Old dog, new tricks:

Age differences in dog personality traits, associations with human personality traits, and links to important outcomes

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Abstract

Work examining dog personality is relatively new, so the degree to which dog personality differs by age, predicts important dog outcomes, and is correlated with human personality is unclear. In a sample of 1,681 dogs (M_{age} = 6.44 years, *SD* = 3.82; 46.2% Female; 50% purebred) and their owners, older dogs were less active/excitable compared to younger dogs. Aggression toward people, responsiveness to training, and aggression toward other animals was highest among 6 to 8 year old dogs. Dog personality was associated with important dog outcomes—chronic health conditions, biting history, and human-dog relationships. We build on previous research by examining demographic differences in dog personality and associations between dog personality and outcomes for both dogs and humans.

Keywords: dogs, personality, development, human-dog relationships, cross-sectional, health and well-being

Old dog, new tricks:

Age differences in dog personality traits, associations with human personality traits, and links to important outcomes

Dogs (*Canis lupus familiaris*) are often referred to as humans' best friends. Dogs offer companionship, consolation, and provide important services for humans. Like humans, not all dogs are the same—they vary in how they approach different situations and their overall temperament. People often make adoption decisions based on a dog's temperament—are they aggressive? Are they an active dog that would require a certain lifestyle change? Would they fit well with a family (Campbell, 1972; Hart & Hart, 1985)? In recent years, many efforts have been undertaken to accurately measure the personality of dogs (Hsu & Serpell, 2003; Jones, 2008; Ley, Bennett, & Coleman, 2008; Svartberg & Forkman, 2002; Wiener & Haskell, 2016). However, it is unclear whether, like human personality, dog personality differs by age. Or, if dog personality predicts important life outcomes among dogs. Or, how dog and human personalities contribute to the quality of human-dog relationships. In the current study, we examined these questions in a sample of 1,681 dogs and their owners. In the sections below, we provide an introduction to the study and measurement of dog personality, reasons why dog personality might differ by age, and reasons why dog personality might be associated with important outcomes for both humans and dogs.

Dog Personality

One of the most comprehensive examinations of the structure of dog personality is Jones' (2008) personality taxonomy for dogs. In this framework, dogs vary along five dimensions—fearfulness, aggression toward people, activity/excitability, responsiveness to training, and aggression toward animals.[1] *Fearfulness* characterizes a dog's general anxiety and fearfulness

toward people, other dogs, new environments, and handling (e.g., by groomers and owners). *Aggression toward people* characterizes a dog's general and situational aggression. *Activity/excitability* characterizes a dog's general level of excitability, playfulness, engagement, and companionability. *Responsiveness to training* characterizes a dog's trainability and controllability (e.g., leaves food alone when they are told to). *Aggression toward other animals* characterizes a dog's aggression and dominance towards other dogs and perceived prey (e.g., squirrels).

The Jones taxonomy was developed using an iterative approach that follows best practice guidelines for measuring personality traits in humans (e.g., Gosling, Rentfrow, & Swann Jr, 2003; Soto & John, 2017). A pool of 1,200 descriptors was gathered from prior dog-personality assessments, shelter assessments, and dog experts (e.g., veterinarians, dog-temperament testers, dog trainers, and animal social behavior experts). A series of exploratory and confirmatory factor analyses were conducted across over 6,000 human participants and their dogs. The resulting measure—the Dog Personality Questionnaire (DPQ)—is discussed in more detail in the Method section of the current paper. had adequate levels of inter-rater reliability, test-retest reliability, and (i.e., DPQ personality traits were significantly correlated with a behavioral test battery administered by kennel staff; Jones, 2008). Regarding possible response biases, there is often a high degree of correlational similarity in personality ratings between owners' scores and their friends, dog walkers, family members, and untrained experts scores when evaluating dog personality (Fratkin et al., 2015; Posluns, Anderson, & Walsh, 2017; Turcsán, Range, Virányi, Miklósi, & Kubinyi, 2012).

Age differences in dog personality

Why would dog personality differ by age and why would it predict important outcomes?

Many of the same mechanisms that are proposed to drive human personality development have also been proposed to drive personality development in other animals (Class & Brommer, 2016). For example, proponents of the Five-Factor Theory tie personality development to a combination of genetic circumstances, physiological changes, or environmental features altering biological processes that underlie the traits (Costa Jr, McCrae, & Löckenhoff, 2019; McCrae & Costa, 2008). Proponents of this perspective for example would hypothesize that personality changes in response to changes in brain development, health, or other biological indicators that lead to variability in personality (McCrae, 2004; Terracciano, 2014). Other perspectives of personality development suggest that personality changes in response to our selection and investment in some social institutions (Bleidorn et al., 2013; Lodi-Smith & Roberts, 2007; Roberts, Wood, & Smith, 2005). For example, proponents of this perspective would hypothesize that personality changes in response to life events and life transitions (e.g., marriage, work).

Based on similar animal literature, some of the same mechanisms might also be associated with personality development in dogs. For example, dogs mature physically as they age, which could lead to differences in personality. Indeed, senescence among animals at least partly drive their behavioral consistency across situations (Class & Brommer, 2016). Such age-related changes in personality among animals are thought to reflect the compromised fitness expectations after the reproductive years of life (Réale, Reader, Sol, McDougall, & Dingemanse, 2007; Smith & Blumstein, 2008). In a study of wild blue tits, one marker of fitness (handling aggression) declines with age (Class & Brommer, 2016). Dogs are also exposed to environmental transitions (e.g., training, being exposed to new environments) that might also lead to differences in personality. Indeed, in the broader animal literature, state-behavior feedback often leads to reliable changes in animal personality (Luttbeg & Sih, 2010; Sih et al.,

2015; Wolf, Van Doorn, Leimar, & Weissing, 2007). However, if environments are largely stable, behavior and reinforcements of that behavior will also be consistent. If environments and circumstances change, then such state-behavior feedback loops are initiated, leading to long-term personality changes (Dingemanse & Wolf, 2010; Sih et al., 2015). In other words, dogs may alter their behavior to meet the demands of a new state. Indeed, there is reliable evidence that repeated training sessions can potentially change dogs' personalities across the course of their lives (Kubinyi, Turcsán, & Miklósi, 2009). Both environmental and biological processes are thought to underlie lifespan variation in personality in many different animals (e.g., chipmanzee, squid, birds, insects; Dammhahn, 2012; Fisher, David, Tregenza, & Rodríguez-Muñoz, 2015; Hall et al., 2015; King, Weiss, & Sisco, 2008; Kubinyi et al., 2009; Massen, Antonides, Arnold, Bionda, & Koski, 2013; Réale, Martin, Coltman, Poissant, & Festa-Bianchet, 2009; Seltmann et al., 2012; Sinn, Gosling, & Moltschaniwskyj, 2008; Suomi, Novak, & Well, 1996).

Unfortunately, many studies focusing on dog personality use a small number of dogs, dogs of a narrow age range (e.g., puppies), highly specific sex and breeds (e.g., female golden retrievers), or dogs in specific contexts (e.g., military dog training programs; Bensky, Gosling, & Sinn, 2013). There are also stereotypes about how dog personality differs by characteristics of the dog, including age, sex, breed, sterilization status, and exposure to training (Kubinyi et al., 2009). In the current study, we examine demographic differences in dogs based on these characteristics. Because of the exploratory nature of the study, we did not make any firm predictions about how dog personality might differ by age or other demographic characteristics. However, given that some of the same mechanisms of personality development in humans may also apply to dogs, we expected that there might be significant age differences in personality among dogs.

Dog Personality and Life Outcomes

Variation in human personality is related to important life outcomes (Rammstedt, Danner, & Lechner, 2017; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007). For example, higher levels of conscientiousness are associated with better work outcomes, better relationships, and greater health and longevity (Lodi-Smith & Roberts, 2007; Roberts, Smith, Jackson, & Edmonds, 2009; Roberts, Walton, & Bogg, 2005). Important outcomes for dogs may also be explained by variation in their personalities. For example, just as human personality is related to human health outcomes, dog personality might be linked to dog health outcomes over time. One possibility is that inactive dogs may be more likely to develop health conditions (e.g., obesity) that might predict the onset of chronic illness. Work has shown that chronic inactivity in humans puts them at similar risk (Blair & Brodney, 1999; Cecchini et al., 2010). Another is that dogs that are responsive to training by their owners may also avoid health-harming behaviors (e.g., eating foods they shouldn't or running away or going somewhere dangerous). Indeed, variation in adaptive behavioral patterns and personality have been found to be related to longevity and health in non-human primates and dogs (Altschul et al., 2018; Burdina & Melikhova, 1961; Weiss, Gartner, Gold, & Stoinski, 2013).

The likelihood of biting humans is also an important outcome for dogs—one that interests owners a great deal, for both their safety and the implications it has for human-dog relationships. Sometimes humans relinquish, or are compelled to relinquish, ownership of a dog that has bitten. Most examinations of biting behavior have focused on documenting characteristics of the victim, how biting rates vary by breed, and developing behavioral measures of biting and predicting biting on that test from previous biting history (Borchelt, 1983; Gershman, Sacks, & Wright, 1994; Guy et al., 2001; Planta & De Meester, 2007). Therefore, we

wanted to examine associations between different dog personality traits and a variety of important dog outcomes, like biting history and chronic health conditions (Hsu & Serpell, 2003). We employed an exploratory approach to examining these questions. Thus, we did not make any firm hypotheses about which dimensions of dog personality would be associated with biting history and chronic health conditions.

Human—Dog Relationships and Personality

Because humans and dogs spend a considerable amount of time together, it is plausible that there might be some degree of similarity in human and dog personality. There is a larger body of research examining how human personality is associated with important dog outcomes (e.g., behavioral problems; Dodman, Brown, & Serpell, 2018; Konok et al., 2015). The personality fit between animals and humans—and the implications of this fit, has also been the subject of empirical work, including how well horses and their riders communicate and how human demographic characteristics predict their satisfaction with their relationship with their dog (Hausberger, Roche, Henry, & Visser, 2008; Meyer & Forkman, 2014; Visser et al., 2008). However, the extent to which dog personality and human personality are similar has received relatively little attention (see O'Farrell, 1995; Podberscek & Serpell, 1997; Turcsán et al., 2012; Zeigler-Hill & Highfill, 2010; for a few exceptions). In a study by Turcsán et al. (2012), the personalities of dogs and humans were rated by owners (self-reports) and friends (peer-reports). Among both raters (owners *r*s; peers *r*s), there was similarity between owners and dogs for neuroticism (.46; .34), extraversion (.31; .32), conscientiousness (.28; .63), and agreeableness (.25; .42).

These reasons for *why* owner and dog personalities might be related can also be found in research for why any two acquainted individuals might be similar to each other on psychological

characteristics (Humbad, Donnellan, Iacono, McGue, & Burt, 2010; Schimmack & Lucas, 2010; Watson et al., 2004). We believe there are at least three reasons why they might be related. First, owners and dogs might have similar personalities based on a selection effect. For example, owners might select dogs that match their personalities and life styles in a similar way that humans purportedly choose friends and partners (Luo & Klohnen, 2005; Tidwell, Eastwick, & Finkel, 2013). Second, owners and dogs might have similar personalities based on a socialization effect. For example, the shared activities and environments of humans and dogs might jointly influence their personalities as in relationships between humans (Chopik, Kim, & Smith, 2018; Jackson, Steptoe, & Wardle, 2015; Mejía & Gonzalez, 2017). Extraverted owners might bring their dogs to social events, which may in turn socialize them to humans (and make them less aggressive). Likewise, there is a degree of emotional and personality contagion among humans who share similar social environments, further suggesting that shared environments might contribute to a correlation between owners and their dogs (Anderson, Keltner, & John, 2003; Hoppmann & Gerstorf, 2009; Neal, Durbin, Gornik, & Lo, 2017). Finally, owners and dogs might have similar personalities because owners have idiosyncratic ways of evaluating things in their lives or even project their personality on things that they evaluate, including their dogs (Kwan, Gosling, & John, 2008; Richters & Pellegrini, 1989; Schul & Vinokur, 2000; Turcsán et al., 2012). Likewise, people tend to perceive similarity with things that they like (Collisson & Howell, 2014; Tidwell et al., 2013), and people generally like their dogs, which might be producing some correlation between humans and their dogs (see Gosling & John, 1999, for an expanded discussion on assessing personality in non-human species). We view these three reasons as possibilities for why owner and dog personality might be correlated.

