

# CHILDREN AND COMPANION ANIMALS: PSYCHOSOCIAL, MEDICAL, AND NEUROBIOLOGICAL IMPLICATIONS

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PUBLISHED IN: Frontiers in Veterinary Science





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ISSN 1664-8714  
ISBN 978-2-88945-559-1  
DOI 10.3389/978-2-88945-559-1

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# CHILDREN AND COMPANION ANIMALS: PSYCHOSOCIAL, MEDICAL, AND NEUROBIOLOGICAL IMPLICATIONS

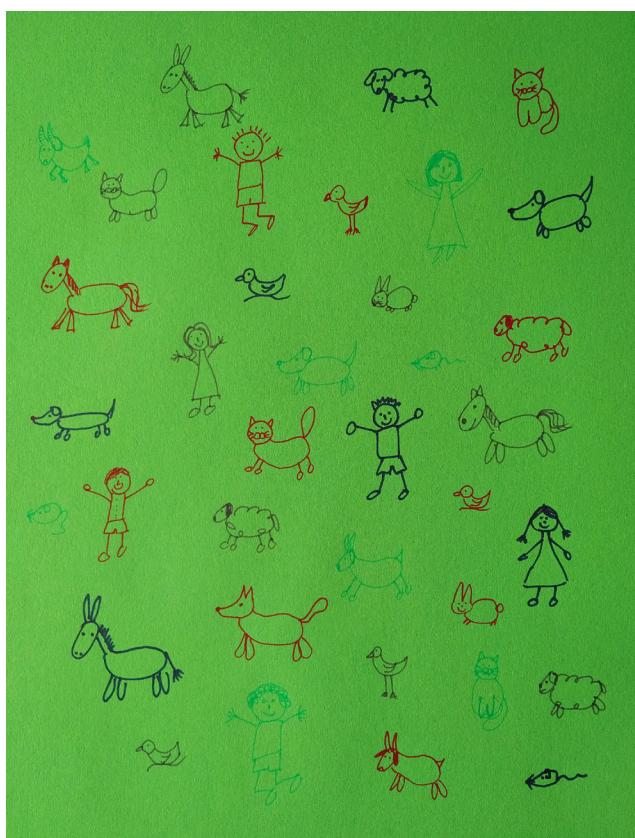
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Children and Animals, by Andrea Beetz, 2018.

Children and companion animals seem to have a natural affinity towards each other. Most children desire a relationship with their own companion animals or at least demonstrate an interest to interact with animals in general. Living with companion animals or interacting with animals may have psychosocial, neurobiological, or medically relevant effects on typically developing children and juveniles as well as those with diverse and special needs.

In this eBook, we present several articles addressing the relationships between children/juveniles and animals in different countries, including Austria, Germany, Jamaica, Japan, the United Kingdom and the United States. Three articles discuss

approaches in animal-assisted education, including animal keeping and animal assisted interventions in schools, and an experimental study investigating immediate effects of dogs on reading competence and accompanying stress reactions with cortisol and behavior. Other articles address topics involving children and their companion animals, including dog-walking by children and juveniles, risks of dog bites by the family dog, selection of pet dogs for families with a child with autism spectrum disorder (ASD) and the relationships that children with ASD have with their family cats.

The interactions between children/juveniles and animals addressed in this eBook provide new insights into some scarcely investigated themes, and underline the significance of animals in children's lives.

**Citation:** Beetz, A. M., Hart, L. A., Jegatheesan, B. I., Koda, N., eds. (2018). Children and Companion Animals: Psychosocial, Medical, and Neurobiological Implications. Lausanne: Frontiers Media. doi: 10.3389/978-2-88945-559-1

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# Editorial: Children and Companion Animals: Psychosocial, Medical and Neurobiological Implications

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**Keywords:** children, companion animals, human-animal interaction, animal-assisted intervention, animal-rearing, autism, dog bites, anthrozoology

## Editorial on the Research Topic

### Children and Companion Animals: Psychosocial, Medical, and Neurobiological Implications

This Research Topic presents experiences with companion animals provided to children in varied settings. Methods include monitoring of the ongoing interaction of children with companion animals, or conducting interviews or surveys, as well as experimental interventions where changes occurring with the presence of the animal are assessed. Children in Austria, Germany, Jamaica, Japan, and the United Kingdom, as well as a minority from the United States, are represented in these studies.

