie [$H(4) = 45.96$, $p < .001$], in positions 2, 4, and 6 by Hine [$H(4) = 17.86$, $p < .001$], and in positions 2 and 6 by Max [$H(4) = 14.62$, $p = .006$], compared to the other food plate positions. Max was the only dog to show that preference position significantly affected his choices [$H(4) = 23.03$, $p < .001$].

Figure 2

The Frequency of Food at Each Rank (1st – 5th; Averaged Across Dogs when Selected at Each Position in the MSWO Preference Assessment)

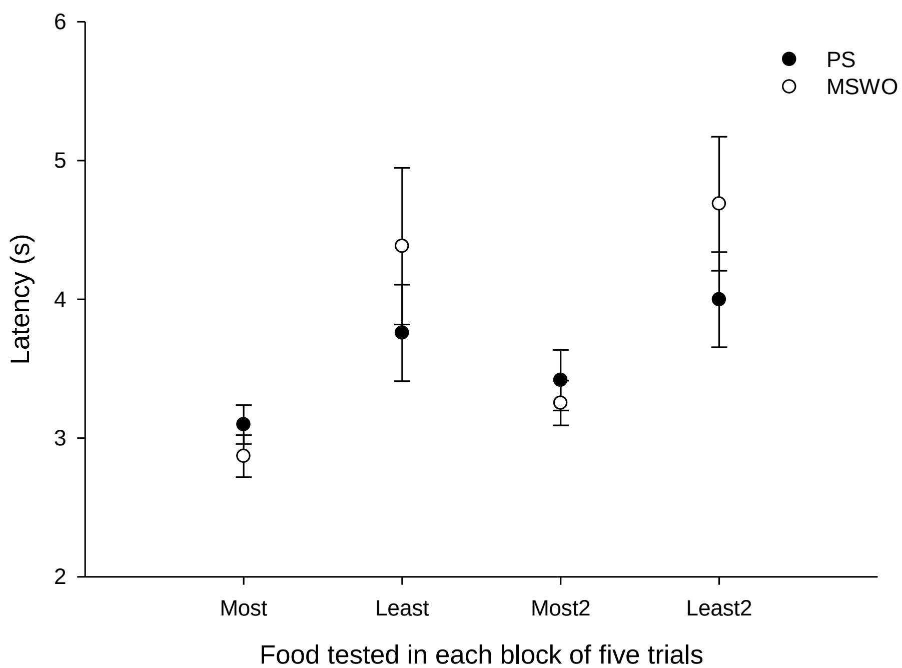


Note. Foods ranked 6th (carrot) were not included as these foods were not consumed by four dogs.

The most preferred foods for the PS and MSWO were unanimously different for each dog, indicating the need for a reinforcer assessment to confirm the most preferred food using a latency task. The reinforcer assessment required each dog to move 5 m to earn a sample of food. The samples were the most- and least-preferred foods for each dog (Figure 3). The first trial for each block was omitted in the analysis. The data for Harry was also excluded because the wrong food was tested in the reinforcer assessment. Wilcoxon sign ranks tests revealed significantly faster latencies to travel 5 m to obtain either the most- and least-preferred foods identified in the PS assessment ($Z = -2.31$, $p = .021$) and MSWO assessment ($Z = -4.84$, $p < .001$). There was a significant difference in the travel times between the first and second block of testing of the most preferred food identified in the MSWO assessment ($Z = -2.27$, $p = .023$) but not between blocks for the most preferred food in the PS assessment or least preferred foods in both assessments (all *p*s < .05).

Figure 3

The Latency in Seconds to Obtain the Most and Least Preferred Foods as Identified by the PS and MSWO Preference Assessments Averaged across Dogs



Note. Either the most or least preferred food was tested in each block of five trials (first trial and Harry omitted for analysis); the most or least preferred food was tested in two blocks each. The error bars indicate the standard error of the mean.

When the latencies were aggregated for the most- and least-preferred foods across dogs for each assessment method, the latencies were more similar in the PS than MSWO assessments. Travel times to obtain foods identified as least preferred in the MSWO assessment ($M = 4.72$ s, SE = 0.39 s) were slower than those identified in the PS assessment ($M = 4.04$ s, SE = 0.25 s; $Z = -2.45$, $p = 0.014$), and the most preferred foods identified in the MSWO assessment ($M = 3.14$ s, SE = 0.12 s) were faster than those identified in the PS assessment ($M = 3.36$ s, SE = 0.13 s; $Z = -2.42$, $p = 0.016$). This means that the dogs moved faster to obtain their most preferred food as identified by the MSWO assessment compared to the most preferred foods identified in the PS assessment.

Discussion

The current study compared the rank order of preferences for six foods identified by PS and MSWO preference assessments in combination with a runway task. The runway task that was used in the preference assessments provided a measure of demand for food. As the dog puts forth effort to move down the runway, it follows that after such expenditure, they select their most preferred food before repeating the work required to select the next most preferred item. The MSWO assessment appears to be a more accurate procedure than the PS assessment because the most preferred foods identified in the MSWO assessment resulted in faster latencies than the most preferred foods identified in the PS assessment in a runway task. This indicates that the way the preference tests are presented (either with food in pairs or with many available at one time) impacts the choices made by the dogs, which, therefore, indicates that the context of choice is important in determining a reinforcer. Overall, the MSWO assessment combined with a runway task would negate the need for a separate reinforcer assessment and could feasibly identify a rank order of food for use by owners in training their dogs in a single session consisting of five MSWO assessments.