Finally, human personality is associated with satisfaction (like marital quality) and

maintenance of close relationships over time (Lodi-Smith & Roberts, 2007; Roberts & Bogg, 2004; Roberts et al., 2007), but does dog personality also predict relationship quality for owners? However, like research on close relationships, it is important to consider the personality characteristics of the other member of a relationship (Dyrenforth, Kashy, Donnellan, & Lucas, 2010). It seems plausible that an owner's feelings of closeness with their dog may at least partly depend on the characteristics of the dog, as some previous research has alluded to (Meyer & Forkman, 2014). However, no study to date has examined how owner and dog personality jointly predict relationship quality of human-dog relationships.

The Current Study

The current study had four aims. First, we examined age differences in dog personality. If many of the same mechanisms that drive personality development in humans are present in dogs, it is possible that dog personality varies by age. Second, we examined whether dog personality was associated with important outcomes among dogs. Given the predictive power of personality in outcomes among humans, we expected associations between dog personality, health, and biting history. Third, we examined whether owner personality was correlated with dog personality. We identified three reasons why owner and dog personality might be related and sought to conceptually replicate previous research (Turcsán et al., 2012). Finally, we examined whether owner personality and/or dog personality were uniquely associated with owner-dog relationship quality. To test these questions, we surveyed 1,681 dog owners who rated their own personalities, their dog's personality, and answered additional questions about their dog's demographic and behavioral history.

Method

The data from this project are available at https://osf.io/68ukr.

Participants

Humans. Participants were recruited from Amazon Mechanical Turk (MTurk; *n*=505) and an undergraduate subject pool (*n*=1176). The samples were combined to maximize statistical power.[2] We excluded 61 participants because they had missing information on both dog age and dog personality. Thus, the final sample comprised 1,681 human participants (M_{age} = 24.64, *SD* = 10.11; 70.3% Female; 81.6% White/Caucasian, 5.9% Asian, 5.1% Black/African American, 3.9% Hispanic/Latino, and 3.5% multiracial or other race/ethnicities). MTurk participants were compensated $.40 for their participation in the survey. Undergraduate participants were compensated with course credit. No a priori decisions about sample size were made; we sought to collect as many participants as we could, provided our resources. Our sample size of 1,681 enabled us to find effects as small as f^2 = .006 (with 80% power and α = .05) or f^2 = .009 (with 95% power and α = .05).

Dogs. The 1,681 target dogs ranged in age from 1.5 weeks to 16 years old (M_{age} = 6.44, *SD* = 3.82; 46.2% Female). Approximately 50% were purebred; 87.3% were spayed/neutered/fixed; 24.1% of dogs had participated in an obedience class; 15.3% had bitten a person; and 30% of dogs had at least one chronic illness (see below for more details). Among purebred dogs, the most common breeds were Labrador Retrievers (8.2%), other Retrievers (6.5%), Terriers (5.8%), Shepherds (5.4%), and Spaniels (3.0%).

Measures

Dog personality. Human owners filled out the short-version of the Dog Personality Questionnaire (DPQ; Jones, 2008), which has adequate levels of inter-rater reliability and test-retest reliability (i.e., DPQ personality traits were significantly correlated with a behavioral test battery administered by kennel staff; Jones, 2008). Regarding possible response biases, there is

often a high degree of correlational similarity in personality ratings between owners' scores and their friends, dog walkers, family members, and untrained experts scores when evaluating dog personality (Fratkin et al., 2015; Posluns et al., 2017; Turcsán et al., 2012).The questionnaire contains 45 items that ask individuals to indicate their level of agreement with each statement on a scale ranging from 1 (*disagree strongly*) to 7 (*agree strongly*). The DPQ measures five dimensions of dog personality: fearfulness (12 items; sample item: "Dog behaves fearfully toward unfamiliar people;" α = .81), aggression toward people (6 items; sample item: "Dog behaves aggressively in response to perceived threats from people (e.g., being cornered, having collar reached for);" α = .82), activity/excitability (12 items; sample item: "Dog seeks constant activity;" α = .75), responsiveness to training (6 items; sample item: "Dog is able to focus on a task in a distracting situation (e.g., loud or busy places, around other dogs;" α = .77), and aggression toward animals (9 items; sample item: "Dog behaves aggressively toward cats;" α = .76). Responses were averaged to create composites for each dimension.

Human personality. Human personality was measured using the Big Five Inventory-2 (BFI-2; Soto & John, 2017). The questionnaire contains 60 items that ask individuals to rate the extent to which each statement accurately describes them (i.e., "I am someone who...") on a scale ranging from 1 (*disagree strongly*) to 5 (*agree strongly*). The BFI-2 measures the personality domains of extraversion (12 items; sample item: "Is outgoing, sociable;" α = .87), agreeableness (12 items; sample item: "Is helpful and unselfish with others;" α = .83), conscientiousness (12 items; sample item: "Is efficient, gets things done;" α = .88), negative emotionality (12 items; sample item: "Is moody, has up and down mood swings;" α = .91), and open-mindedness (12 items; sample item: "Is curious about many different things;" α = .87). Responses were averaged to create composites for each dimension. The five BFI-2 dimensions can be further differentiated

into 15 facets. Facet-level analyses were not the focus of the present report. However, facet-level information is calculated and is available in the data at https://osf.io/68ukr/?view_only=61ab6b5c70364e239ab0b8883ec40671.

Outcome measures. Three outcomes were measured in the current study—chronic health conditions, biting history, and relationship quality. It is worth noting, none of these outcome measures were covered in the items of the DPQ, so there is no direct predictor-criterion overlap for these analyses.

Chronic health conditions for dogs was measured using an 8-item checklist used in previous research (Jones, 2008). The question asked owners to indicate whether their dogs had any of 8 health problems (deaf in one ear, deaf in both ears, blind in one eye, blind in both eyes, arthritis, hip dysplasia, other joint dysplasia, and other disability). Owners could nominate multiple health conditions. The number of conditions was summed and redundant health problems were summed to equal 1 (e.g., if an owner nominated both deafness in one ear and deafness in both ears, they received a score of 1 on deafness in both ears). Thirty percent of dogs had at least one health condition.

Biting history was measured with a single item ("Has your dog ever bitten a person?") to which owners could respond with yes (1), no (0), or unknown (set to missing).

Relationship quality was measured with two items. One item measured relationship closeness ("How close do you feel toward your dog?") on a scale ranging from 1 (*not close at all*) to 7 (*extremely close*). One item measured relationship satisfaction ("How satisfied are you with your relationship with your dog") on a scale ranging from 1 (*not at all satisfied*) to 7 (*extremely satisfied*). Because the two items were so highly intercorrelated ($r = .79$, $p < .001$), they were averaged to create an index of relationship quality. Due to these items being added late

to data collection, relationship quality is only available for 64% of the sample (*n*=1077).

Results

Means, standard deviations, and correlations between all the aforementioned study variables reported below are provided in Table 1. Because dog and human demographic characteristics were often related to personality, we limit our discussion to regression analyses that control for these characteristics when estimating the effects of age on personality and personality on outcomes.

How Does Dog Personality Differ by Age?

Our first question examined whether and how dog personality differed by age. To answer this question, we ran a series of regression equations predicting each dog personality dimension from the dog's age, sex, breed, sterilization status, history of obedience training, and history of owner training. These covariates were included in each analysis given their possible confounding effects based on previous research (Podberscek & Serpell, 1996; Roll & Unshelm, 1997). For example, Kubinyi et al. (2009) noted significant differences in sex, breed, sterilization, and training/obedience that affects the development of dog personality across the lifespan. In models involving owner personality, owner age and gender were included for the same reason—human personality varies considerably based on age and gender (Schmitt, Realo, Voracek, & Allik, 2008; Srivastava, John, Gosling, & Potter, 2003). Categorical variables were contrast coded (-1, 1; see table notes for complete scoring information) and age was mean-centered. Because previous research has documented both linear and quadratic effects of age on personality (Soto, John, Gosling, & Potter, 2010; Srivastava et al., 2003; Terracciano, McCrae, Brant, & Costa, 2005), we examined whether the inclusion of a quadratic effect of age was significant. If it did not significantly contribute to the overall model, the simpler, linear model was retained. To

decompose any quadratic effects, we employed a variation of Simonsohn's (2018) two-line test. The two-line test first identifies the apex/nadir of a quadratic curve. Then, separate regression lines for values before and after this point are estimated. If the slope estimates are significant and in opposite directions, the data properly depict a u-shape function. In the interest of transparency, we also report models with and without covariates for readers to see how the effects vary based on inclusion of the aforementioned variables (Simmons, Nelson, & Simonsohn, 2011). The model parameters were defined as robust if they were significant in models both with and without the covariates.

Results for age differences in dog personality are presented in Table 2. For fearfulness, the linear effect model was the best fitting model, as the inclusion of the quadratic term was not significant (p = .40). Nevertheless, the linear effect of age was not significant. Thus, young and old dogs are similar in their levels of fearfulness. Purebred dogs, fixed dogs, and dogs exposed to an obedience class were less fearful.

For aggression toward people, the model that included a quadratic effect was the best fitting model. The quadratic effect of age was a significant predictor of aggression toward people, but the linear effect of age was not a significant predictor. Importantly, the quadratic effect of age was marginally significant without the covariates and at p = .04 when the covariates were included. P-values so close to p = .05 should be interpreted with caution given the little evidentiary value they provide (Benjamin et al., 2018; Simonsohn, Nelson, & Simmons, 2014). Decomposing this quadratic effect revealed that the apex of the curve occurs at 6.69 years old for dogs. The slope prior to this point is significant and positive (β = .11, p = .008) and the slope after this point is not significant (β = -.06, p = .08). Thus, dogs around this point are higher in aggression toward people than younger dogs but are similar in aggression as older dogs. This

pattern can be seen in Figure 1. In all the figures, the diamonds represent the mean personality rating at each age and have been superimposed over the regression line; figures used standardized T-score units. Female dogs, purebred dogs, and fixed dogs were less aggressive toward people.

For activity/excitability, the linear effect model was the best fitting model, as the inclusion of the quadratic term was not significant (p = .43). The linear effect of age was significant, such that younger dogs were more active/excitable than older dogs. Dogs exposed to an obedience class and dogs trained by their owners were more active/excitable.

For responsiveness to training, the model that included a quadratic effect was the best fitting model. The quadratic effect of age was a significant predictor of responsiveness to training, but the linear effect was not a significant predictor. Decomposing this quadratic effect revealed that the apex of the curve occurs at 7.44 years old for dogs. The slope prior to this point is significant and positive (β = .10, p = .007) and the slope after this point is not significant (β = -.05, p = .16). Thus, dogs around this point are higher in responsiveness to training than younger dogs but are similar in responsiveness to training as older dogs. This pattern can be seen in Figure 2. Dogs trained by their owners were higher in responsiveness to training.

For aggression toward animals, the model that included a quadratic effect was the best fitting model. The quadratic effect of age was a significant predictor of aggression toward animals, but the linear effect was not a significant predictor. Decomposing this quadratic effect revealed that the apex of the curve occurs at 7.74 years old for dogs. The slope prior to this point is positive but not significant (β = .05, p = .18) and the slope after this point is negative and significant (β = -.10, p = .006). Thus, there are not significant age differences prior to this point, but older dogs are less aggressive than younger and middle-aged dogs. This pattern can be seen

in Figure 3. Purebred dogs and fixed dogs are less aggressive toward other animals.[34]

Is Dog Personality Associated with Health and Biting History?

