

Abstract

A multitude of research studies have been conducted on the relationship between nutrition and brain health; however, research to date has failed to discover a natural immunotherapy that is effective at treating neurodegenerative disorders such as Alzheimer's disease and dementia. Humans are not the only vulnerable subjects of developing neurodegenerative disorders later in life. Canine Cognitive Dysfunction Disorder is an underdiagnosed disorder amongst the canine population that has been shown to closely mimic the signs and symptoms associated with Alzheimer's and dementia in humans. The primary aim of this study is to investigate the relationships between nutritional supplementation as well as age, and its effects on cognitive functioning in canines. Furthermore, this research will also investigate the relationship between diet and age of canines. Cognitive functioning will be measured based on owner's survey responses about their dog's spatial orientation, social interaction, sleep-wake cycle, learning and memory, activity level, and anxiety levels. By further investigating the factors that influence cognitive functioning in canines, it is possible to develop new immunotherapies for Alzheimer's, dementia and Canine Cognitive Dysfunction Disorder through nutritional supplementation for canines that may eventually be extended to humans.

Introduction to Neurodegenerative Disorders

Alzheimer's and Dementia in Humans

- The build up of beta amyloid plaque is the main component for diagnosing an individual with Alzheimer's (Moore et al., 2017)
- Tangles, tau proteins, are important for stabilizing microtubules. When these proteins form connections, specifically in the memory center of the brain, cells throughout the brain begin to die (Pruthi, 2018).
- Research has shown that the development of Alzheimer's (AD) heavily results from poor lifestyle choices and poor nutritional intake (Holford, 2004).

Canine Cognitive Dysfunction (CCD)

- Canine Cognitive Dysfunction Disorder is an underdiagnosed neurodegenerative disorders affecting at minimum 14% of the geriatric dogs (Benzal and Rodríguez, 2016).
- The most prevalent symptoms include: sleep and wake cycle disturbances, aggressive behavior, hearing loss, disorientation in typical and familiar settings, hearing loss, and excessive vocalization (Benzal and Rodríguez, 2016).



Figure 1. Dog owners who enrolled in the online survey were invited to take part in a clinical trial in the HAWC Lab at Monmouth University. Pictured: Emma Sacco (Lead Researcher) & Marissa Kraemer (Manager of the Applied Animal Behavior Research Clinic at Monmouth University)

Results

Factors of Cognitive Functioning	Number of Items per Subscale	Example Question
Spatial Orientation	4 item scale	Does your dog have a hard time recognizing familiar faces?
Social Interaction	3 item scale	Is your dog in need of constant contact? ("clingy")
Sleep Wake Cycle	2 item scale	Increased sleep during the daytime?
Learning & Memory	5 item scale	Does your dog experience decreased responsiveness to familiar commands and tricks?
Activity Levels	6 item scale	Has your dog experienced a loss of interest in activity and play?
Anxiety Levels	4 item scale	Does your dog experience separation anxiety?

Table 1. Example questions from each of the subscales in order to assess cognitive functioning in canines. Participants had the option of "Severe" "Moderate" "Mild" and "None" in order to assess if the following behaviors applied to their dog (All of the factors had a significance levels of $p < .001$).

