



# Puppy food preferences are maintained in adulthood

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**Abstract:** Balanced diets that meet nutritional requirements for various life stages of animals are important to sustain health as dietary needs change with development. Dog owners want to offer a tasty and nutritionally balanced diet to their dogs. Dog food product developers strive to formulate such diets in a timely manner and that meet a dog's specific nutritional requirements in various life stages. Palatability assessments during product development can be expensive and time-consuming when evaluating specially designed foods for multiple breed types, dog sizes, and ages of dogs. Assessments of puppy food by puppies is especially expensive because a narrow window for food trials exists before they reach adulthood. Moreover, it is not practical or ideal for palatability assessment centers to continually acquire puppies when the dogs can only test as puppies for a fraction of their lifetime. Thus, we evaluated if preference trials of diets formulated specifically for small breed puppies could be assessed by small breed adults and yield similar results. We ran seven paired preference trials over 14 days with twenty dogs at ages 5-8 months old (i.e., puppyhood) and again at 14-17 months old (i.e., adulthood). In six of seven trials, dogs were consistent in their preference as adults and as puppies. While it is not recommended that dog owners feed their adult dog puppy food on a regular basis, the results suggest that pet food developers do not need to have constant access to puppy panels to evaluate palatability of puppy foods. Rather, adult dog panels could be a quicker, more practical, and more economical option to aid pet food developers in getting a product to market that puppies would likely enjoy.

**Key Words:** development; dog; food; palatability; preference; small breed;

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## Introduction

Growing puppies should be fed a diet specifically formulated to meet their nutritional needs for normal development. Puppy foods are specially designed for their nutritional needs during growth, so feeding adult food will rob your puppy of important nutrients, such as higher levels of protein and fat (American Kennel Association, 2018).

Palatability is a critical component when formulating dog food in addition to essential nutrients, because a quality food is of little value if the dog will not eat it. "Palatability" describes how well a dog likes the taste, smell, and texture of a food (IAMS Pet Food, 2018). Premium dog food manufacturers spend considerable time conducting controlled feeding studies to determine the right combination of ingredients and processing techniques to produce a nutritious and palatable food (IAMS Pet Food, 2018). Palatability is vital during puppyhood to ensure food intake for normal growth and development.

Taste preferences of puppies may change as they age. A study of free-ranging dogs in India found that adult dogs showed a preference for meat, while puppies did not (Bhadra & Bhadra, 2014). Developmental changes in food preferences have been documented in a variety of other species from birds to humans. Fledged house sparrows abruptly switched from preferring insects

to seeds (Mueller, 1986). Four to 24-month-old human infants showed a heightened acceptance for saline solution relative to water; however, by 31-60 months they tended to reject saline solution relative to water (Beauchamp et al., 1986).

We focused on small breed dogs because of the trend for increasing ownership of these dogs. Small breed ownership has increased 4% from 2012 to 2017 (Euromonitor, 2018), and pet food companies are responding to this by launching small breed puppy food lines. Blue Buffalo, Diamond, Eukanuba, Holistic, Iams, Nutro, Purina ProPlan, Royal Canin, and many other brands now produce small breed puppy foods, which are typically marketed for dogs less than one year of age. Small breed dogs, which are 9 kg (20 lbs.) or less when fully grown, usually transition to an adult formula when they are 9 to 12 months of age (IAMS Pet Food, 2018; Nestle Purina, 2018), whereas medium dogs transition between 12 and 14 months old, and large breeds (greater than 22.7 kg (50 lbs.) when fully grown) transition between 12 and 24 months of age.

Small breeds can be advantageous when assessing adult food preferences, because they reach adulthood sooner (Hawthorne et al., 2004). On the other hand, small breeds are puppies for less time than other breed sizes, which could be a disadvantage for assessing puppy food preferences long-term. Due to the relevance of having puppies assess puppy food, yet the narrow window of opportunity that small breeds are puppies, we address whether young adults are suitable to assess puppy food. If found to be suitable, costs of high-maintenance puppy panels at assessment centers could be reduced, a broader range of specially formulated foods can be assessed in a shorter amount of time and retaining quality assessment dog panels long term would be an economical benefit for assessment centers.

The current study assessed the stability of puppy food preferences from puppyhood (5-8 months of age) to young adulthood (14-17 months of age) for small breed dogs. The topic is of interest to both dog owners and dog food developers. Dog owners can be confident their puppy will enjoy a food despite palatability assessments by adult dogs, and food developers can be confident adult dogs are suitable, more practical, and more economical in assessments of puppy foods.

## Material and methods

### *Subjects*

Twenty small breed dogs were purchased at 8-11 weeks of age from a private breeder and raised at AFB International's Palatability Assessment Resource Center (PARC; Saint Charles, MO). Breeds and breed mixes included: Cavapoo, Cavalier, Poodle, Pekepoo, Yorkiepoo, Shihpoo, Teddy Bear, and Maltese. Dogs were spayed or neutered at 16 weeks of age. Fourteen were male and 10 were female; their adult weight ranged from 2.7 to 7.3 kg (mean = 5.9) (6 to 16 lbs.; mean = 13).