## OPEN ACCESS

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### Specialty section:

This article was submitted to  
Veterinary Humanities and  
Social Sciences,  
a section of the journal  
*Frontiers in Veterinary Science*

**Received:** 31 March 2018

**Accepted:** 11 May 2018

**Published:** 04 June 2018

### Citation:

Beetz A, Hart LA, Jegatheesan BI  
and Koda N

(2018) Editorial: Children and  
Companion Animals: Psychosocial,  
Medical and Neurobiological  
Implications.

*Front. Vet. Sci.* 5:112.  
doi: 10.3389/fvets.2018.00112

## ANIMALS IN EDUCATIONAL CONTEXTS

Nakajima contrasts two approaches: incorporating animals into school curricula or employing them in interventions to facilitate specific learning. Animal-rearing is a Japanese educational tradition, specified by the Japanese government in the course of study for formal elementary education. Matsuda (1, 2), a science educator, laid the theory and methods showing the value for children of rearing animals; it thus became a method of teaching. “Education through assisting animals,” embeds animal-rearing within formal education as an educational tool.

Koda et al. describe how some classrooms integrate rearing goats into instruction at urban schools in Japan. Children share responsibility for feeding, cleaning, and caring for the goats, while working with teachers. Teachers view experience with goats as beneficial to the children. Challenges during holidays and weekends require cooperation among faculty and parents. Some teachers would be cautious about recommending goat-keeping to other schools unless they were very well-prepared.

More conventionally for animal-assisted education, Schretzmayer et al. tested an intervention using a dog to facilitate reading performance and physiological relaxation of third graders lacking reading proficiency. Although a calming effect of the dogs might have been expected due to an oxytocin effect (3), the presence of a dog was associated only with short-term improvements in reading performance, and small changes in cortisol and behavior, for these children with low reading skills.

## PET ANIMALS FOR CHILDREN

Although most exposure of children to pets is at home, exactly how children interact with the pets at home is unknown. Westgarth et al. employed a large database to assess dog-walking by children

up to 18 years of age in the United Kingdom. Simply having a dog was not associated with more walking by the child. Previously, it might have been assumed that children would naturally engage in walking their dogs.

Having a dog at home presents some level of risk of dog bites to children. Arhant et al. conducted a web survey of 402 caregivers living with a dog and a child up to 6 years of age. Aggressive growls but not bites were reported, and only non-serious injuries were generally associated with the child giving the dog treats or taking objects from the dog during play. Messam et al. focused specifically on dog bites to children 5–15 years of age, with 297 interviews of parents in Kingston, Jamaica, and San Francisco. Where the dog slept, and whether the dog had access to a yard, played a role in the likelihood of the child having a dog bite; patterns of dog ownership and dog bites differed between the two cities. Younger children, and especially boys (10.7 and 12.0% in San Francisco and Kingston, respectively), experienced the most bites.

For children diagnosed with Autism Spectrum Disorder, interest is growing in the possible use and value of assistance dogs (4), throughout the world (5). Currently, no method assists parents of autistic children in pet selection; they may just acquire more than one. Guérin et al. argue for the importance of offering choices to children with autism who may benefit from contact with animals, even those who are profoundly affected and non-verbal. They propose developing electronic presentations of active animals so the autistic child can witness the animal and its behavior, and reveal their level of interest in a particular animal.

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Families having both a companion cat and an autistic child 3–12 years of age participated in a study by Hart et al. to explore the extent to which cats are compatible pets with these children. The cats exhibited affectionate behavior and very low levels of aggression with the children. The children were very attracted to the cats, pointing to the value of selecting well-socialized cats for autistic children.