To examine whether dog personality was associated with health, we ran a regression predicting chronic health conditions from the five dog personality domains, age, sex, breed, sterilization status, history of obedience training, and history of owner training. The results from this regression can be found in Table 3. The only significant personality dimension predicting chronic health conditions was activity/excitability, such that dogs that were more active/excitable had fewer chronic health conditions. Younger and female dogs had fewer chronic health conditions. Responsiveness to training was associated with more health conditions (again at p = .04), but this association became non-significant after the covariates were included (β went from .06 to .03).

To examine whether dog personality was associated with biting history, we ran a logistic regression predicting biting history (0=no history, 1=has bitten a human) from the five dog personality domains, age, sex, breed, sterilization status, history of obedience training, and history of owner training. The results from this regression can be found in Table 4. Dogs that were high in aggression toward people were more likely to have bitten a human. Dogs high in responsiveness to training were less likely to have bitten a human. As dogs increase in aggression toward people (responsiveness to training), the odds of a dog having bit a human increases by 89% (decreases by 26%). Older dogs (9%), male dogs (21%), and dogs trained by their owners (24%) were more likely to have bitten a human. This last finding is particularly surprising, that dogs trained by their owners have a history of biting. To speculate, it could be that owners initiated training following the dog biting a human. This is supported by the evidence that training efforts are unrelated to the personality trait of aggression toward people

but is related to biting history.[5]

Are Owner Personality and Dog Personality Correlated?

Our third question examined whether owner and dog personality were correlated. Owner and dog personality dimensions were often correlated at the bivariate level (see Table 1). We adopted the approach of predicting each dog personality dimension from the five owner personality traits, owner demographics, and the aforementioned dog covariates. The associations reported below are similar to the bivariate associations reported in Table 1.

As seen in Table 5, there were several instances in which owner and dog personality were correlated. Owners high in extraversion rated their dogs as more active/excitable, but extraversion was largely unrelated to the other dog personality dimensions after the remaining four owner personality dimensions were controlled for. Owners high in agreeableness, high in conscientiousness, or high in open-mindedness rated their dogs as less fearful, more active/excitable, and less aggressive toward people and animals. Owners high in extraversion, conscientiousness, or high in open-mindedness also rated their dogs as more responsive to training. Owners high in negative emotionality rated their dogs as more fearful and active/excitable, and less responsive to training.

Are Owner and Dog Personality Associated with Relationship Quality?[6]

Our final question examined whether owner and dog personality were associated with owner-reports of relationship quality in the owner-dog relationship. To test this question, we predicted relationship quality from the five owner personality traits, the five dog personality traits, human age, human gender, dog's age, dog's sex, breed, sterilization status, history of obedience training, and history of owner training.

The results from these analyses can be seen in Table 6. Owner agreeableness was

associated with higher relationship quality. Owners report higher relationship quality if their dogs are more active/excitable and more responsive to training. Female owners report higher relationship quality with their dogs. Owners of older dogs report higher relationship quality. Aggression toward people negatively predicted relationship quality, but this association was not significant after the covariates were included in the model.

Discussion

In line with the literature on senescence (Class & Brommer, 2016) and state-behavior feedback loops (Sih et al., 2015), dog personalities differ by age (Kubinyi et al., 2009; Smith & Blumstein, 2008). Specifically, younger dogs were more active/excitable, less aggressive toward people, more aggressive toward other animals, and less responsive toward training compared to "middle aged" (e.g., 6-8 years older) and older dogs. There were no age differences in fearfulness in dogs. Quadratic effects of age were found, such that age differences were often found among younger dogs and less so among older dogs, with some exceptions. That age differences were more dramatic in younger dogs is consistent with research on humans demonstrating similar large differences early in life, but not later in life (Roberts, Walton, & Viechtbauer, 2006; Soto et al., 2010; Srivastava et al., 2003). The increases in responsiveness to training is consistent with dogs responding to changes in states that require greater discipline, a finding also seen in the human literature (Kubinyi et al., 2009; Roberts & Mroczek, 2008; Roberts et al., 2006). Although comparisons between the magnitude of differences between dogs and humans were not the subject of the current study, lifespan differences (in terms of T-score units) are relatively similar to those found in studies of humans (Soto et al., 2010), which is consistent with research with other non-human animals (Weiss & King, 2015).

The lifespan differences in aggression among dogs showed curvilinear effects with age,

which may explain discrepancies found in past research. For example, some research studies find that older dogs are more friendly to humans and animals; others find that older dogs are less friendly to humans and animals; yet other studies find no significant age differences (Bennett & Rohlf, 2007; Ley & Bennett, 2008; Seksel, Mazurski, & Taylor, 1999; Strandberg, Jacobsson, & Saetre, 2005). In one of the largest studies of age differences in dog aggression, Casey, Loftus, Bolster, Richards, and Blackwell (2013) found that aggression toward other dogs (both unfamiliar and other dogs in the household) was higher among older dogs compared to younger dogs. In our study, we found similar results—the linear effect of age was marginally associated with higher aggression toward both other animals and humans. However, the quadratic effect of age was the best fitting model, suggesting that aggression may taper off among older dogs. Dogs may become less aggressive toward animals and humans later in life because of lower levels of activity/excitability, worse health, or some other mechanism that drives better intra- and interspecies behavior. For example, like wild blue tits, senescence is associated with lifespan declines in characteristics associated with enhanced fitness, like aggression (Class & Brommer, 2016). Similar late-life personality changes (towards greater prosociality) are often found in humans, although the mechanisms leading to increases in prosociality are likely different between dogs and humans (Matsumoto, Yamagishi, Li, & Kiyonari, 2016).

Dog outcomes and human-dog associations

These results also provide evidence for associations between dog personality traits and important dog outcomes in a large sample of dogs. Fewer chronic health conditions were associated with higher levels of activity/excitability in dogs. Additionally, dogs rated as having high aggression toward people, older dogs, male dogs, and dogs trained by their owners were the most likely to have bitten a human. Owner ratings of relationship quality are also important for

dogs; how happy humans are with their dogs likely predicts the quality of care and affection that humans provide. Humans reported higher relationship quality if their dogs were more active/excitable and responsive to training. That dog personality was associated with important dog outcomes is also consistent with the predictive power of human personality for human outcomes (Hill & Roberts, 2015; Roberts et al., 2007). Early life increases in positive characteristics among dogs (e.g., responsiveness to training) is analogous to a "maturity principle" that is found in humans (Roberts, Wood, et al., 2005) and the hypothesized process behind state-dependent behavior leading to personality changes (Sih et al., 2015): dogs that demonstrated more (ostensibly) positive characteristics (e.g., were more active/excitable and responsive to training, less aggressive and fearful) had the most positive outcomes.

The implications of human-dog personality associations. There were many dog personality dimensions that were correlated with owner personality dimensions. These findings contribute to the small body of work looking at the similarities between a dog's perceived personality and their owner's personality (e.g., Turcsán et al., 2012). Some of the most intriguing results found were instances of personality "compatibility" between owners and their dogs. For example, extraverts rated their dogs as more active/excitable; conscientious owners rated their dogs as more responsive to training; agreeable owners rated their dogs as less aggressive; neurotic owners rated their dogs as more fearful. Given that non-owners (both well acquainted others and strangers) rate a dog's personality in a similar way as the owner undermines the argument that a correlation between owner-dog personality results entirely from owners projecting their personality onto dogs (Fratkin et al., 2015; Posluns et al., 2017; Turcsán et al., 2012). Specifically, it seems unlikely that human-dog correlations result entirely from owners foisting their personalities onto targets like their dogs. If owners were indeed engaging in this

projection of their traits on their dogs, we would likely have seen a very specific pattern of results. For example, extraversion would likely have the *largest* association with activity/excitability, as extraverted owners might project that their dogs are more extraverted than they are. Likewise, negative emotionality would likely have the largest associations with fearfulness or aggression toward people/animals. This was, in fact, not the case: agreeableness and open-mindedness were the largest predictors of having a dog that was active/excitable. Agreeableness, conscientiousness, and open-mindedness were either comparable or larger predictors of having a dog that was fearful. These patterns of results further suggests that owners do not merely project their personalities on their dogs. The other two possibilities—that humans choose dogs that are compatible with their lifestyles and that humans' lifestyles jointly shape human and dog personality over time are possible directions for future research.

A related question—whether dog and owner personalities that "fit" together have better outcomes (e.g., satisfaction, happiness, health) is another exciting direction for future research, as there is empirical support for this possibility (e.g., in horses; Hausberger et al., 2008). Using the taxa in the current study, there are not one-to-one correspondences between the Big Five model in humans and a properly analogous model of the same Big Five characteristics in dogs. As a result, it would be appropriate to model how the fit between a human's agreeableness and a dog's agreeableness predict how happy the human is. However, agreeableness is not among the taxonomy we used. Although some analogues exist (e.g., human extraversion and dog activity/excitability), there are some traits (e.g., openness) that are not represented in both models. A study examining the implications of human-owner fit for humans and dogs, preferably using the most up-to-date methods of doing so, is a much needed one (see Eastwick, Finkel, & Simpson, 2019; Humberg, Nestler, & Back, 2018, for examples for examining fit between dyad

members; van Scheppingen, Chopik, Bleidorn, & Denissen, 2018; Weidmann, Schönbrodt, Ledermann, & Grob, 2017)

Limitations and future directions

The current study had many strengths. We collected a large sample of ratings of dogs that were diverse in age, sex, breed, sterilization status, and training history. Many previous studies examined only a small number of dogs that were often one breed and one sex. We also measured human personality and multiple dog outcomes to examine associations between dog personality, owner personality, and their associations with important outcomes for dogs.

Nevertheless, we focus on three main limitations and provide some directions for exciting future research: (1) the design of the study (e.g., cross-sectional, single-informant), (2) the assessment of dog personality, and (3) the size of the effects observed in the current study.

Study design. First, our study was cross-sectional, utilized only one informant, and did not assess any mechanisms for why dog personality might change across the dog's lifespan. We treated this study as an exploration into whether there were age differences in dog personality. However, it is unclear whether cross-sectional age differences reflect developmental changes that dogs experience or differences between dogs born in different years. This is often debated in the human literature, as researchers question how large a concern cohort differences are in distorting the conclusions drawn from cross-sectional studies of psychological characteristics (e.g., Costa & McCrae, 1982; Roberts, Edmonds, & Grijalva, 2010; Trzesniewski, Donnellan, & Robins, 2008; Twenge, 2006). Although it seems odd to think of how exposure to current cultural phenomena (e.g., social media, a culture of egotism) or broader generational/cultural changes in humans might affect dogs, the possibility may not be as far-fetched as one might think. If generational/cultural changes considerably influence human behavior, it could be that their pets

may also be affected if some degree of their personality is attributable to a human's lifestyle or even by changes toward the role of domesticated dogs more generally (George, Slagle, Wilson, Moeller, & Bruskotter, 2016). One approach to address this limitation is to follow multiple cohorts of dogs and their owners to appropriately model both (a) changes in dog personality over time and (b) human-dog exchanges in personality development. Another approach would be to examine how personality development in dogs is similar or different across cultures, as the role and place of dogs in society might vary across context (Bleidorn et al., 2013; McCrae et al., 2000).