The dogs were group-housed but were individually kenneled during feeding trials. The amount of food a dog was allowed to consume in each trial was determined based on each dog's body condition score based on a 5-point scale (American Animal Hospital Association, 2010). This study was approved by the Institutional Animal Care and Use Committee (Protocol C1.001).

### *Food trials*

The first round of feeding trials (puppy age; 5-8 months) was conducted in September 2017, and the second round (adult age; 14-17 months) in June 2018. Puppies were not assessed until 5 months of age because of training required to perform the pet food industry standard paired preference trial (described below).

Seven pairings of commercially available puppy foods were offered to dogs twice over 14 days

(Table 1) during each round. Food pairings and the order in which they were offered remained the same between feeding rounds. Foods were offered as paired preference trials in which a dog is offered two bowls during mealtime, each containing one of the two foods. For the second day of each pairing, placement of food bowls was alternated between the left and right side to account for potential side bias. Dogs had up to 20 minutes to finish their meal. Mealtime occurred once a day in the mornings.

**Table 1.** Feeding trial design where each pairing of fourteen commercially available foods (A-N) was offered for 2 days. The seven trials were conducted when dogs were 5-8 months of age and again at 14-17 months of age (n=20 dogs).

Day	Trial	Left Bowl Placement	Right Bowl Placement
1	1	A	B
2	1	B	A
3	2	C	D
4	2	D	C
5	3	E	F
6	3	F	E
7	4	G	H
8	4	H	G
9	5	I	J
10	5	J	I
11	6	K	L
12	6	L	K
13	7	M	N
14	7	N	M

### Significance tests

Preference for one food over the other in each of the paired preference trials was determined by calculating the intake ratio. For each dog, the total amounts (in grams) of Foods A and B, for example, that were consumed over two days were calculated. The intake ratio was then calculated for each dog as the two-day total consumption of Food A divided by the two-day total consumption of both Foods A and B. Then, these two-day intake ratios were averaged over all dogs. The p-value is a measure of the statistical significance of the intake ratio. An intake ratio value that is statistically significant ( $< 0.05$ ) indicates an average preference for that food. Intake ratios that are not significantly different are generally regarded as showing parity, or the lack of a preference for one food. The p-value is based on a two-sided statistical test.

### Results

In six out of seven paired preference trials, dogs preferred the same puppy foods when they were puppy aged and when they were adult aged (Table 2). In two trials (Trials 6 and 7), parity preference was consistent across both rounds of feeding trials. Thus, despite no preference for one food over the other in these pairings, dogs were consistent in their no preference as puppies and as adults. In just one food pairing (Trial 5), dogs preferred one food over another as pup-

pies, but this preference did not persist as adults. These results support the suitability of young adult small dogs to assess preferences of puppy foods.

**Table 2.** Six of seven puppy food pairings yielded the same outcome when dogs were 5-8 months and 14-17 months of age (n=20 dogs).

Trial	Food Pairings	Dog Age					
		5-8 months			14-17 months		
		Preferred Food	Intake Ratios	p-value	Preferred Food	Intake Ratios	p-value
1	A vs B	A	98:2	<.001	A	83:17	<.001
2	C vs D	C	96:4	<.001	C	79:21	<.001
3	E vs F	F	23:77	<.001	F	29:71	<.001
4	G vs H	H	13:87	<.001	H	16:84	<.001
5	I vs J	J	30:70	<.05	NS <sup>a</sup>	40:60	>.1
6	K vs L	NS	53:47	>.1	NS	40:60	.096
7	M vs N	NS	56:44	>.1	NS	53:47	>.1

<sup>a</sup>NS indicates a non-significant result in which neither food was preferred.

## Discussion

Our results support the suitability of young adult small breed dogs for assessing puppy food when determining food preferences of small breed puppies. In six of the seven paired food trials, the dogs showed the same preference pattern when they were young adults (14-17 months of age) as they displayed when they were puppies (5-8 months of age). Small dogs are only puppies for a short period of time, which creates a time constraint for food developers when fine-tuning formulas small breed puppies will enjoy. However, this constraint can be viewed as less of a concern because the majority of food preferences persisted in young adulthood.

We were unable to assess if the taste preferences of very young small breed puppies (2 to 4 months) would align with the preferences shown by 5-8-month-old puppies. It is possible small breed dogs may show different taste preferences from adults if assessed in early puppyhood. Development of puppies is a delicate period, deeply influenced by the mother (Guardini et al., 2015; 2016; 2017) and external stimuli (Gazzano et al., 2008) and categorized into four phases: neonatal, transitional, socialization and juvenile (Nott, 1992). Puppies in this study were assessed during the juvenile developmental period.

Previous studies have shown that diet experienced in puppyhood can influence the development of food preferences. Therefore, it was previously assumed that puppies may be required to assess palatability of puppy foods. Kuo (1967) found that puppies raised with limited exposure to foods of varying odor and taste during the first six months of life showed narrow food preferences. In contrast, puppies raised with exposure to a mix of foods with different flavors and textures showed greater acceptance of novel foods (Kuo, 1967). We observed food preferences were primarily maintained from the juvenile puppy period to young adulthood, which could be because all puppies in this study were raised on variety of puppy foods that varied in odor, taste, texture, and appearance. The practice of varying puppy foods is done so that puppies will sample and assess the palatability of a wide variety of dog food products as adults.