Both of the assessment methods were reliable in that each provided a similar rank order of preference over sessions. The average rank order of the preference supplied by both the PS and MSWO assessments were reliable in a single session when correlated with the averaged rank order across the three sessions. However, the two assessments identified two different foods as the most preferred food. When each food was tested in the reinforcer assessment, the dogs moved faster to obtain foods identified as most preferred in the MSWO assessment rather than those identified in the PS assessment. Furthermore, the PS is a derived assessment of preference with pairs of foods offered and the rank order calculated. In contrast, the MSWO is a direct test as all options are offered at once, which is a truer measure of relative preference.

The theory of motivating operations and stimulus control has been discussed in depth in the literature (e.g., Edwards et al., 2019; Michael, 1982). What might function as a reinforcer for a particular organism during testing on a specific day may change the next day, due to internal and external factors, such as their history of reinforcement, the current level of deprivation, or disposition (Killeen & Jacobs, 2017; Webber et al., 2015). For example, dogs learn to prefer varied rewards after habituating to a constant and likely highly-valued food (Bremhorst et al., 2018). Preference assessments should be conducted under similar conditions to what is experienced when the reinforcer is used in practice to assist in identifying a stable reinforcer for training behavior when, other than immediate food deprivation, all other factors that might affect choice are unmeasurable by the trainer. In dog training, this might include location, handler, level of hunger, or even type of response operanda that they will experience during training.

This study yielded surprising results in that the most preferred foods were different in the PS and MSWO assessments with the MSWO assessment, generally identifying more valued foods. Therefore, the foods appear to differ in their value as a reinforcer depending on how the question is asked, which is not ideal when trying to identify a potent reinforcer. Differences in the identification of the most- or least preferred or rank order of items have been found between PS and MSWO assessments with humans (e.g., Call et al., 2012; Davies et al., 2013; Reed et al., 2009). Reed et al. (2009) identified different rank orders of items between PS, MSWO, and free-operant (all options available for the entire session) assessments. Then, the participant pressed a switch according to a simple progressive ratio (PR) schedule to earn each item. Items identified as highly-preferred in each of the assessments elicited responding to the largest breakpoints. The food identified as most-preferred by the PS assessment elicited the highest response rate. Our experiment only tested the most and least preferred foods in the reinforcer assessment, and future testing could include all possible reinforcers. The fact that the PS and MSWO identified different most-preferred items across animals is important and highlights the need to understand how asking the question changes preference.

When to use the PS or MSWO assessment is now an important consideration for animal trainers. In our experiment, the MSWO assessment identified more highly valued foods than the PS assessment; thus, if feasible, this method is more useful because it is fast and appropriate for regular or pre-training usage (Call et al., 2012; DeLeon & Iwata, 1996) due to its single session and trial utility compared to the paired stimulus which requires more trials to prepare a rank order of preference. Fulgencio (2018) found that in dogs, the PS assessment was easier and faster to implement. The number of trials for the PS and MSWO assessments and the runway approach was the same in the current experiment. However, the experimenter reported that both assessments were similar in effort from her point of view as the runway provided plenty of time to reset the experiment for each trial. Two people were needed to conduct both assessment methods, one to prepare the food and the other to handle the dog, which is impractical in some settings such as in an animal shelter (Fulgencio, 2018). Given time and for a single person and situations with dogs that might not be able to walk on a lead, such as those in a shelter or with histories of aggression, the PS could be more useful than MSWO. Presenting a simple paired stimulus assessment through an enclosure door might prove advantageous, safe, and manageable to building positive associations with humans and identifying a reinforcer to improve the behavior for future training attempts.

The MSWO assessment provided an accurate identification of a high-value food within a single session for most dogs; however, three dogs selected foods based on their position in the semicircle, but this only affected the rank order of preference for one of these dogs. Waterhouse and Fritsch (1967) found that 5 of 100 dogs displayed a bias to one side of their cage during a PS assessment. They suggested that cage-side bias be tested after the animals' relocation, possibly due to the cage's external environment, such as a conspecific in the adjacent cage. In the current experiment, the sides of the environment were kept as similar as possible to attenuate the possibility of a position bias during testing. Still, the small amount of bias highlights early identification of any bias to conduct correction trials or eliminate environmental causes. Also, we used a small number of dogs to test our method and identify improvements to the design and identified small adjustments in future trials of the method to increase the validity of the findings. This includes using a clean empty plate instead of a plate that had contained the previously selected foods to minimize lingering effects of foods and to completely randomise the order of foods each trial (rather than at the beginning of each block) to mitigate the development of biases.

In conclusion, the PS method appeared to provide a consistent rank order with fewer but more intensive sessions. In comparison, the MSWO was faster and fractionally less effective at identifying a consistent rank order of preference in a single session, more suitable for regular pre-training testing. Overall, the MSWO identified the most valued food for reinforcing a behavior, such as moving down a runway. For this reason, we suggest that the MSWO preference assessment would be more useful to trainers, owners, or scientists when conducted in a similar environment to that employed during training, to identify high-value foods for their animals regularly to function as effective reinforcers for the elicitation of behaviors in a training context.

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