In follow-up work, we also hope to collect additional variables that might speak to the mechanisms driving changes in dog personality over time. For example, the degree to which dog personality changes across time should be related to the dogs training and obedience experience. In the current study, we only had a crude (yes or no) measure for whether owners tried to train their dog and whether they enrolled the dog in obedience classes. The distribution of training and obedience practices prevented us from modeling these processes further. For example, although a large number of people (20.6% of the sample) both tried to train their dog and enrolled it in obedience classes, only 3.5% of the sample tried to train their dog without enrolling it in an obedience class. An exciting direction for future work would be to examine how personality development varies across exposure to different training regimens. A study in which dogs are randomly assigned to different training/obedience exposures, and with personality being assessed longitudinally, would be the most ideal design. Another limitation of the current study is that we had a simple measure of biting history (yes, no, or unknown). It would have been informative to know at what point in the dog's life course the bite happened, the circumstances of the bite, and the consequences for the dog, owner, and dog-owner relationship. Knowing more about the bite

history could help explain why owner training predicted a higher likelihood of biting someone—training could have been initiated directly because of this bite. Future research can examine how (and why) dog personality changes after significant life events for dogs, like biting or adoption.

A longitudinal study of dog personality would also provide researchers the opportunity to test different models of personality development in dogs. Two major theoretical approaches to personality development differ widely on what they consider the mechanisms driving personality change. Do changes result from physiological changes in biological systems or as a result of training and life experiences (Bleidorn et al., 2013; Costa Jr et al., 2019)? Are there individual differences in dog personality change, such that some dogs may change more than others? What variables might predict individual differences in change among dogs, and how would they be measured? The answers to questions like these have important implications for dogs and their owners. Knowing the mechanisms underlying changes in dog personality can inform the extent to which interventions/training may be effective (e.g., so reasonable expectations can be set), the time course of personality changes (e.g., whether you can teach an old dog new tricks), and aid in the initial selection of dogs.

Assessment of dog personality. Second, in the current study we focused on the five-factor personality taxonomy provided by the DPQ (Jones, 2008; Jones & Gosling, 2005). However, there are several measures and taxonomies for personality in dogs (e.g., Hsu & Serpell, 2003; Ley, Bennett, & Coleman, 2009). Other researchers have adapted human questionnaires for the purposes of dog research (e.g., Gosling, Kwan, & John, 2003; Turcsán et al., 2012). We focused on the DPQ as we considered it to the most rigorously developed dog personality questionnaire—one that included consultations from dog experts, a series of exploratory and confirmatory factor analyses, inter-rater reliability tests, test-retest evaluations,

and predictive validity batteries among large diverse samples of dogs. There is a high degree of conceptual and empirical overlap between the DPQ and other measures of dog personality (Henriksson, 2016; Posluns et al., 2017; Rayment, Peters, Marston, & Groef, 2016). Nevertheless, future research can examine age differences in dog personality using other measurement tools and further improve measures of dog personality. These studies can also expand their measurement of variables that might be associated with dog personality (e.g., family lineage, number of other dogs in the house, length of ownership).

Magnitude of effect sizes and constraints on generalizability. Third, our large sample of dogs enabled us to detect smaller effect sizes. There are many places in which age was as large a predictor (or larger) than many variables that people assume exert a large influence on personality (e.g., breed, sterilization). Likewise, dog personality could be a large predictor of behavior in some circumstances (e.g., aggression toward people strongly predicted biting history). However, it is important to contextualize the effect sizes in the current study; they were mostly small in magnitude. Measuring more proximal variables to dog personality may yield larger effect sizes. For example, measuring age cross-sectionally may be an imperfect measure for assessing how dog personality develops over long periods of time. The use of longitudinal studies could reveal if there are large individual differences in changes in dog personality over time (Fratkin, Sinn, Patall, & Gosling, 2013). Some dogs may change dramatically in one direction or another whereas some dogs may more or less stay the same. Unfortunately, the cross-sectional nature of our study prevents us from assessing such questions. Likewise, a broader examination of quantifying how dog personality differs on other characteristics (e.g., how specific dog breeds differ) would also be an exciting direction for future research. Finally, as with many studies, our results and conclusions can only be applied to the owners and dogs that

were acquired through our selection criteria. As a result, it is possible that these results may not extend to other populations of owners and dogs.

Conclusion

The current study examined age differences in dog personality and associations between dog personality, important dog outcomes, owner personality, and relationship quality with owners. A great deal of attention and resources are paid to assessing dog personality. Shelters, adoption agencies, and potential owners make many inferences about a dog and its personality. Having knowledge about a dog's personality, how it will change, and how dog and human personality are related can be major boons for such organizations and for owners. Aside from the practical benefits that future research into dog personality change and human-dog interactions can provide, examining why dog personality changes can also provide important information for many existing theories of lifespan development.

Table 1. Correlations and Descriptive Statistics for Study Variables

	Mean/%	SD	1	2	3	4	5	6	7	8	9
1.) Sex_D	46.2% Female										
2.) $Gender_H$	70.3% Female		.08**								
3.) Age_D	6.44	3.82	.03	-.03							
4.) Age_H	24.64	10.11	.05*	-.13***	.04						
5.) $Extraversion_H$	3.38	.74	-.02	.08**	-.02	-.19***					
6.) $Agreeableness_H$	3.82	.61	.03	.15***	.06*	.03	.18***				
7.) $Conscientiousness_H$	3.70	.69	.04	.12***	.04	.16***	.27***	.42***			
8.) Negative $Emotionality_H$	2.77	.83	-.01	.18***	.04	-.20***	-.35***	-.33***	-.42***		
9.) Open-$mindedness_H$	3.76	.69	.02	-.01	.04	.06*	.25***	.25***	.15***	-.11***	
10.) $Fearfulness_D$	3.08	1.01	.06*	-.03	.03	-.11***	-.24***	-.24***	-.22***	.21***	-.16***
11.) Aggression toward $People_D$	2.71	1.29	-.08**	-.15***	-.04	-.01	-.21***	-.21***	-.16***	.07**	-.13***
12.) $Activity/Excitability_D$	5.17	.82	.03	.11***	-.32***	.02	.18****	.18***	.16***	-.06*	.19***
13.) Responsiveness to $Training_D$	4.55	1.21	.01	-.01	.02	.14***	.15***	.17***	.22***	-.20***	.13***
14.) Aggression to $Animals_D$	3.37	1.04	-.03	-.08**	-.001	-.05*	-.05*	-.20***	-.18***	.08**	-.10***
15.) $Breed_D$	50.2% purebred		-.04	.01	.02	-.01	.08**	-.001	.07**	-.04	.06*
16.) $Castration_D$	87.3% spayed/neutered/fixed		.09***	.03	.14***	-.04	-.01	.001	.03	.02	.01
17.) $Obedience_D$	24.1% attended a class		.001	.06*	.02	-.12***	.06*	.03	.01	.05	.02
18.) $Training_D$	63.5% attempted to train		-.001	.06*	-.04	-.14***	.12***	.07**	.04	-.02	.03
19.) $Health_D$	30% have at least one issue		-.05*	-.02	.39***	.07**	.00	-.03	-.03	.06**	.01
20.) Biting $History_D$	15.3% have bitten a human		-.08**	-.01	.08**	-.07**	.01	-.09***	-.06*	.05*	-.04
21.) $RelationshipQuality_{HD}$	6.26	1.03	.05	.12***	.06	.08**	.13***	.23***	.17***	-.15***	.11***

Note. Gender (Human): 1=male, 1=female; Sex (Dog): -1=male, 1=female; Breed: -1=mixed, 1=purebred; Castration: -1=intact, 1=spayed/neutered; Obedience: -1=did not participate in obedience class, 1=participated in at least one obedience class; Training: -1=owner made no attempt to formally train, 1=owner attempted to train. Biting History: 0=no history, 1=has bitten a human

10	11	12	13	14	15	16	17	18	19	20
.51***										
-.29***	-.18***									
-.28***	-.27***	.17***								
.36***	.61***	-.05	-.35***							
-.10***	-.07**	-.02	.02	-.05*						
.07**	-.10***	-.03	.03	-.03	-.16***					
-.05*	-.04	.11***	.02	-.01	.06*	.14***				
.01	-.01	.12***	.09***	-.001	.03	.04	.26***			
.05*	.01	-.24***	.003	-.01	.05	.06*	-.01	-.01		
.19***	.35***	-.09***	-.19***	.26***	-.03	-.01	.04	.04	.08**	
-.24***	-.25***	.20***	.29***	-.21***	.07*	.01	.04	.09**	.07*	-.15***

Table 2. Age Differences in Dog Personality

Fearfulness						95% Confidence Interval							95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	3.07	.03		117.47	< .001	3.02	3.12	2.95	.05		63.83	< .001	2.86	3.04
Age	.01	.01	.05	1.96	.05	< .001	.03	.01	.01	.04	1.70	.09	-.002	.03
Sex								.05	.03	.05	1.87	.06	-.002	.10
Breed								-.09	.03	-.09	-3.43	.001	-.14	-.04
Castration								.10	.04	.07	2.45	.01	.02	.18
Obedience								-.07	.03	-.06	-2.19	.03	-.13	-.01
Training								.04	.03	.03	1.27	.21	-.02	.09
Note. $F(6, 1518) = 5.86$, $p < .001$; $R^2 = .02$.														

Aggression toward People						95% Confidence Interval							95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	2.72	.05		59.85	< .001	2.63	2.81	2.85	.07		42.32	< .001	2.72	2.99
Age	-.01	.01	-.02	-.61	.54	-.02	.01	.002	.01	.01	.20	.85	-.02	.02
Age^2	-.004	.002	-.05	-1.67	.10	-.01	.001	-.004	.002	-.06	-2.06	.04	-.01	< .001
Sex								-.09	.03	-.07	-2.75	.01	-.15	-.03
Breed								-.11	.03	-.09	-3.45	.001	-.18	-.05
Castration								-.21	.05	-.11	-4.05	< .001	-.31	-.11
Obedience								-.04	.04	-.03	-.97	.33	-.11	.04
Training								.02	.04	.01	.46	.64	-.05	.09
Note. $F(7, 1517) = 5.87$, $p < .001$; $R^2 = .03$.														

Activity/Excitability						95% Confidence Interval							95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	5.20	.02		264.38	< .001	5.16	5.24	5.24	.04		150.26	< .001	5.17	5.31
Age	-.07	.01	-.35	-14.40	< .001	-.08	-.06	-.07	.01	-.34	-14.18	< .001	-.08	-.06
Sex								.02	.02	.03	1.15	.25	-.02	.06
Breed								-.01	.02	-.01	-.30	.77	-.05	.03

Castration								-.02	.03	-.01	-.54	.59	-.08	.04
Obedience								.08	.02	.09	3.51	< .001	.04	.13
Training								.06	.02	.07	2.77	.01	.02	.10
Note. $F(6, 1519) = 39.67$, $p < .001$; $R^2 = .14$.														
Responsiveness to Training						95% Confidence Interval							95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	4.69	.04		108.34	< .001	4.60	4.77	4.61	.07		71.10	< .001	4.48	4.74
Age	.02	.01	.05	1.83	.07	-.001	.03	.02	.01	.05	1.79	.07	-.002	.03
Age^2	-.01	.002	-.11	-4.02	< .001	-.01	-.004	-.01	.02	-.11	-3.88	< .001	-.01	-.004
Sex								-.01	.03	-.01	-.23	.82	-.07	.05
Breed								.05	.03	.04	1.41	.16	-.02	.11
Castration								.05	.05	.03	1.00	.32	-.05	.15
Obedience								-.02	.04	-.01	-.44	.66	-.09	.06
Training								.10	.03	.08	3.06	.002	.04	.17
Note. $F(7, 1518) = 4.16$, $p < .001$; $R^2 = .02$.														
Aggression toward Animals						95% Confidence Interval							95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	3.40	.04		92.17	< .001	3.33	3.48	3.46	.06		62.51	< .001	3.35	3.57
Age	.01	.01	.04	1.30	.20	-.01	.02	.01	.01	.05	1.69	.09	-.002	.03
Age^2	-.01	.002	-.07	-2.70	.01	-.01	-.001	-.01	.002	-.08	-2.87	.004	-.01	-.002
Sex								-.02	.03	-.02	-.85	.40	-.08	.03
Breed								-.07	.03	-.07	-2.56	.01	-.12	-.02
Castration								-.09	.04	-.05	-2.04	.04	-.17	-.003
Obedience								-.01	.03	-.01	-.37	.71	-.07	.05
Training								.02	.03	.02	.63	.53	-.04	.07

Note. $F(7, 1518) = 2.64$, $p = .01$; $R^2 = .01$. Sex: -1=male, 1=female; Breed: -1=mixed, 1=purebred; Castration: -1=intact, 1=spayed/neutered; Obedience: -1=did not participate in obedience class, 1=participated in at least one obedience class; Training: -1=owner made no attempt to formally train, 1=owner attempted to train.