## NEXT DIRECTIONS

A broad range of topics on children and pets remains unexplored, including cross-cultural ways of dealing with children's specific challenges such as autism (6). Positive health effects of animal ownership on children (such as on allergies, obesity, immune system) should be addressed in future research. Also, in animal assisted education, many research questions are open, e.g., effects of school dogs on children of different ages, with and without special education needs. Research also is needed on underlying mechanisms of positive effects of human-animal interaction, e.g., activation of the oxytocin system; results so far pertain to adults, and should be replicated with children, if non-invasive methods are available today.

## AUTHOR CONTRIBUTIONS

All authors listed have made substantial, direct, and intellectual contributions to the work and approved it for publication.

6. Jegatheesan B. Cross-cultural issues in parent professional interactions: A qualitative study of perceptions of Asian American mothers of children with developmental disabilities. *Res Pract Persons Severe Disabl* (2009) 34(3):123–36. doi: 10.2511/rpsd.34.3-4.123

**Conflict of Interest Statement:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The handling Editor declared a shared affiliation, though no other collaboration, with one of the authors LH.

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# Comparing the Effect of Animal-Rearing Education in Japan with Conventional Animal-Assisted Education

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## OPEN ACCESS

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**Specialty section:**

This article was submitted  
to Veterinary Humanities  
and Social Sciences,  
a section of the journal  
*Frontiers in Veterinary Science*

**Received:** 26 February 2017

**Accepted:** 18 May 2017

**Published:** 07 June 2017

**Citation:**

Nakajima Y (2017) Comparing the  
Effect of Animal-Rearing Education in  
Japan with Conventional  
Animal-Assisted Education.  
*Front. Vet. Sci.* 4:85.

doi: 10.3389/fvets.2017.00085

An increasing number of teachers are introducing animals into their class so that pupils foster cognitive, physiological, and social skills through their interaction with animals. Along with such an educational style termed animal-assisted education (AAE), Japanese formal education has also utilized animals for education. Japanese animal-rearing education is unique regarding the following two points: (1) it takes the form of “education through assisting animals” rather than “animals assisting education” and (2) animal rearing is embedded in formal education. While conventional AAE expects the benefit from the social support of animals, Japanese animal-rearing education expects benefit from nurturing and caring for animals. The present study aims to identify effective methods for using animals for education by highlighting the benefits of Japanese animal-rearing education. An overview of Japanese animal-rearing education is followed by a critical review of empirical studies of conventional AAE and Japanese animal-rearing education. Despite the differences in the educational styles, it was found that both systems commonly help children adapt to school. Additionally, conventional AAE were effective in enhancing cognitive and athletic ability of students and foster social skills, while Japanese animal-rearing education enhanced academic knowledge and skills and cultivated sympathy for animals and other people. Furthermore, it was demonstrated that the experience of raising animals affects children’s development for a long time even after children stop raising animals. In order to determine the effect of animal presence at school, however, more empirical studies with various viewpoints are necessary for both styles of education. Concerning Japanese animal-rearing education, the effects of the differences such as the amount of exposure to animals, developmental stage or character of individual children, the types of animals need to be controlled for a more sophisticated examination. Empirical studies show that preadolescence is one of the periods in which animal rearing has the greatest impact on children’s development. It is suggested that through the program of raising school animals, conventional AAE obtains more a variety of effects in their interaction with animals.

**Keywords:** animal-rearing education, school animals, animal-assisted education, Japanese educational system, intellectual and emotional development

## INTRODUCTION

Since 1980s, accumulating data has indicated the possibility that children's relationship with companion animals has a therapeutic [e.g., Ref. (1, 2)] as well as psychological [e.g., Ref. (3, 4)] and behavioral [e.g., Ref. (5, 6)] impact on children's development. Such findings have encouraged teachers to introduce animals into their class so that pupils foster cognitive, physiological, and social skills through interacting with animals (7, 8). The number of teachers who bring animals into their class has been increasing (9, 10).