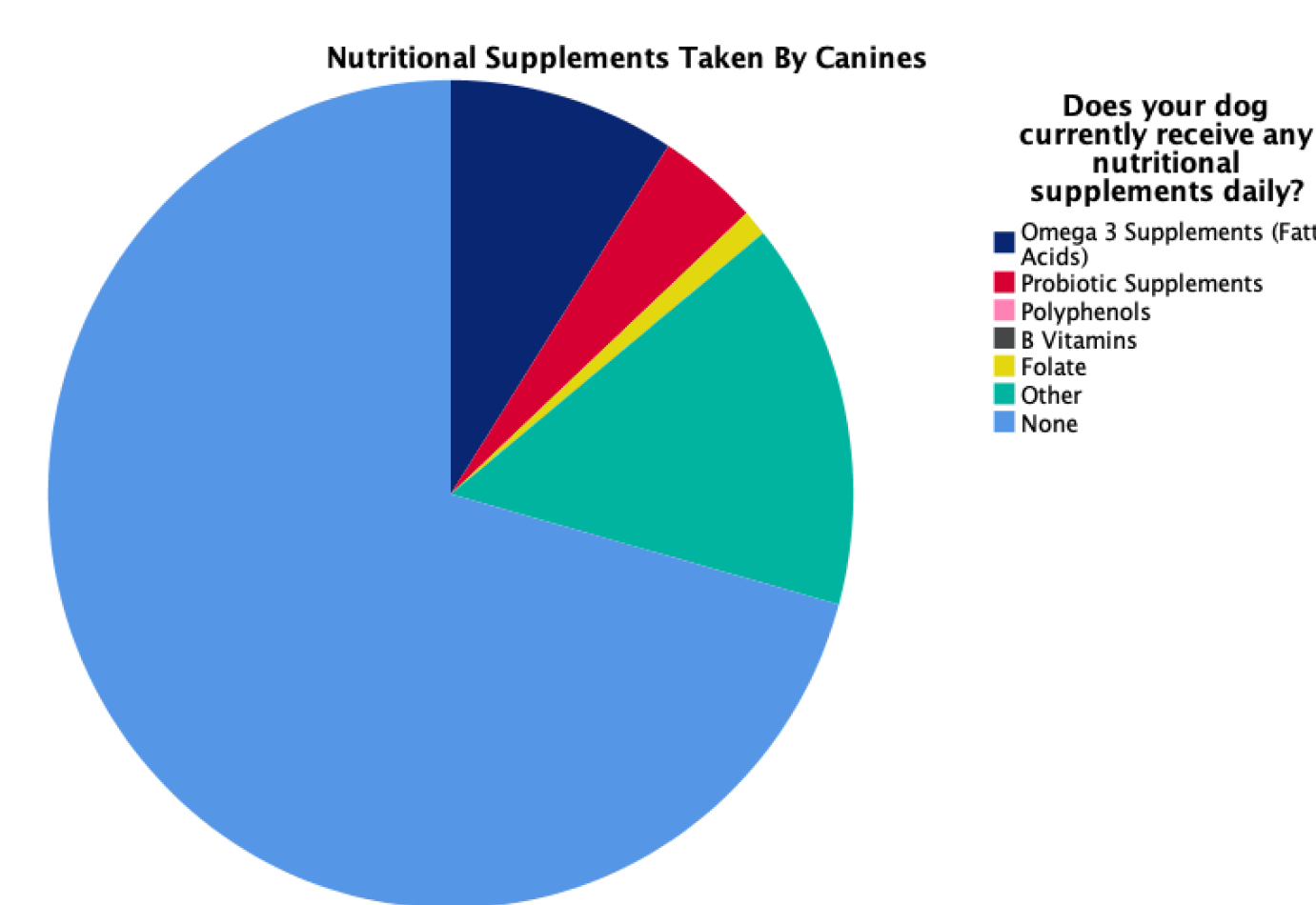


Figure 2. A pie chart showing the different nutritional supplementation of canines currently enrolled in this study ($N = 105$). There has been extensive research conducted on the benefits of Omega 3's supplementation, and its relationship to neuroplasticity in humans.