Table 3. Personality Predicting Chronic Health Conditions

						95% Confidence Interval						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	1.14	.14		8.32	< .001	.87	1.40	.70	.14		5.17	< .001	.43	.96
Fearfulness	.01	.02	.01	.43	.66	-.03	.04	.01	.02	.02	.84	.40	-.02	.05
Aggression toward People	-.02	.02	-.03	-1.00	.32	-.05	.02	.001	.02	.003	.09	.93	-.03	.03
Activity/Excitability	-.18	.02	-.26	-9.85	< .001	-.22	-.14	-.09	.02	-.13	-4.76	< .001	-.13	-.05
Responsiveness to Training	.03	.01	.06	2.04	.04	.001	.05	.01	.01	.03	1.09	.28	-.01	.04
Aggression to Animals	.01	.02	.02	.59	.55	-.02	.05	-.01	.02	-.01	-.47	.64	-.04	.03
Age								.05	.004	.34	13.37	< .001	.04	.06
Sex								-.03	.01	-.06	-2.41	.02	-.06	-.01
Breed								.02	.01	.04	1.54	.12	-.01	.05
Castration								.01	.02	.01	.57	.57	-.03	.05
Obedience								-.01	.02	-.01	-.44	.66	-.04	.03
Training								.01	.02	.02	.84	.40	-.02	.04

Note. $F(11, 1512) = 27.98$, $p < .001$; $R^2 = .17$. Sex: -1=male, 1=female; Breed: -1=mixed, 1=purebred; Castration: -1=intact, 1=spayed/neutered; Obedience: -1=did not participate in obedience class, 1=participated in at least one obedience class; Training: -1=owner made no attempt to formally train, 1=owner attempted to train.

Table 4. Personality Predicting Biting History

						95% Confidence Interval (Exp(b))							95% Confidence Interval (Exp(b))	
	b	*SE*	*Wald*	*p*	*Exp(b)*	*LB*	*UB*	*b*	*SE*	*Wald*	*p*	*Exp(b)*	*LB*	*UB*
Intercept	-2.02	.76	7.16	.01	.13			-2.63	.80	10.92	.001	.07		
Fearfulness	-.02	.09	.03	.87	.99	.82	1.19	.003	.10	.001	.98	1.00	.83	1.22
Aggression toward People	.60	.08	54.28	< .001	1.82	1.55	2.14	.64	.09	55.20	< .001	1.89	1.60	2.23
Activity/Excitability	-.17	.10	2.83	.09	.84	.69	1.03	-.06	.11	.32	.57	.94	.76	1.17
Responsiveness to Training	-.27	.07	14.18	< .001	.76	.66	.88	-.30	.07	16.77	< .001	.74	.64	.86
Aggression to Animals	.15	.10	2.39	.12	1.16	.96	1.41	.12	.10	1.59	.21	1.13	.93	1.37
Age								.09	.02	15.51	< .001	1.09	1.05	1.14
Sex								-.24	.08	8.17	.004	.79	.67	.93
Breed								.02	.08	.03	.86	1.02	.86	1.19
Castration								.02	.13	.03	.86	1.02	.80	1.31
Obedience								.12	.09	1.60	.21	1.13	.94	1.36
Training								.22	.09	5.72	.02	1.24	1.04	1.48

Note. χ^2 *(11)* = 223.16, $p < .001$; *Nagelkerke* $R^2 = .17$. Sex: -1=male, 1=female; Breed: -1=mixed, 1=purebred; Castration: -1=intact, 1=spayed/neutered; Obedience: -1=did not participate in obedience class, 1=participated in at least one obedience class; Training: -1=owner made no attempt to formally train, 1=owner attempted to train.

Table 5. Human Personality Predicting Dog Personality

Fearfulness						95% Confidence Interval						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	4.74	.27		17.43	< .001	4.21	5.27	4.56	.31		14.90	< .001	3.96	5.16
Extraversion	-.03	.04	-.02	-.74	.46	-.10	.04	-.05	.04	-.04	-1.38	.17	-.13	.02
Agreeableness	-.22	.05	-.13	-4.83	< .001	-.30	-.13	-.23	.05	-.14	-4.85	< .001	-.32	-.14
Conscientiousness	-.15	.04	-.10	-3.77	< .001	-.23	-.07	-.11	.04	-.08	-2.70	.01	-.20	-.03
Negative Emotionality	.13	.03	.10	3.82	< .001	.06	.19	.12	.04	.10	3.34	.001	.05	.20
Open-mindedness	-.14	.04	-.10	-3.91	< .001	-.21	-.07	-.12	.04	-.08	-3.10	.002	-.19	-.04
Age_D								.01	.01	.05	2.09	.04	.00	.03
Sex_D								.07	.02	.06	2.66	.01	.02	.12
$Breed_D$								-.07	.03	-.07	-2.65	.01	-.12	-.02
$Castration_D$								.10	.04	.06	2.47	.01	.02	.17
$Obedience_D$								-.08	.03	-.07	-2.73	.01	-.14	-.02
$Training_D$								.05	.03	.04	1.70	.09	-.01	.10
Age_H								-.01	.00	-.09	-3.39	.001	-.01	-.004
$Gender_H$								-.03	.03	-.03	-1.08	.28	-.09	.03

Note. $F(13, 1506) = 16.08$, $p < .001$; $R^2 = .12$.

Aggression toward People						95% Confidence Interval						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	5.40	.35		15.28	< .001	4.71	6.09	4.62	.39		11.87	< .001	3.85	5.38
Extraversion	.004	.05	.002	.08	.93	-.09	.09	.02	.05	.01	.47	.64	-.07	.12
Agreeableness	-.34	.06	-.16	-5.89	< .001	-.46	-.23	-.27	.06	-.13	-4.45	< .001	-.39	-.15
Conscientiousness	-.18	.05	-.10	-3.40	.001	-.28	-.08	-.09	.05	-.05	-1.74	.08	-.20	.01
Negative Emotionality	-.06	.04	-.04	-1.33	.18	-.14	.03	.06	.05	.04	1.18	.24	-.04	.15
Open-mindedness	-.16	.05	-.08	-3.29	.001	-.25	-.06	-.16	.05	-.09	-3.32	.001	-.26	-.07

Age_D	-.004	.01	-.01	-.42	.67	-.02	.01
Sex_D	-.07	.03	-.05	-2.09	.04	-.13	-.004
$Breed_D$	-.09	.03	-.07	-2.90	.004	-.16	-.03
$Castration_D$	-.19	.05	-.10	-3.75	< .001	-.28	-.09
$Obedience_D$	-.03	.04	-.02	-.81	.42	-.11	.04
$Training_D$	.04	.03	.03	1.06	.29	-.03	.10
Age_H	.001	.003	.01	.30	.76	-.01	.01
$Gender_H$	-.20	.04	-.14	-5.38	< .001	-.27	-.13

Note. $F(13, 1505) = 11.51$, $p < .001$; $R^2 = .09$.

Activity/Excitability						95% Confidence Interval						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	3.14	.23		13.96	< .001	2.70	3.58	3.18	.23		13.56	< .001	2.72	3.63
Extraversion	.07	.03	.07	2.49	.01	.02	.13	.05	.03	.05	1.74	.08	-.01	.11
Agreeableness	.16	.04	.12	4.28	< .001	.09	.23	.17	.04	.13	4.76	< .001	.10	.25
Conscientiousness	.12	.03	.10	3.52	< .001	.05	.18	.12	.03	.10	3.61	< .001	.05	.18
Negative Emotionality	.06	.03	.06	2.12	.03	.004	.11	.08	.03	.08	2.68	.01	.02	.13
Open-mindedness	.16	.03	.13	5.13	< .001	.10	.21	.15	.03	.13	5.06	< .001	.09	.21
Age_D								-.08	.01	-.36	-15.30	< .001	-.09	-.07
Sex_D								.01	.02	.01	.56	.57	-.03	.05
$Breed_D$								-.02	.02	-.03	-1.08	.28	-.06	.02
$Castration_D$								-.02	.03	-.02	-.66	.51	-.08	.04
$Obedience_D$								.08	.02	.08	3.46	.001	.03	.12
$Training_D$								.05	.02	.06	2.44	.01	.01	.09
Age_H								.003	.002	.04	1.56	.12	-.001	.01
$Gender_H$								.04	.02	.04	1.62	.11	-.01	.08

Note. $F(13, 1506) = 29.51$, $p < .001$; $R^2 = .20$.

Responsiveness to Training						95% Confidence Interval						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	3.04	.33		9.23	< .001	2.39	3.68	2.78	.37		7.51	< .001	2.06	3.51
Extraversion	.08	.04	.05	1.95	.05	-.001	.17	.13	.05	.08	2.81	.005	.04	.23
Agreeableness	.09	.05	.05	1.65	.10	-.02	.20	.11	.06	.05	1.87	.06	-.01	.22
Conscientiousness	.23	.05	.13	4.77	< .001	.14	.33	.21	.05	.12	4.03	< .001	.11	.31
Negative Emotionality	-.16	.04	-.11	-3.98	< .001	-.24	-.08	-.11	.05	-.07	-2.39	.02	-.20	-.02
Open-mindedness	.13	.04	.07	2.86	< .001	.04	.21	.10	.05	.05	2.06	.04	.004	.19
Age_D								.002	.01	.005	.19	.85	-.01	.02
Sex_D								-.02	.03	-.02	-.73	.47	-.08	.04
$Breed_D$								.01	.03	.01	.35	.72	-.05	.07
$Castration_D$								.07	.05	.04	1.51	.13	-.02	.16
$Obedience_D$								.003	.04	.002	.07	.94	-.07	.07
$Training_D$								.10	.03	.08	3.08	.002	.04	.16
Age_H								.02	.003	.13	4.87	< .001	.01	.02
$Gender_H$								-.01	.04	-.01	-.38	.70	-.08	.06

Note. $F(13, 1506) = 12.33$, $p < .001$; $R^2 = .10$.

Aggression toward Animals						95% Confidence Interval						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	5.31	.29		18.54	< .001	4.75	5.87	5.01	.32		15.60	< .001	4.38	5.64
Extraversion	.02	.04	.02	.56	.58	-.05	.09	.02	.04	.02	.59	.56	-.06	.11
Agreeableness	-.24	.05	-.14	-5.01	< .001	-.33	-.14	-.20	.05	-.12	-4.07	< .001	-.30	-.11
Conscientiousness	-.20	.04	-.13	-4.75	< .001	-.28	-.12	-.17	.04	-.11	-3.78	< .001	-.26	-.08
Negative Emotionality	-.03	.04	-.02	-.86	.39	-.10	.04	.02	.04	.01	.39	.69	-.06	.09

Open-mindedness	-.08	.04	-.05	-1.98	.05	-.15	-.001	-.09	.04	-.06	-2.12	.03	-.16	-.01
Age_D								.01	.01	.03	1.20	.23	-.01	.02
Sex_D								-.01	.03	-.01	-.34	.73	-.06	.04
$Breed_D$								-.05	.03	-.05	-1.91	.06	-.10	.001
$Castration_D$								-.07	.04	-.04	-1.64	.10	-.15	.01
$Obedience_D$								-.01	.03	-.01	-.30	.76	-.07	.05
$Training_D$								.03	.03	.02	.93	.35	-.03	.08
Age_H								-.002	.003	-.02	-.84	.40	-.01	.003
$Gender_H$								-.08	.03	-.07	-2.51	.01	-.14	-.02

Note. $F(13, 1506) = 7.66$, $p < .001$; $R^2 = .06$.