## Conventional Animal-Assisted Education (AAE)

The conventional style of utilizing animals for education, termed AAE, is used in many European countries. One of the most popular AAE programs is the "school dog" where teachers regularly (1–5 days/week) take their dogs into the classroom as school dogs. Beetz (9) reported that more than 500 teachers in these countries work with their school dogs. The goal of a teacher-school dog team is to influence social behavior, socioemotional competence, and the empathy of the children and to improve the classroom environment, motivation, and discipline (9, 11, 12).

The canine-assisted reading program is also a popular AAE program. The goal of the program is to support children with poor reading skills and who are reluctant to read aloud (10). This program is widely popular among elementary schools and at libraries of more than 42 states in the United States (10) as well as in Canada, Australia, the United Kingdom, Italy, and India (13). Reading Education Assistance Dogs (READ) is one of the first programs that was established, in 1999, and it was followed by many other canine-assisted reading programs, including the All Ears Reading and Share program, Literacy Education Assistance Pups (LEAP), Paws to Read (10).

International guidelines for AAE have been adopted (14, 15), which suggests that education with the help of animals has become more prevalent worldwide. Systematic guidelines for introducing animals into the classroom have been developed (16, 17). The necessity and importance of education assisted by animals have been acknowledged in the society.

In such a context, the possibility and the impact of school dogs are also being investigated in Japan (18). The introduction of school dog is, however, rather an unusual style of AAE in Japan. Japan has developed a unique style of AAE for keeping animals in schools as a part of formal education for more than 100 years.

## Animal Rearing Embedded in Japanese Formal Education

Traditionally, but not compulsorily, Japanese kindergartens and elementary schools have had animals such as rabbits and chickens in school for education. Japanese formal education started in the late 19th century. Matsuda described how animals were introduced into formal education, explaining the kinds of animals that are appropriate to keep at a school, how to rear them, and the effective usage and impact of having animals as teaching tools (1908, 1911, and 1913). In his science-teaching plan, Matsuda (19) used chickens kept at school as a teaching

tool to help pupils learn chickens' form, habits, and biology. These papers by Matsuda show that interaction with and the rearing of animals has been employed as a method of teaching in Japan. Rabbits and chickens were recommended to keep because of their gentle nature and because they are easy to care for and tame (20, 21), and so are they found in schools in today.

The Japanese program is unique regarding the following two points:

1. Japanese animal-rearing education takes the form of "education through assisting animals" rather than "animals assisting education."
2. Animal rearing is embedded in formal education.

First, "rearing of animals" is centered on the method of AAE in Japan. That is, while "children getting assisted by animals" is a popular approach in other nations and areas, Japanese schools try to foster children's knowledge, health, and emotional intelligence through their "assisting" animals. Regarding this point, raising school animals is the means and also the goal of education. As the second point, the Japanese national government formally promotes the "rearing of school animals" as an educational tool. National guidelines for keeping animals in school also exist. According to this policy, animals are raised by pupils as an educational tool from preschool through junior high school. Schools also make an annual academic schedule that includes animal rearing, and children raise animals as an academic activity.

## The Goals of the Present Study

The goal of the present study is to quest a new possibility of AAE through focusing on Japanese animal-rearing education.

When we think about the bond between humans and pets, its relationship is reciprocal; pets provide us social support, and we also support pets. The presence of pets alleviates stress (22, 23), improves psychological well-being (24, 25), and reduces physiological risks [e.g., Ref. (26, 27)]. The presence of pet also physically and psychologically supports children. Children receiving inpatient psychiatric treatment show improvement in their state of mind after therapy incorporating a dog (1). Reviewing articles on animal-assisted intervention for autism spectrum disorder, O'Haire (2) suggested that autistic children become relaxed and ease their stress through interaction with animals, which helps them lessen their aggressive emotions.