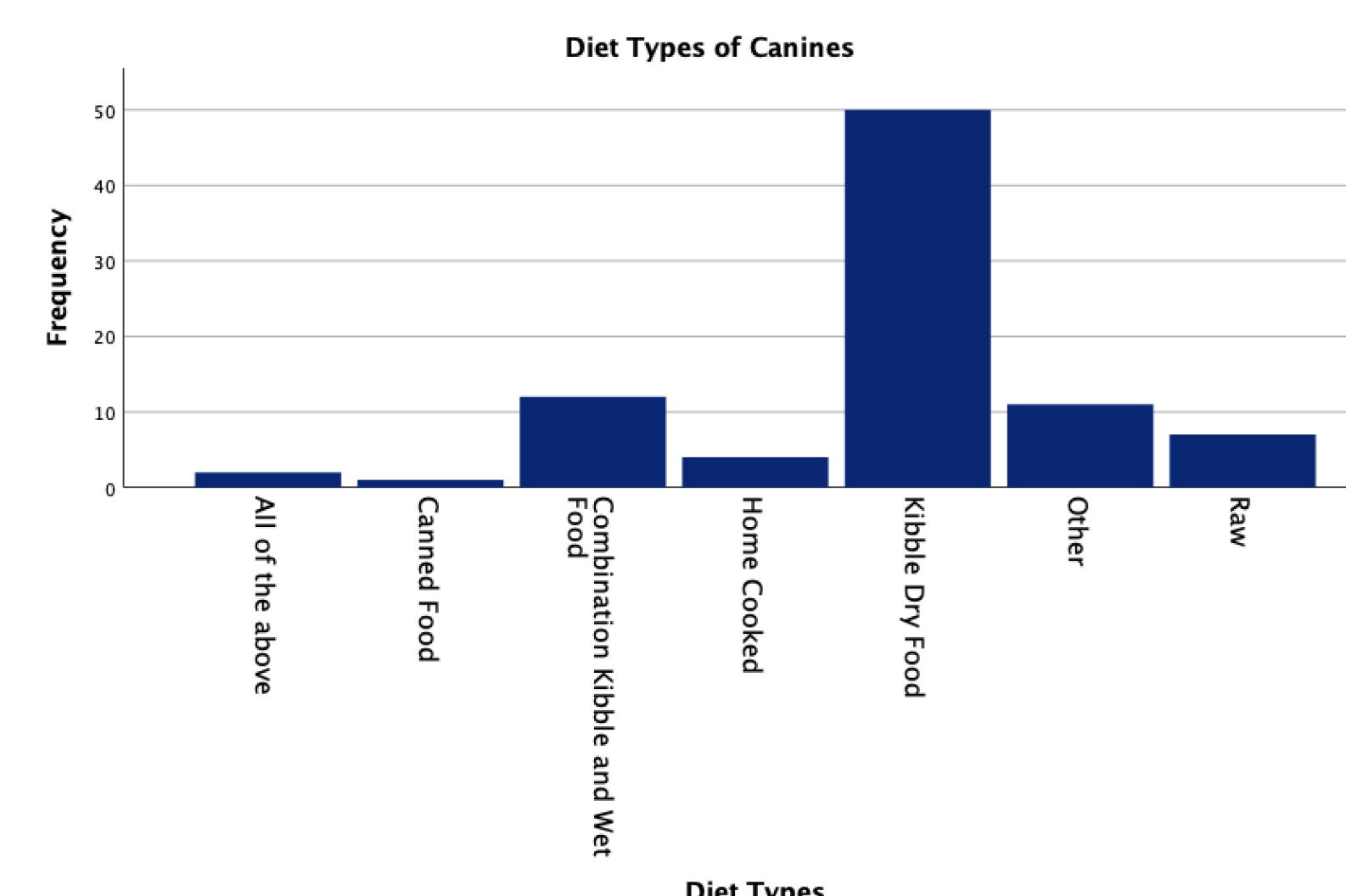


Figure 3. Frequencies of different diet types of canines in this study ($N = 105$)