Table 6. Human and Dog Personality Predicting Relationship Quality

						95% Confidence Interval						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	4.28	.44		9.79	< .001	3.43	5.14	4.54	.46		9.94	< .001	3.64	5.43
Extraversion	.06	.04	.05	1.51	.13	-.02	.15	.06	.05	.04	1.21	.23	-.04	.15
Agreeableness	.22	.06	.14	3.94	< .001	.11	.33	.18	.06	.12	3.25	.001	.07	.29
Conscientiousness	.004	.05	.003	.08	.94	-.09	.10	-.04	.05	-.03	-.82	.42	-.14	.06
Neuroticism	-.02	.04	-.01	-.35	.73	-.10	.07	-.06	.05	-.05	-1.21	.23	-.15	.04
Openness to Experience	-.003	.05	-.001	-.02	.98	-.09	.09	-.01	.05	-.004	-.12	.90	-.10	.08
Fearfulness	-.06	.04	-.06	-1.65	.10	-.13	.01	-.06	.04	-.07	-1.75	.08	-.13	.01
Aggression toward People	-.08	.03	-.10	-2.50	.01	-.14	-.02	-.06	.03	-.08	-1.86	.06	-.12	.003
Activity/Excitability	.12	.04	.10	2.94	.003	.04	.19	.15	.04	.12	3.55	< .001	.07	.23
Responsiveness to Training	.16	.03	.20	6.06	< .001	.11	.22	.16	.03	.19	5.74	< .001	.10	.21
Aggression to Animals	.01	.04	.02	.38	.71	-.06	.09	.01	.04	.01	.16	.87	-.07	.08
Age (Human)								.003	.003	.04	1.08	.28	-.002	.01
Gender (Human)								.09	.03	.09	2.73	.01	.03	.16
Age (Dog)								.02	.01	.09	2.90	.004	.01	.04
Sex (Dog)								-.01	.03	-.01	-.26	.79	-.07	.05
Breed								.04	.03	.04	1.39	.16	-.02	.10
Castration								.02	.05	.02	.48	.63	-.07	.11
Obedience								.01	.04	.01	.31	.76	-.06	.08
Training								.04	.03	.04	1.14	.26	-.03	.10

Note. $F(18, 956) = 11.50$, $p < .001$; $R^2 = .18$. Gender (Human): -1=male, 1=female; Sex (Dog): -1=male, 1=female; Breed: -1=mixed, 1=purebred; Castration: -1=intact, 1=spayed/neutered; Obedience: -1=did not participate in obedience class, 1=participated in at least one obedience class; Training: -1=owner made no attempt to formally train, 1=owner attempted to train.

Figure 1. Age differences in aggression toward people

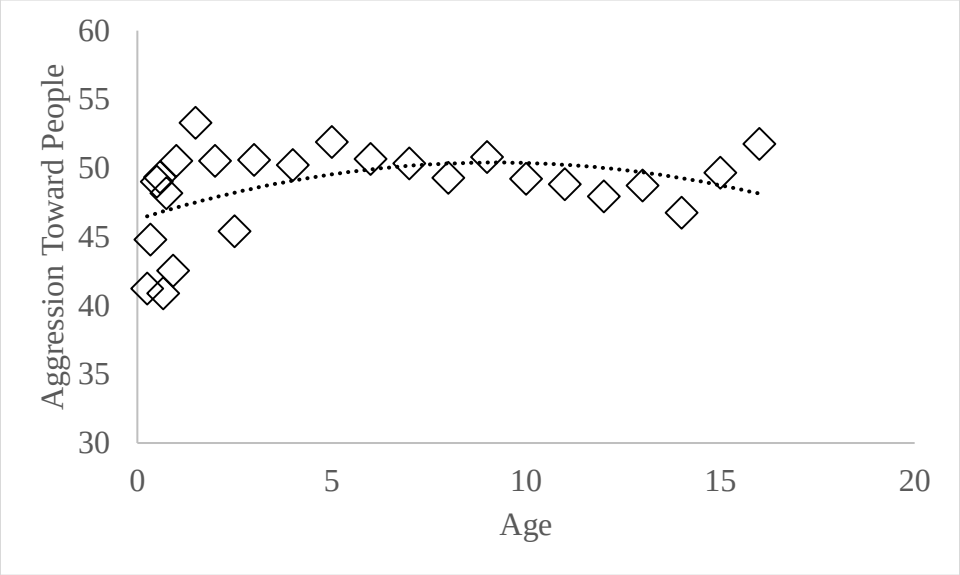


Figure 2. Age differences in responsiveness to training

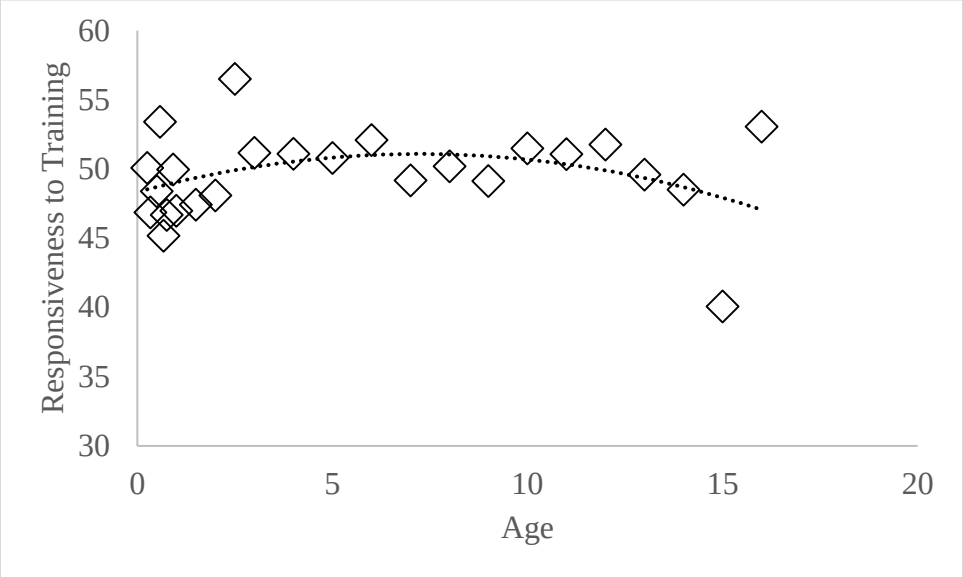
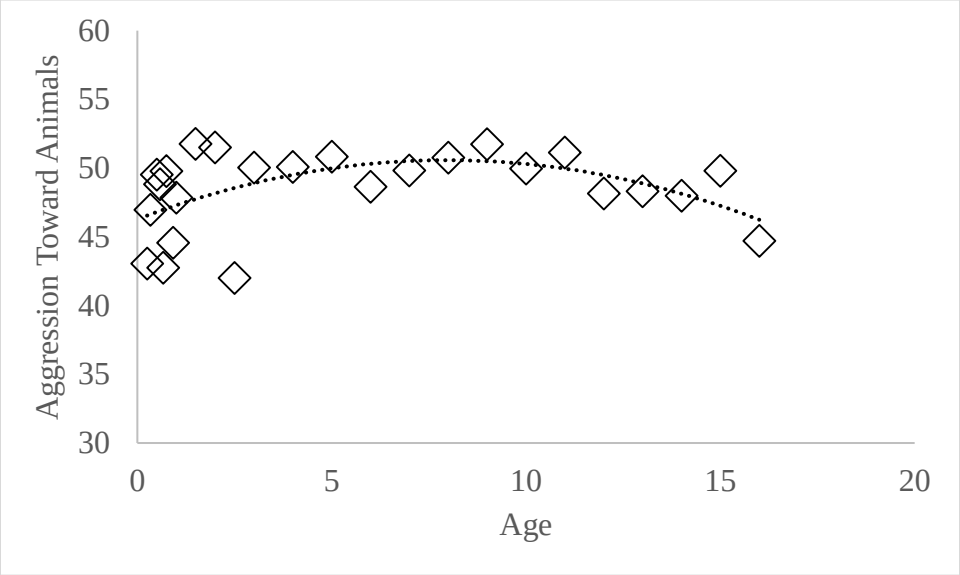


Figure 3. Age differences in aggression toward animals



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Supplementary Table 1. Age differences in dog personality facets

Fear of People						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	2.96	.06		49.45	< .001	2.84	3.08
Age	-.02	.01	-.06	-2.35	.02	-.04	-.003
Sex	.09	.03	.06	2.50	.01	.02	.15
Breed	-.12	.03	-.09	-3.48	.001	-.19	-.05
Castration	.11	.05	.06	2.16	.03	.01	.22
Obedience	-.06	.04	-.04	-1.46	.15	-.14	.02
Training	.04	.04	.03	1.20	.23	-.03	.12
Nonsocial Fear						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	2.90	.06		51.07	< .001	2.79	3.01
Age	.03	.01	.09	3.67	< .001	.01	.05
Sex	.03	.03	.02	.79	.43	-.04	.09
Breed	-.11	.03	-.09	-3.28	.001	-.17	-.04
Castration	.12	.05	.06	2.32	.02	.02	.22
Obedience	-.05	.04	-.03	-1.21	.23	-.12	.03
Training	.02	.03	.01	.53	.60	-.05	.09
Fear of Dogs						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	2.69	.06		45.58	< .001	2.57	2.80
Age	.01	.01	.02	.65	.52	-.01	.02
Sex	.11	.03	.09	3.32	.001	.04	.17
Breed	-.003	.03	-.003	-.11	.92	-.07	.06
Castration	.10	.05	.05	1.97	.05	< .001	.20
Obedience	-.06	.04	-.04	-1.43	.15	-.13	.02
Training	.05	.03	.04	1.38	.17	-.02	.11
Fear of Handling						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	3.24	.07		48.95	< .001	3.11	3.37
Age	.03	.01	.09	3.31	.001	.01	.05
Sex	-.03	.04	-.02	-.67	.50	-.10	.05
Breed	-.13	.04	-.09	-3.46	.001	-.21	-.06
Castration	.07	.06	.03	1.13	.26	-.05	.18
Obedience	-.11	.05	-.07	-2.51	.01	-.20	-.03
Training	.04	.04	.03	1.07	.28	-.04	.12
General Aggression						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	2.93	.08		38.01	< .001	2.78	3.09

Age	.01	.01	.02	.67	.50	-.01	.03
Age^2	-.01	.002	-.07	-2.55	.01	-.01	-.001
Sex	-.08	.04	-.05	-2.01	.05	-.15	-.002
Breed	-.17	.04	-.12	-4.47	< .001	-.24	-.09
Castration	-.23	.06	-.10	-3.93	< .001	-.35	-.12
Obedience	-.03	.05	-.02	-.57	.57	-.11	.06
Training	-.002	.04	-.001	-.05	.96	-.08	.08
Situational Aggression						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	2.73	.06		44.23	< .001	2.61	2.85
Age	-.01	.01	-.02	-.78	.44	-.03	.01
Sex	-.11	.04	-.08	-3.02	.003	-.17	-.04
Breed	-.06	.04	-.04	-1.62	.11	-.13	.01
Castration	-.18	.06	-.09	-3.27	.001	-.29	-.07
Obedience	-.05	.04	-.03	-1.18	.24	-.13	.03
Training	.03	.04	.02	.90	.37	-.04	.11
Excitability						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	4.14	.06		75.53	< .001	4.03	4.25
Age	-.12	.01	-.35	-14.35	< .001	-.13	-.10
Sex	-.002	.03	-.001	-.06	.96	-.06	.06
Breed	-.05	.03	-.04	-1.45	.15	-.11	.02
Castration	-.08	.05	-.04	-1.63	.10	-.17	.02
Obedience	.11	.04	.07	2.87	.004	.03	.18
Training	.03	.03	.02	.75	.45	-.04	.09
Playfulness						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	5.51	.06		93.98	< .001	5.30	5.53
Age	-.10	.01	-.29	-11.65	< .001	-.12	-.08
Sex	.01	.03	.01	.20	.84	-.06	.07
Breed	.01	.03	.01	.33	.74	-.05	.08
Castration	.02	.05	.01	.36	.72	-.08	.12
Obedience	.06	.04	.04	1.54	.13	-.02	.14
Training	.14	.04	.10	4.07	< .001	.07	.21
Active Engagement						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	5.54	.05		117.88	< .001	5.45	5.63
Age	-.07	.01	-.26	-10.36	< .001	-.09	-.06
Sex	.04	.03	.04	1.40	.16	-.02	.09
Breed	< .001	.03	< .001	.01	.99	-.05	.05
Castration	-.06	.04	-.03	-1.32	.19	-.14	.03