Meanwhile, as the other side of the relationship with pets, we are also benefitted through raising and caring for pets. Children develop nurturance skills through the rearing of pets (5, 28). Intimate relationship with pets also fosters empathy for others (3) or prosocial attitude (4) among children.

Thinking through this reciprocal viewpoint, conventional AAE is benefitted mainly from the supportive nature of animals. On the other hand, Japanese animal-rearing education reflects the other side—the benefit through caring for animals.

Contrasting these two educational systems—conventional AAE and Japanese animal-rearing education, the present study is to examine the merits of Japanese AAE and analyze the factors that make Japanese AAE effective and its problems. Highlighting on a Japanese animal-rearing education, the present study proposes

another possibility of education through animal presence that may complement conventional AAE.

## The Course of the Present Study

First, this study presents an overview of Japanese animal-rearing education. Then, comparing the conventional AAE and Japanese animal-rearing education, the present study examines their similarities and differences. It also examines the factors that make Japanese animal-rearing education effective through the reports from school teachers and veterinarians. Finally, the issues that need to be solved for future study are discussed.

## JAPANESE ANIMAL-REARING EDUCATION—ITS OVERVIEW

Rearing school animals is incorporated into formal education in Japan, with school animals employed as teaching tools. In the course of study established by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), there are guidelines for keeping and utilizing school animals for each grade and covering several subjects. The following excerpt of the course of study (29) indicates how the rearing of school animals is embedded in school education.

### Living Environment Studies for First and Second Grades

In the subject living environment studies, animal rearing is included as an academic activity for first- and second-grade pupils. One of the goals of living environment studies is to “help pupils become interested in the relationship between themselves and people around them, society and nature through concrete activities and experiences (29).”

According to this goal, the course of study for living environment studies poses the necessity of raising animals and growing plants so that pupils become interested in the habitat of animals and plants and their changes and growth. The course of study also suggests that raising animals and growing plants help pupils realize that these are living and growing entities, become familiar with living things, and cherish them. In order to meet this goal, the course of study for living environment studies recommends that schools have children keep animals for two successive years, from first through second grade. Although the course of study does not specify the kind of animals, Shimano (30), a school inspector for MEXT, discusses that the species of animals to be familiar to pupils and are robust, resistant to disease, and suitable for school and the surrounding environment. Generally, keeping guinea pigs or hamsters in the classroom is popular, and teachers then encourage the children to take care of the animals.

### Period for Integrated Studies for Higher Grades

Older children in the third through the sixth grade learn about raising animals and having respect for their life through the course, the period for integrated studies.

In Japanese education, the period for integrated studies is unique on the point that it does not have a concrete, uniform style

of learning. The goal and the contents of the period for integrated studies are entrusted to each school. Schools are just required to conduct cross-synthetic learning activities in the period for integrated studies, such as international understanding, information, environment, welfare/health based on pupils’ interests and concerns.

In order to reach this goal, many schools utilize school animals as learning tools, because learning respect for life is taken as one of the most important tasks for children to achieve in elementary school. As a school inspector for MEXT, Shimano (31) discusses that through raising animals children learn and synthesize knowledge and experience concerning “respect for life.” They learn about life in various subjects—domestic science, living environment studies, Japanese, science, and so on. Such knowledge they gain from those subjects, however, is just a partial knowledge of life. Shimano (31) maintained that the actual experience of raising, caring for, and having contact with animals synthesizes this partial knowledge of life, and, further, lets children learn the importance of life—not only for animals but also for friends and other people.

In the context of the period for integrated studies, schools formulate an annual teaching program. Schools set minute goals (**Figure 1**) for the academic year. On the basis of these goals and manuals, the activities for each month were determined. Animal rearing can also be related to other subjects, including Japanese, science, music, art, or moral education so that children can attain the required goals in each area.

