# For Smarter, More Trainable Puppies:

# Effect of Docosahexaenoic Acid

# on Puppy Trainability

# FOR SMARTER MORE TRAINABLE PUPPIES; EFFECT OF DOCOSAHEXAENOIC ACID ON PUPPY TRAINABILITY

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## BACKGROUND

A number of long-chain polyunsaturated fatty acids (PUFAs), including docosahexaenoic acid (DHA, C22:6, omega-3), play important structural and functional roles in the canine body. DHA is an important component of the nervous system (especially the brain), the eyes (in particular the retina), blood vessels, and other cells and organs. DHA is transferred across the placenta, is present in milk, and accumulates in the brain and retina during fetal and perinatal development.[1] DHA can be formed in the liver, but the rate of DHA synthesis in young mammals may be insufficient to support optimal brain and retinal development.[2] Enriched sources of DHA include cold-water fish, eggs, and organ meat.

The high concentrations of DHA in the retina and in brain grey matter suggest that this fatty acid has an important role in retinal and neural function. Indeed, DHA has been shown to be critical for optimal neural development in several mammalian species, including humans. Studies over the last three decades have provided evidence that depletion of DHA from the developing retina and brain leads to abnormalities in electroretinogram and visual evoked potential responses and learning behaviors.[1] These changes in cognitive performance, behaviour and the transmission of visual and auditory information could involve the effects of DHA on neurotransmitter metabolism, ion channel activity, signaling pathways, or gene expression.

In recent years, several studies have shown that omega-3 fatty acid deficiency alters the metabolism of dopamine and serotonin in the brain of rodents and young piglets.[3, 4] Particular interest has been given to the dopaminergic system because of the role of dopamine in the cognitive advances of early childhood in humans, as a modulator of attention and motivation, and in the visual pathways.[5] Human infants fed formulas with DHA have been shown to have improved neurological outcomes, such as increased speed of information processing and higher problem-solving scores, compared with infants fed unsupplemented formulas.[6]

Recent research has provided evidence that the nutritional requirement for omega-3 fatty acids in canines depends on life stage. These studies have shown that a puppy's fatty acid status, particularly DHA status, is highly dependent on the status of the dam, which in turn depends on diet and reproductive history.[7] DHA is especially critical during the last third of in utero development and subsequent postnatal growth period. To evaluate effects of DHA on neurological development, the following study assessing trainability in puppies was performed.

## THE STUDY

Beagle puppies representing 27 litters were used to evaluate the effect of different levels of dietary DHA on trainability. The objective was to determine whether dietary DHA could positively impact puppy trainability by impacting membrane DHA status through dietary intervention. The relative impact of dietary DHA was assessed by pre-weaning (maternal) and post-weaning (puppy) supplementation.

For the maternal portion of the study, Beagle bitches were fed complete and balanced test formulas based on a Eukanuba dry diet matrix to support growth and reproduction, varying only in DHA content, from proestrus until their puppies were weaned. Assignment of treatment diet for the bitches was random. For the post-weaning portion, weaned puppies were fed the same diet their dams had been fed. Study monitors were blinded to the identity of the diet.

To further control for sources of experimental variation in the study, the bitches and puppies used had similar genetic backgrounds. Bitches were also similar in parity status (litter 2 to 4) and had similar pre-study DHA status, based on RBC membrane analysis. All animals in the study were managed similarly, including feeding, housing, socialisation, training, and testing. To simulate an in-home environment, puppies were socialised through play and human interaction for two weeks prior to the test.

At 9 weeks of age, the puppies began a one-week training period for the maze test; (*Figure 1*). They were taught to associate a symbol (a square or a circle) with the location of a food treat in a simple T-maze. For example, a circle might indicate the treat was located in the left arm of the maze. The symbol-location association was randomly