Obedience	.14	.03	.11	4.32	< .001	.08	.20
Training	.07	.03	.07	2.57	.01	.02	.13
Companionability						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	5.87	.04		140.17	< .001	5.78	5.95
Age	-.01	.01	-.02	-.88	.38	-.02	.01
Sex	.05	.02	.06	2.17	.03	.01	.10
Breed	.01	.02	.01	.36	.72	-.04	.06
Castration	.05	.04	.03	1.25	.21	-.03	.12
Obedience	.02	.03	.02	.81	.42	-.03	.08
Training	-.01	.03	-.01	-.38	.70	-.06	.04
Trainability						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	4.68	.07		68.55	< .001	4.54	4.81
Age	.01	.01	.03	.93	.35	-.01	.03
Age^2	-.01	.002	-.10	-3.84	< .001	-.01	-.004
Sex	-.01	.03	-.01	-.36	.72	-.08	.05
Breed	.05	.03	.04	1.48	.14	-.02	.11
Castration	-.01	.05	-.01	-.23	.82	-.11	.09
Obedience	-.01	.04	-.01	-.28	.78	-.09	.07
Training	.10	.04	.08	2.91	.004	.03	.17
Controllability						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	4.54	.08		59.50	< .001	4.39	4.69
Age	.02	.01	.06	2.20	.03	.002	.04
Age^2	-.01	.002	-.09	-3.18	.002	-.01	-.003
Sex	-.002	.04	-.002	-.07	.95	-.08	.07
Breed	.04	.04	.03	1.06	.29	-.03	.11
Castration	.11	.06	.05	1.92	.06	-.002	.23
Obedience	-.02	.04	-.01	-.50	.62	-.11	.06
Training	.10	.04	.07	2.61	.01	.03	.18
Aggression toward Dogs						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	2.84	.08		37.58	< .001	2.69	2.99
Age	.08	.01	.20	7.41	< .001	.06	.10
Age^2	-.01	.002	-.08	-3.10	.002	-.01	-.003
Sex	.03	.04	.02	.79	.43	-.04	.10
Breed	-.12	.04	-.09	-3.32	.001	-.19	-.05
Castration	-.07	.06	-.03	-1.29	.20	-.19	.04
Obedience	-.08	.04	-.05	-1.73	.08	-.16	.01

Training	-.03	.04	-.02	-.65	.52	-.10	.05
Prey Drive						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	3.83	.06		64.61	< .001	3.71	3.94
Age	-.05	.01	-.14	-5.46	< .001	-.07	-.03
Sex	-.02	.03	-.02	-.65	.52	-.09	.04
Breed	-.06	.03	-.04	-1.72	.09	-.12	.01
Castration	-.03	.05	-.01	-.48	.63	-.13	.08
Obedience	.03	.04	.02	.73	.47	-.05	.11
Training	.04	.04	.03	.99	.32	-.04	.11
Dominance over Other Dogs						95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	3.69	.07		51.41	< .001	3.55	3.83
Age	.01	.01	.03	.91	.36	-.01	.03
Age^2	-.01	.002	-.07	-2.67	.01	-.01	-.002
Sex	-.08	.04	-.06	-2.22	.03	-.15	-.01
Breed	-.03	.04	-.02	-.73	.47	-.09	.04
Castration	-.15	.05	-.08	-2.81	.01	-.26	-.05
Obedience	.01	.04	.01	.32	.75	-.07	.09
Training	.04	.04	.03	1.18	.24	-.03	.12

Supplementary Table 2. Age Differences in Dog Personality with Outcome Measures added as covariates

Fearfulness						95% Confidence Interval							95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	3.08	.03		90.16	< .001	3.01	3.14	3.16	.06		49.24	< .001	3.03	3.29
Age	.02	.01	.07	2.30	.02	.003	.04	.01	.01	.03	.78	.43	-.01	.03
Sex								.06	.03	.05	1.77	.08	-.01	.12
Breed								-.08	.03	-.08	-2.48	.01	-.14	-.02
Castration								.16	.05	.10	3.18	.002	.06	.25
Obedience								-.03	.04	-.02	-.71	.48	-.11	.05
Training								.05	.04	.05	1.43	.15	-.02	.12
Relationship Quality								-.24	.03	-.22	-7.06	< .001	-.30	-.17
Health								.14	.06	.07	2.21	.03	.02	.26
Biting History								.31	.05	.20	6.58	< .001	.22	.40

Note. $F(9, 953) = 16.12$, $p < .001$; $R^2 = .13$.

Aggression toward People						95% Confidence Interval							95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	2.77	.06		46.53	< .001	2.65	2.89	3.37	.09		38.06	< .001	3.20	3.55
Age	.002	.01	.01	.19	.85	-.02	.03	.00	.01	-.01	-.30	.76	-.03	.02
Age^2	-.003	.003	-.04	-1.15	.25	-.01	.002	-.01	.003	-.07	-2.07	.04	-.01	< .001
Sex								-.06	.04	-.05	-1.54	.12	-.14	.02
Breed								-.09	.04	-.07	-2.37	.02	-.17	-.02
Castration								-.18	.06	-.09	-3.09	.002	-.30	-.07
Obedience								-.003	.05	-.002	-.07	.94	-.10	.09
Training								-.02	.04	-.02	-.49	.62	-.10	.06
Relationship Quality								-.22	.04	-.16	-5.45	< .001	-.30	-.14
Health								.09	.08	.04	1.17	.24	-.06	.24
Biting History								.60	.06	.32	10.59	< .001	.49	.71

Note. $F(10, 952) = 19.74$, $p < .001$; $R^2 = .17$.

Activity/Excitability						95% Confidence Interval							95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	5.15	.02		206.78	< .001	5.10	5.20	5.17	.05		107.86	< .001	5.08	5.27
Age	-.07	.01	-.34	-11.30	< .001	-.09	-.06	-.06	.01	-.29	-9.02	< .001	-.08	-.05
Sex								.03	.02	.03	1.08	.28	-.02	.07
Breed								-.01	.02	-.01	-.30	.76	-.05	.04
Castration								-.03	.04	-.02	-.69	.49	-.10	.05

Obedience	.07	.03	.08	2.47	.01	.02	.13
Training	.04	.03	.05	1.69	.09	-.01	.10
Relationship Quality	.19	.02	.22	7.43	< .001	.14	.23
Health	-.17	.05	-.12	-3.66	< .001	-.26	-.08
Biting History	-.03	.03	-.02	-.79	.43	-.10	.04

Note. $F(9, 954) = 25.36$, $p < .001$; $R^2 = .19$.

Responsiveness to Training						95% Confidence Interval							95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	4.73	.06		85.01	.00	4.62	4.84	4.43	.09		52.09	< .001	4.26	4.60
Age	.02	.01	.05	1.55	.12	.00	.04	.02	.01	.06	1.66	.10	-.003	.04
Age^2	-.01	.003	-.12	-3.40	.00	-.01	-.004	-.01	.003	-.11	-3.39	.001	-.01	-.004
Sex								-.01	.04	-.01	-.24	.81	-.08	.06
Breed								.02	.04	.02	.54	.59	-.05	.09
Castration								.00	.06	-.001	-.02	.98	-.11	.11
Obedience								-.06	.05	-.04	-1.38	.17	-.16	.03
Training								.09	.04	.07	2.30	.02	.01	.17
Relationship Quality								.34	.04	.27	8.80	< .001	.27	.42
Health								.03	.07	.01	.36	.72	-.12	.17
Biting History								-.31	.05	-.18	-5.69	< .001	-.41	-.20

Note. $F(10, 953) = 15.13$, $p < .001$; $R^2 = .14$.

Aggression toward Animals						95% Confidence Interval							95% Confidence Interval	
	b	*SE*	*β*	*t*	*p*	*LB*	*UB*	*b*	*SE*	*β*	*t*	*p*	*LB*	*UB*
Intercept	3.41	.05		71.79	< .001	3.31	3.50	3.75	.07		50.69	< .001	3.60	3.89
Age	.01	.01	.03	.76	.45	-.01	.03	.004	.01	.01	.38	.71	-.02	.02
Age^2	-.005	.002	-.07	-2.13	.03	-.01	< .001	-.01	.002	-.09	-2.68	.01	-.01	-.002
Sex								-.01	.03	-.01	-.34	.73	-.08	.05
Breed								-.04	.03	-.04	-1.14	.26	-.10	.03
Castration								-.07	.05	-.04	-1.33	.18	-.16	.03
Obedience								.01	.04	.01	.36	.72	-.06	.09
Training								.002	.04	.001	.04	.96	-.07	.07
Relationship Quality								-.14	.03	-.13	-4.10	< .001	-.20	-.07
Health								.03	.06	.02	.53	.60	-.09	.16
Biting History								.37	.05	.25	7.82	< .001	.28	.46

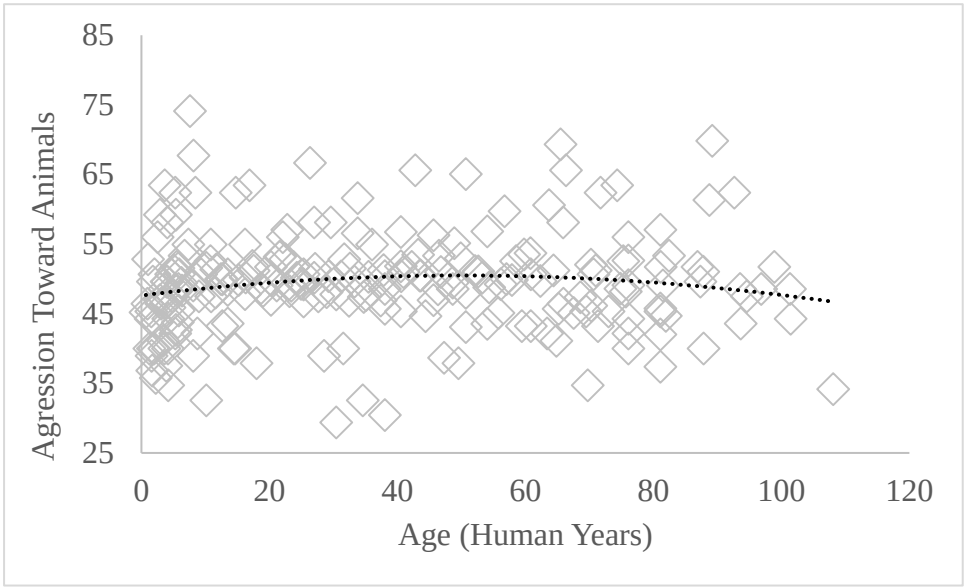
Note. $F(10, 953) = 10.25$, $p < .001$; $R^2 = .10$. Sex: -1=male, 1=female; Breed: -1=mixed, 1=purebred; Castration: -1=intact, 1=spayed/neutered; Obedience: -1=did not participate in obedience class, 1=participated in at least one obedience class; Training: -1=owner made no attempt to formally train, 1=owner attempted to train. Biting History: -1=no history, 1=has bitten