### Moral Education and Science

The course of study for moral education, from the first grade to the sixth grade, underscore that children should cherish animals and plants and respect the life of other people, animals, and themselves. The background to this idea is that today children have scarce opportunities to cherish and respect lives. Nakamura (33) investigated children’s ideas about life among 372 fourth and fifth graders and found that, when asked whether a deceased person would revive, 33.9% answered, “yes” and 31.5% answered, “I don’t know.” In such a climate of children’s thought for life, the Central Council for Education strongly proposed moral education based on actual experience as a way of helping children think about life and death. Thus, the course of study for moral education attaches importance to the rearing of animals and growing plants, which can lead children to experience the importance of life and to value nature, animals, and plants (34).

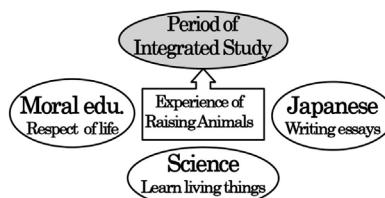
The course of study for science also considers observation and interaction with familiar animals as an important teaching practice. Also, the course of study for science explains that, through caring for animals, children learn about the mechanisms of animals’ bodies and the differences and commonalities between animal bodies and the human body. The course of study expects that raising animals, including fish and insects, at school can cultivate a scientific outlook in children.

Interestingly, the course of study emphasizes the linkage between science and moral education. Hioki (35), a senior specialist for curriculum in MEXT, explained that the ability to show respect for life or to have a protective attitude toward animals is cultivated through touching, interacting with, and raising them

Guidance of “animal raising” for the period of integrated study

1. Name of the unit: Learning through animal raising (four the fourth grade)
2. Goals of the unit
  - a. To foster the respect of life in pupils’ mind through continuous care of animals.
  - b. To raise the interest in animals and foster the ability to creatively deal with various issues occurring in the course of raising animals.
3. Annual academic schedule

April	Beginning of rearing activity. Conformation of the procedure of daily work, turns of duties, and care on holidays. Explanation at PTA (development of children, familial volunteers on caring animals).
May	Meeting with the class that take a turn of the animal rearing. Inviting vets for animals caring orientation.
June	Research on animals’ body and the method of raising animals. Writing an essay about the first turn of animal rearing.
July	Conformation of the caring procedure during summer. Conformation of the care during summer holidays including procedure and the rota system.
September	A class by vets.
October	Animal Raising Project: pupils study the questions and the points to be improved that s/he found and present about.
November	Pupils lecturing the first grade pupils about the characteristics of each animal and how to hold animals.
December	Conformation of the caring procedure during winter. Conformation of the care during winter holidays including procedure and the rota system.
January	Planning of baton passing meeting to the third grade pupils. Pupils prepare a program and teaching materials for the meeting.
February	The baton passing meeting with the third grade pupils.
March	On-the-job training of the third grades. The fourth grades teach how to care for animals.



**FIGURE 1 |** Annual educational plan of PIS using animal rearing as an educational tool. Source: data adapted from Ref. (32).

for a certain period of time. Thus, the course of study presents learning about the physiobiological aspects of animals as a way of guiding children to cultivate consideration for them and other living things.

### Special Activity

Another popular way of rearing school animals is to join the animal-rearing committee that constitutes the student-body activity. The course of study requires that children participate in student-body so that they build good social relations and develop a self-motivated attitude. The student committee, including the

animal-rearing committee, usually consists of children from upper grades. The members of the committee take care of the animals on behalf of the other pupils and report the current condition of and problems related to raising the animals to the student-body activity (36).

### The Network of the Support

MEXT also makes an effort to enlighten teachers about preferable animal-rearing practices in schools. Commissioning a study with a private research institute, MEXT distributed a handbook, *Desirable Animal Rearing at School* (37) to kindergartens,

elementary schools. The handbook covers a broad range of topics: the relationship between children's psychological/physical development and animal rearing; desirable ways of caring for animals both in terms of the animals' welfare and child development; issues and countermeasures related to animal rearing at school; and examples of practical instruction so that each school can refer to it when owning and caring for animals.