Results, Continued

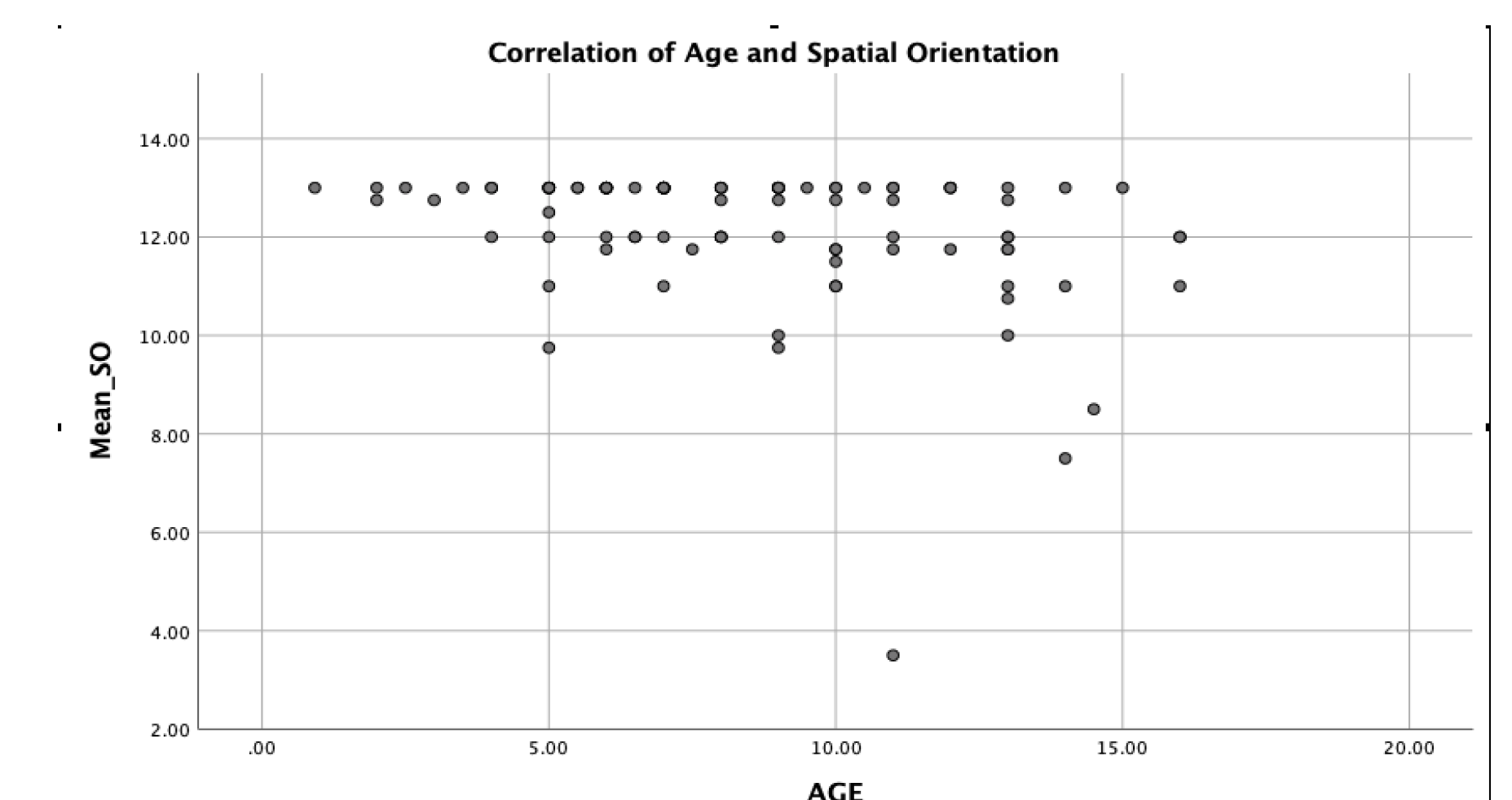


Figure 4. The hypothesized correlation between age ($M = 8.44$, $SD = 3.42$) and spatial orientation ($M = 12.24$, $SD = 1.36$) was significant, $r = -.342$, $p < .001$