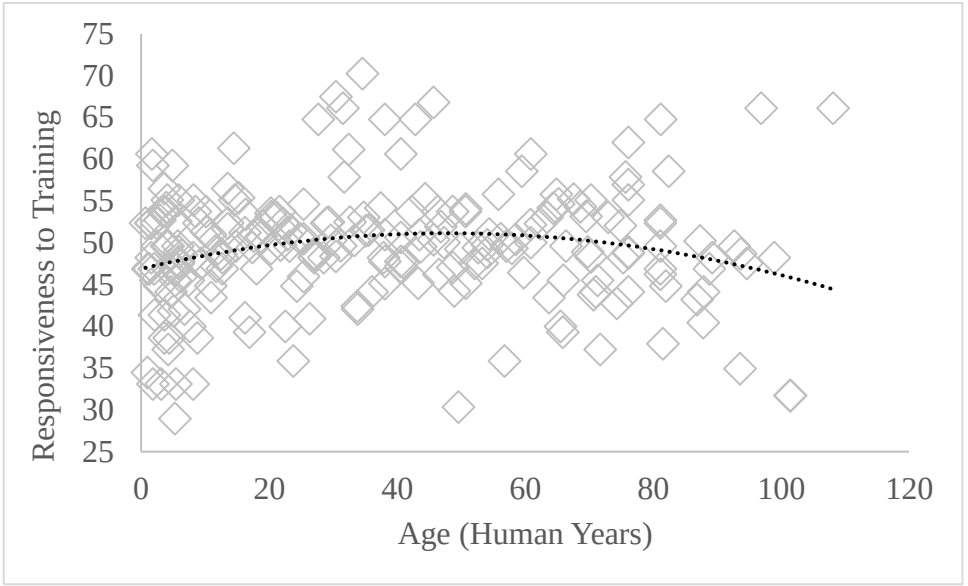
During the review process, one of the reviewers recommended that we try to convert/scale the age variable into an equivalent type of "human years". We thought it was a great idea and would make the results comparable with the human work. However, in doing some research, we realized that the traditional calculation of (dog's age)*(7 years) = human years isn't actually based on anything scientific or formal reasoning. Not only that, but life expectancy varies pretty wildly across (a) dog breeds and (b) the size of the dog.

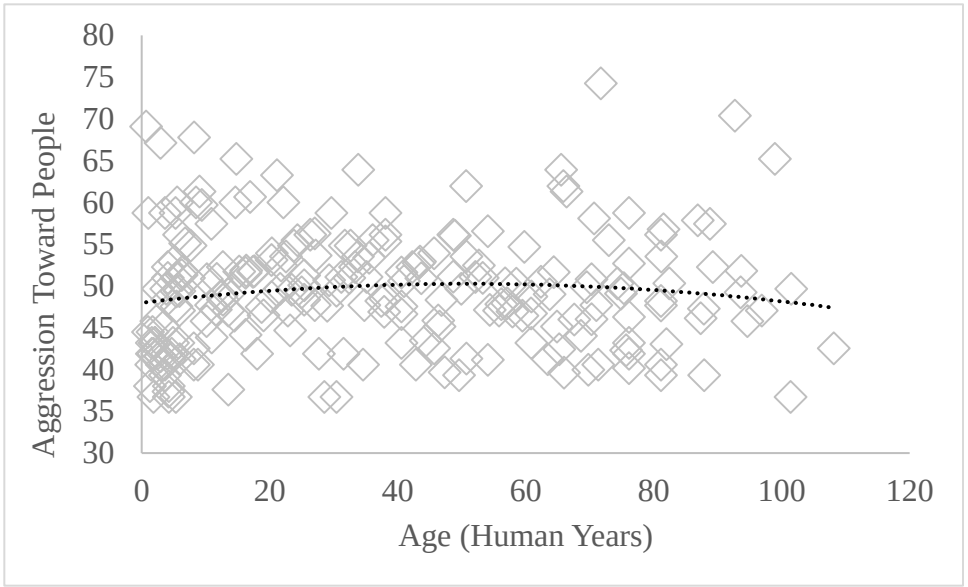
Further, with respect to mixed/mutt dogs, it was unclear what their corresponding breeds are, what the dominant breed is, and how large they are. Based on our searching, we estimated that a mixed dog might have a life expectancy of 10-13 years, but this was mostly conjecture. Even if we did find a straightforward transformation across all breeds, we didn't think there were unambiguous life stages (e.g., adolescence) for dogs, like Weiss & King (2015) matched for apes.

So we were left a little unsure what to do because it was not a direct linear transformation. Nevertheless, we tried our best to convert dog years to human years. We found the upper bound of life expectancy for each of the 52 different dog breeds in our data. We then calculated a sex-adjusted human lifespan age based on the average life expectancy for human men (76.1) and women (81.1). Thus, there was a conversion factor for each breed/sex to convert to human years (e.g., male poodles' "human age" was the dog's age*5.07333). These results in T-scores are plotted below in two ways: first, the raw data is plotted with a line of best fit superimposed over the data. Second, we "binned" age to make the pattern a little less messy but acknowledge that this approach has limitations. Although this represented an imperfect solution to comparing age differences in personality between dogs and humans, we encourage future researchers to make more formal comparisons between different species.

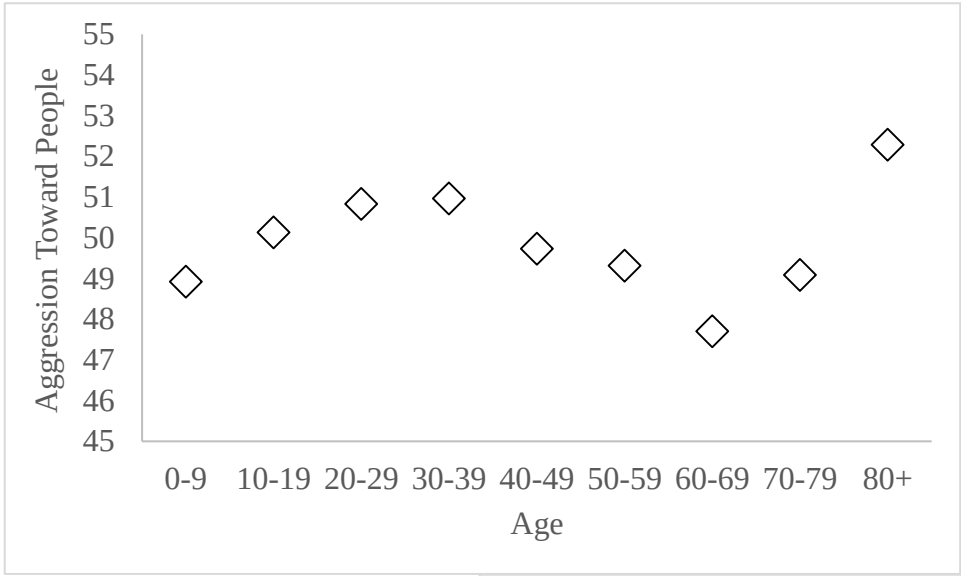
Supplementary Figures 1-3. Age differences in human years using the raw scores

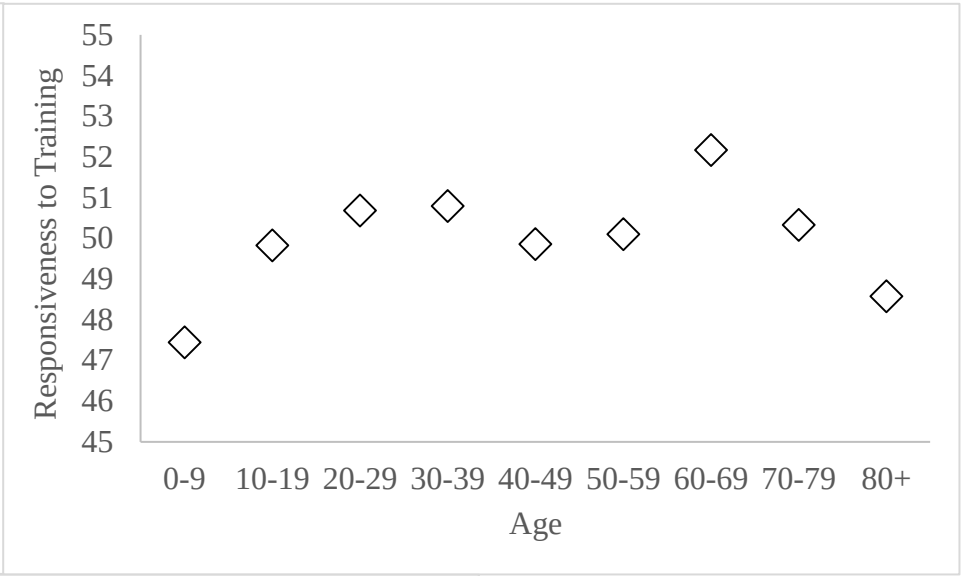






Supplementary Figures 4-6. Age differences in human years using binned age





[1] The five DPQ dimensions can be further differentiated into facets. Although the focus of the current report was on age differences among these broader factors, age difference analyses for the facets are available in Supplementary Table 1.

[2] MTurk is different in many ways from undergraduate samples, particularly with respect to mean age (MTurk = 36.44 years old; undergrads = 19.58 years old; d = 2.58). Many of the differences in study variables might be attributable to differences in these characteristics. Worth noting, the two samples differed on a number of variables; most of these differences were small (e.g., the smallest significant difference was that MTurk workers were more open-minded than undergraduate students; d = .13). Some moderate differences also existed (e.g., the largest significant difference was that undergraduates were more extraverted than MTurk workers; d = .56). We re-ran all of our analyses with group affiliation (-1: undergrad; 1: MTurk) as a covariate. None of the effects changed in terms of direction, magnitude, or significance and are not discussed further. A copy of these analyses can be requested from the first author.

[3] The inclusion of the outcome variables (e.g. health, biting history, and relationship quality) did not change the pattern of age differences reported in text. These analyses can be seen in Supplementary Table 2.

[4] During the review process, a reviewer suggested that we convert each dog's age to make the results more comparable to the research in humans (see King et al., 2008; Weiss & King, 2015, for a similar approach). However, in addressing this comment, we ran into some difficulty. First, the common approach of multiplying a dog's age by 7 is not supported by any animal research. Second, life expectancies (and thus lifespans) differ dramatically across dog breeds and sizes. Third, it is unclear how particular ages of dogs corresponded to life stages of humans (e.g., adolescence, older adulthood). Fourth, because about half the sample comprised of mixed breed dogs, there was no straightforward calculation of life expectancy/span given that we did not know which breeds the dog was (and in what proportions) in nearly all circumstances. Thus, we created an adjusted age metric that is weighed by the breed and sex of each dog. We then plotted the average age differences in Supplementary Figures 1-3 (for all ages continuously) and 4-6 (for "binned" ages). If readers are curious about this imperfect calculation and age differences plotted over an extended lifespan, we refer them to the supplementary figures for more information.

[5] Human characteristics were unrelated to biting history and chronic health conditions in dogs. Their inclusion in the model also did not change the direction and significance of the effects reported in the text.

[6] A natural question readers might have is whether dyadic data analyses are required to model relationship quality as a function of owner and dog personality. The impetus to use dyadic data analyses is when there is non-independence found in the *outcomes* (i.e., dependent variables), such that outcomes are measured for multiple participants that can be nested within a larger group (and are thus non-independent; Kenny, Kashy, & Cook, 2006). Non-independence in predictor variables are accounted for in the context of traditional regression analyses. In the current study, we only had outcome information from one informant, the owner. A dyadic study

of dogs and owners would need outcome information collected from both dogs and owners. The design of such a study is difficult to imagine, but conceivably it is possible.