One more unique aspect of raising animals in schools in Japan is the assistance that the veterinary community provides. MEXT requires schools to consult with veterinarians about proper animal rearing (29, 38). Thus, prefectoral veterinary associations support schoolteachers throughout the country. Veterinarians provide medical care for school animals, advise teachers on how to raise animals, and help children cultivate a humane attitude toward animals. Thus, veterinarians are also strong supporters of the practice of animal rearing in schools.

## Animals in Japanese Elementary Schools—General Situation

Then, how and what kinds of animals are kept in schools? Where in the school are the animals located? The current study presents the status of the practice of raising school animals according to a study by Hatogai (39). Hatogai, in 2003, randomly chose 866 elementary schools out of all the elementary schools in Japan and sent them a questionnaire about animals reared in schools (mammals and birds). Out of the 866 elementary schools, a total of 579 responded to the questionnaire.

Out of the 579 schools, 88% owned mammals or birds. Many schools kept multiple types of animals. The most popular animal was the rabbit (78.7%), followed by chickens (65.5%), small birds (17.0%), duck (4.3%), hamster (3.6%), and guinea pig (2.0%).

The number of most of these animals was single to five (63.55% of rabbits, 62.2% of chickens, 95.5% of ducks, 94.1% of hamsters, and 100% of guinea pigs). Almost all rabbits (97.7%) and chickens (98.8%) were kept in an animal house located in the schoolyard (see **Figure 2**), while hamsters (94.1%) and guinea pigs (66.7%) were kept inside the school building, including in hallways and classrooms (see **Figure 3**). MEXT, supported from the Japan Veterinary Association, has presented guidelines for the habitat of each kind of animal, including rabbits and chickens. The goal of this detailed advice is to keep animals clean and hygienic and ensure their welfare in accordance with Act on Welfare and Management of Animals (1973, amended in 2012) (40) as well as help children learn respect for life, experience pleasure in caring animals, and find that they can easily care for animals.

The daily work involved in rearing animals includes feeding them and cleaning their living space. In most schools, children mainly engage with caring for animals whether or not the activity is an academic subject (living environment studies or the period for integrated studies) or a committee project. Preparation of food for the animals is also included in the work of rearing at some schools. Children care for the animals before the start of the school day, during lunchtime, or after school. Children at some schools enjoy playing with the animals after taking care of them, while others just spend time tending them.

Among the schools that own animals, more than 70% responded they utilize school animals for teaching living



**FIGURE 2** | Animals in the animal house of the schoolyard.



**FIGURE 3** | Animals in a cage in the classroom.

environment studies. In the event of an animal's death, almost 80% of schools replied that they would bury the animal with the pupils taking part (39). Teachers think that raising animals fosters respect for life, kindness to animals, a sense of responsibility, and consideration for others in children. The background of teachers' such belief is that children take care of animals on their own. In line with the school curriculum, teachers observe the pupils' activity, and those in upper grades help the ones in lower grades develop their skills of caring for animals. The background of such animal-rearing education is the belief that taking care of animals helps children's scientific and psychological development.

Hatogai (39) found that, at more than 70% of schools, the pupils on the animal-rearing committee and teachers in charge of the committee took care of the animals. At approximately 20% of the schools, all pupils in a particular grade and their teachers were in charge of caring for the animals (for living environment studies or the period for integrated studies). If that is the case, then it is mainly members of the animal-rearing committee who develop

respect for life, kindness toward animals, responsibility, and consideration for others? Tanaka and Tachikawa (41) conducted a study with 330 elementary schools and found that more than 70% of pupils were reported to visit the school animals during their free time. They also reported that pupils at schools in which they can easily access the animals visited them significantly more often as compared to pupils at schools in which access to the animals is somewhat more difficult. Moreover, pupils visited animals significantly more frequently when schools make arrangements for the space or time to see the animals as compared to schools that do not. Although pupils, other than those on the animal-rearing committee, may only occasionally, and not sufficiently, engage with school animals, through living environment studies or through play, they also cherish the animals, which may lead to their developing consideration for animals as well as respect for life.