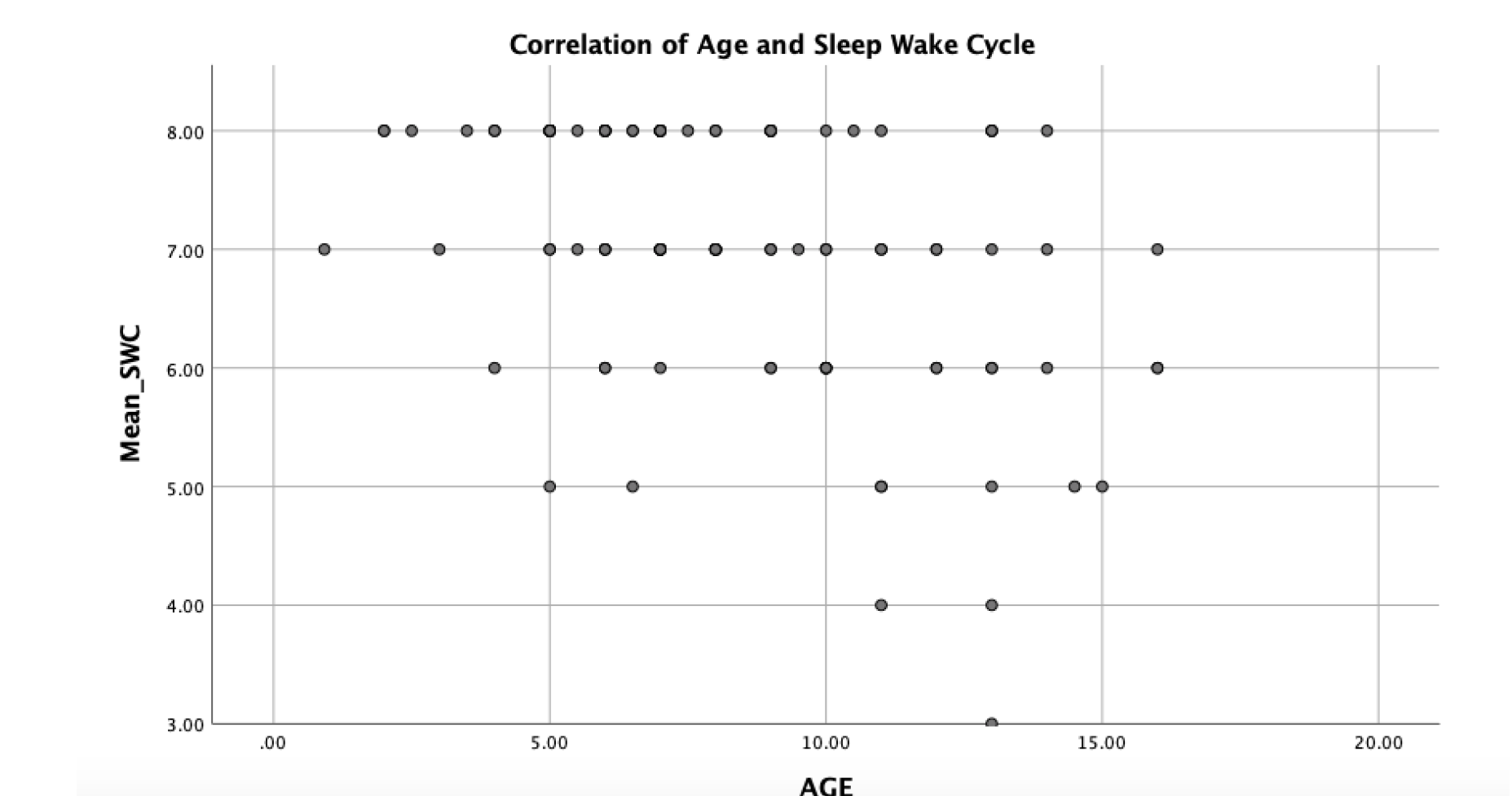


Figure 5. The hypothesized correlation between age ($M = 8.44$, $SD = 3.42$) and sleep wake cycle ($M = 7.00$, $SD = 1.10$) was significant, $r = -.440^*$, $p < .001$