*Figure 1.*

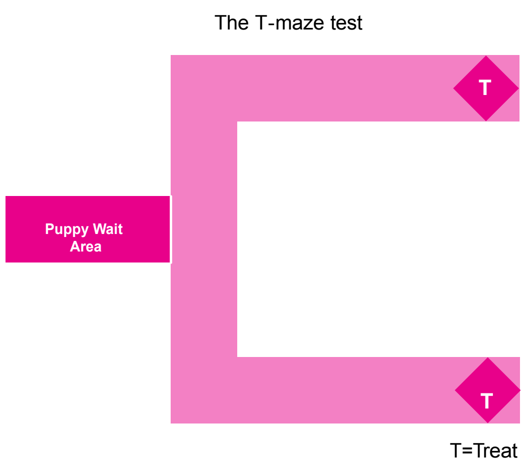



*Figure 2.*

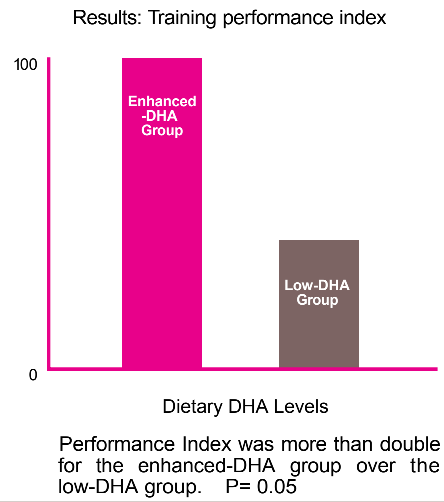
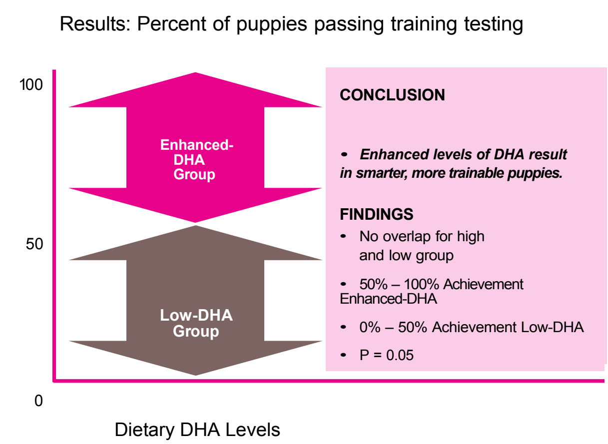



*Figure 3.*




assigned for puppies in both treatment groups. Following the one-week training period, each puppy was tested daily, with multiple trials each day. Testing was designed to be self-learning, with the pup receiving a treat as a positive reward.

Daily testing continued until the puppy correctly maneuvered the maze 80% of the time over 2 consecutive sessions, then the location denoted by the shape was switched (e.g., if a circle originally designated the food treat was in the right arm of the maze, it now designated the food treat was in the left arm of the maze). There was no additional training. When a puppy completed this phase, it was switched back to its original location-shape combination and testing resumed. Testing was conducted for 30 days, including the 5 days of training in week 1.

## Results

Puppies from the enhanced-DHA group (n=19) consistently out-performed the puppies from the low-DHA group (n=20) on the maze test (P=0.05).

- The training performance index for the enhanced-DHA group was more than double that of the low-DHA group. This index is an indication of training performance, based on the number of puppies achieving a success criteria (passing at least one test; *Figure 2*).
- Training performance was clearly different between the low- and enhanced-DHA groups (*Figure 3*). Across all replicates, the percentage of puppies achieving at least one success criteria was more than 50% for puppies from the enhanced-DHA group, and less than 50% for the puppies from the low-DHA group.

Based on these results, puppies that came from enhanced-DHA dams and that were fed the enhanced-DHA diet were considered more trainable. This is likely to have resulted from the effects of DHA on memory or receptivity to training.

## Discussion

Trainability may be considered a combination of willingness to learn/please (attitude/motivation), ability to understand what the trainer wants (intelligence) and ability to remember the tasks being taught (memory). In the studies described here, puppies nourished with enhanced levels of DHA were found to have greater trainability than puppies with low levels of DHA. This increased trainability could be attributable to better attitude and/or superior memory associated with feeding an enhanced-DHA diet.

In a study that evaluated the effects of DHA on memory formation, rats were fed a fish oil-deficient diet through three generations.[8] When young (five-week-old) male rats of the third generation were given oral DHA over 10 weeks, the number of errors in reference memory (information that should be retained until the next trial) in performance of a maze test was significantly reduced, without affecting the number of errors in working memory (information that disappears in a short time). These results agree with the results of our study and indicate that DHA supplementation is conducive to the improvement of reference memory-related learning ability. This improvement in reference memory-related learning ability can lead to improved trainability.

In addition, DHA supplementation has been shown to affect stress-related behavior in rodents. In one study, mice fed a DHA-sufficient diet for 4 weeks showed significantly lower rearing frequency (an anxiety index), compared with mice fed a DHA-deficient diet.[9] In another study, the effects of 1-week supplementation with DHA on stress responses were evaluated in male rat pups that came from dams fed an omega-3 fatty acid-deficient diet from mating through lactation and that were fed the same diet as their dams.[10] Rat pups supplemented with DHA had improved responses, based on the results of a maze test, hormone-induced behavior assessment, and conditioned fear test. The results of these studies suggest that DHA supplementation can benefit attitude/motivation, which also can lead to improved trainability.

## Key Points

- Dietary DHA level was a key determinant of training performance success rate
- Results were consistent over multiple replications
- Enhanced-DHA nourished puppies were significantly more trainable than low-DHA nourished puppies

## Potential Implications/Practical Application

- Better socialisation into a family environment
- Quicker grasping of training & obedience challenges
- Reduced destructive behavior
- Fewer returned puppies due to higher trainability

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