The assumption that palatability of puppy food diets needs to be assessed by puppy taste

testers may have been promoted by studies of developmental factors that influence flavor preference in neonatal puppies. Wells & Hepper (2006) demonstrated that flavors in the mother's milk and amniotic fluid influence neonatal flavor preferences of puppies. They also showed that postnatal, but not prenatal, exposure to aniseed flavor significantly affected food preference of the puppies after weaning at 10 weeks of age. They found prenatal flavor learning was lost by weaning. Puppies are typically not fed commercial puppy food until weaning age. As our assessments did not occur until 5 months of age, any early transient flavor preferences puppies may have had would have not been detected in this study and would not have provide useful information for puppy food development.

We plan to longitudinally follow our small dogs' preferences by repeating similar trials at mature age, senior, and geriatric life stages to monitor changes in puppy food preference across their lifespan. For longitudinal assessments we will use homemade kibbles to control for formulation changes over time that will likely occur for commercially produced products. The later in life that preferences for puppy foods persist, the more economical it would be for assessment centers to have adult dogs assess puppy foods for puppies. It is possible that with age, especially during the senior and geriatric life stage, that food preferences may change due to increased flavor learning or decreased olfactory and taste sensitivity. Hirai et al. (1996) reported atrophic changes with degeneration in the olfactory epithelium of dogs older than 14 years, and prominent changes in dogs over 17 years old. With age there was a decrease in the number of olfactory cells, of cilia of olfactory cells, and microvilli of supporting cells, which are likely to change dog odor sensitivity to foods. This notion is supported by Pelchat's (2000) finding that elderly dogs with poor olfaction showed less reluctance to try unpleasantly smelling foods.

Naturally, adult dogs cannot replace every aspect of food assessment for puppies. Notably, special diets formulated for medical conditions in puppies are important to be assessed by puppies. Likewise, it is not recommended that adult dogs are fed a regular diet of puppy food, particularly adult dogs that are overweight.

## Conclusions

Taste preferences in small breed puppies at 5-8 months old were maintained when assessed again as young adults at 14-18 months old. This suggests that pet food developers do not need to have constant access to puppy panels to evaluate palatability of puppy foods. Rather, adult dog panels could be a quicker, more practical, and more economical option to aid pet food developers in getting a nutritionally balanced and tasty product to market that puppies would likely enjoy.

## Acknowledgements

The authors would like to thank the staff at the AFB International Palatability Assessment Resource Center. Their hard work and love of dogs made this research possible.

## Conflict of interest

This work was conducted by researchers employed by AFB International. AFB International produces pet food palatants. To prevent conflict of interest, all puppy foods offered in this study were commercially available and purchased from Pet Stores.

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## Le preferenze alimentari del cucciolo sono mantenute nell'età adulta

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### *Sintesi*

Le diete bilanciate che soddisfano i requisiti nutrizionali per le varie fasi della vita degli animali sono importanti per sostenere la salute poiché le esigenze alimentari cambiano con lo sviluppo. I proprietari di cani vogliono offrire ai loro cani una dieta gustosa ed equilibrata dal punto di vista nutrizionale. Gli sviluppatori di prodotti per alimenti per cani si sforzano di formulare tali diete in modo tempestivo e che soddisfino i requisiti nutrizionali specifici di un cane in varie fasi della vita. Le valutazioni della palatabilità durante lo sviluppo del prodotto possono essere costose e richiedere molto tempo quando si valutano alimenti appositamente progettati per più tipi di razza, dimensioni e età dei cani. La valutazione del cibo da parte dei cuccioli è particolarmente costosa perché esiste una finestra ristretta per le prove alimentari prima che raggiungano l'età adulta. Inoltre, non è pratico o ideale per i centri di valutazione dell'appetibilità acquisire continuamente cuccioli poiché restano tali solo per una breve frazione della loro vita. Pertanto, abbiamo valutato se le prove di preferenza su diete formulate specificamente per cuccioli di piccola razza potessero essere valutate da adulti di piccola razza e produrre risultati simili. Abbiamo eseguito sette prove di preferenza accoppiate per 14 giorni con venti cani di età compresa tra 5-8 mesi e di nuovo a 14-17 mesi. In sei delle sette prove, i cani erano coerenti nelle loro preferenze come adulti e come cuccioli. Sebbene non sia consigliabile che i proprietari di cani nutrano regolarmente i propri cani adulti con alimenti per cuccioli, i risultati suggeriscono che gli sviluppatori di alimenti per animali domestici non devono avere un accesso costante ai gruppi di cuccioli per valutare l'appetibilità degli alimenti a loro destinati. Piuttosto, i cani adulti potrebbero essere un'opzione più rapida, più pratica ed economica per aiutare gli sviluppatori di alimenti per animali domestici a ottenere sul mercato un prodotto che i cuccioli probabilmente apprezzeranno.