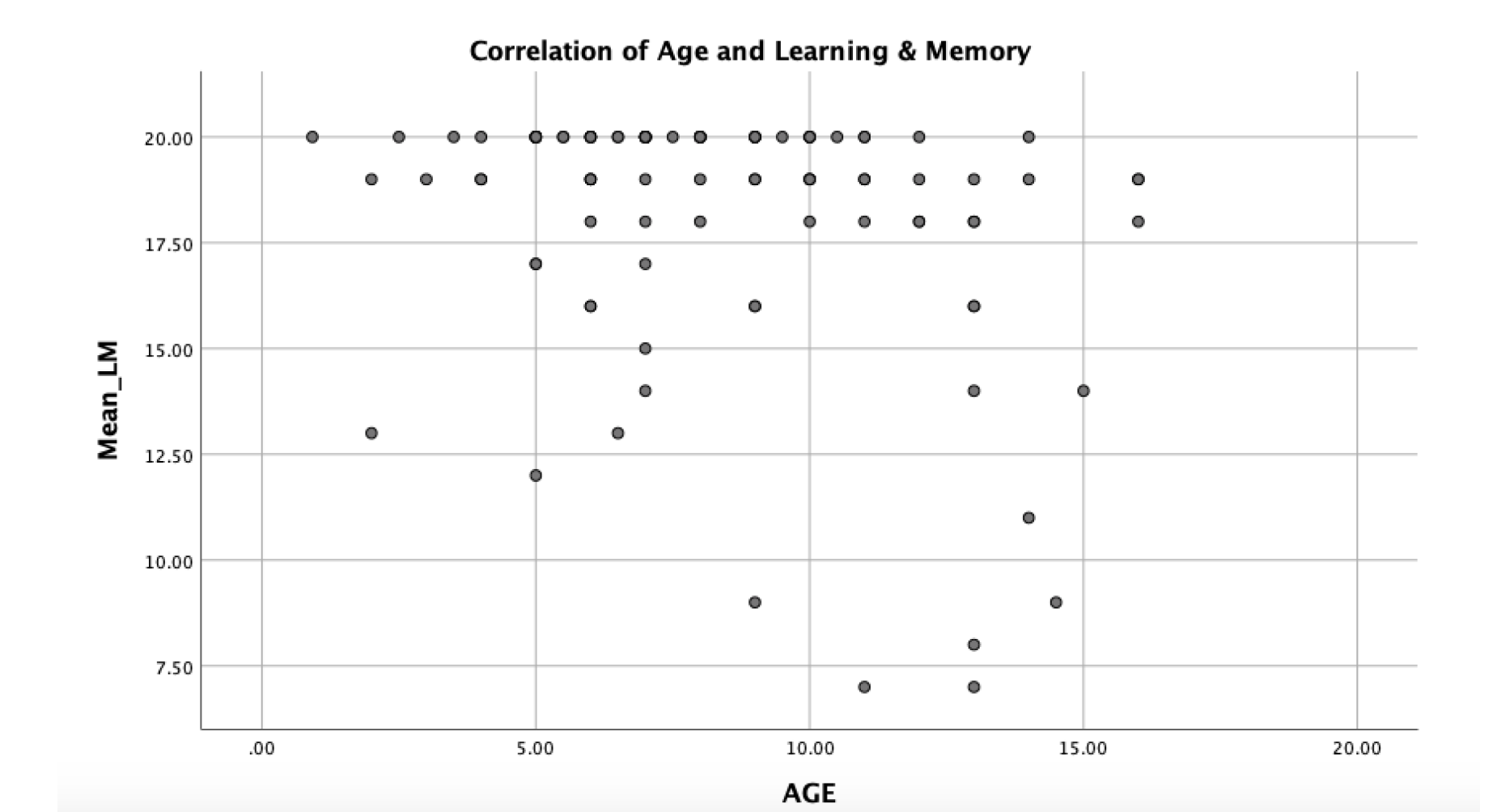


Figure 6. The hypothesized correlation between age ($M = 8.44$, $SD = 3.42$) and learning and memory ($M = 18.12$, $SD = 3.07$) was significant, $r = -.287^*$, $p < .001$

- The hypothesized correlation between age ($M = 8.44$, $SD = 3.42$) and social interaction ($M = 10.35$, $SD = 1.50$) was not significant, $r = .045$, $p = .660$
- The hypothesized correlation between age ($M = 8.44$, $SD = 3.42$) and activity levels ($M = 21.26$, $SD = 2.36$) was not significant, $r = -.129$, $p = .203$
- The hypothesized correlation between age ($M = 8.44$, $SD = 3.42$) and anxiety levels ($M = 10.28$, $SD = 1.80$) was not significant, $r = .167$, $p = .095$

Method

Participants

A total of 105 dog owners took part in this study. Ages of canine participants ranged from ages 11 months to 16 years old ($M = 8.44$, $SD = 3.42$). Approximately 49% of canines were male, and 51% of canines were female. They were over sixty reported breed types both pure as well as mixed breeds. When owners were asked to report how their dog was acquired, 35% reported from a local animal shelter/ humane society, 10% from a pet store, 31% from a breeder, and 25% reported other. Approximately 40% of owners reported their canines to currently be on some form of medication. 10% of owners reported their dog to have pre-existing cognitive disorder. Disorders included the following: Cognitive Dysfunction (as well as early signs of Cognitive Dysfunction), Anxiety, Separation Anxiety, and seizure disorders.

Materials

Electronic consent form, an online survey, and an electronic debriefing form. The online survey was ran through Qualtrics with assistance from the Monmouth Polling Institute.

Factors of Cognitive Functioning were divided into six total subscales: Spatial Orientation ($\alpha = .737$), Social Interaction ($\alpha = .181$), Sleep Wake Cycle ($\alpha = .334$), Learning & Memory ($\alpha = .847$), Activity Levels ($\alpha = .479$), and Anxiety Levels ($\alpha = .479$).

Design

The following study was a correlational design with predictive factors being diet and nutritional supplements, and the output variables being the six subscales.

Procedure

Participants were recruited via email and social media. They were asked to read an online consent form that was attached to the Qualtrics survey. From their, dog owners had access to complete the "Factors Influencing Cognitive Functioning in Canines" questionnaire. This questionnaire took approximately 15-20 minutes for participants to complete. The questionnaires consist of nine subsections. Additional questions asked owner to make note of any behavior from their dog that was not touched upon, and if they were interested in a phase one clinical trial in the near future regards nutritional supplements and cognitive functioning on the Monmouth campus. After completion of the survey, participants then read an online debriefing script, and were thanked for their time, and participation in the study.

Discussion

- The results indicate that age is moderately inversely correlated with spatial orientation and sleep wake cycle. In addition, age had a weak inverse correlation with learning and memory. Both diet type and nutritional supplementation had a significant positive association with cognitive functioning. We did not find that age significantly correlated with social interaction, activity, and anxiety.
- The results of the current study help us better understand the relationship between factors such age, diet, and nutritional supplementation, and its lasting effects on cognitive functioning and brain health. By investigating the factors that are within our control such as diet and supplementation and their influence on cognitive functioning in canines, it is possible to develop new natural treatments for those diagnosed with Alzheimer's, dementia and Canine Cognitive Dysfunction.