The nationwide survey on animal rearing at school has not been conducted for more than a decade since Hatogai (39). The proportion of schools that keep animals, the number and types of animals, the place these animals are located could have changed since then. A new survey is required to clarify how the situations surrounding animal rearing have changed.

## THE EFFECT OF ANIMAL-REARING EDUCATION—COMPARISON WITH CONVENTIONAL AAE

Then, what kind of impact does animal-rearing education have and how do the effects differ from the one through conventional AAE? To make these points accurate, I rely on the studies that specifically cite animal utilizing education at school as their main focus.

Since both the studies of animal-assisted and animal-rearing education are rather new, accumulation of empirical study of the education is not abundant. In such a situation, the first principle of inclusion was the publication of the original research in a peer-reviewed scientific journal. Mainly Educational Resource Information Center (ERIC), Teacher Reference Center, Psychology and Behavioral Science Collection, MEDLINE, and J-STAGE were used to search articles. Search terms were “animal-assisted education,” “school,” “animal,” and “pet.” The presentation abstract of academic conferences were also included. Further, the three criteria were as follows: (1) the articles in which subjects were older than university students were excluded because the review focused on the impact on children. (2) The study of which context was not school situation was excluded even when subjects are children. (3) The articles that targeted to assess the quality of the animals for AAE is also excluded. The reviewed articles concerning conventional AAE are summarized in **Table 1**, while the reviewed articles concerning Japanese animal-rearing education are summarized in **Table 2**.

### Conventional AAE

#### Effect on Athletic Performance

Gee et al. (43) investigated whether the presence of a dog affects the performance of motor skills tasks. They found that children

completed the tasks faster when the dog was present than when the dog was absent. Gee et al. (43) suggest that the presence of the dog made the children feel more relaxed, less stressed, and more motivated, which lead to an improved speed in task completion. The presence of the dog, however, did not lead to a better performance in tasks.

#### Effect on Adherence to Instructions

Gee et al. (44) examined if the presence of a real dog relate preschoolers' ability to follow instruction in motor skill tasks. Children performed the tasks in four conditions; the presence of a real dog, the presence of a stuffed dog, the presence of a human, and performing alone. It was found that children tend to adhere to instructions better when the dog was acting as a model compared to other conditions. Gee et al. (44) suggest that a dog could act as a model of good behavior in different situations. They infer that children might be motivated to perform the tasks in the same way the dog did, which encouraged children to adhere to instructions. This indicates that it is because of the unpredictable nature of the dog, relative to a human performer, made the level of tandem tasks difficult. However, when children performed the tasks in tandem with the dog, the adherence to the instructions was poorer than when they performed with a human or stuffed dog.

Gee et al. (45) examined the effect of the dog's presence on instruction adherence during cognitive tasks such as object/picture recognition. They investigated if the number of instructional prompts such as “face forward” or “pick one of the object/picture” differs according to the difference of conditions: a dog's presence, a human's presence, and a stuff dog's presence. They found that the dog's presence condition required fewer instructional prompts relative to the other two conditions. They argue that the result of their experiments deny the common assumption that the presence of a dog can be distracting for children during the execution of cognitive tasks. Gee et al. (45) infer that children enjoyed the cognitive tasks more with the attached dog than with the stuffed dog or the human, which motivated children for the task. However, if the degree of attachment was the key, there is a question whether the three conditions were truly homogeneous.

#### Effect on Cognitive Performance

Gee et al. (46) examined the effect of the dog's presence on 12 children's performance of cognitive tasks such as choosing a picture of an object that match another under three conditions: a dog's presence, a human's presence, and a stuff dog's presence. They found that the presence of the dog resulted in fewer erroneous choices than other conditions. They suggest that the presence of the dog reduce children's stress and make them more relaxed, which helped children to focus their attention on the demands of the tasks.

#### Effect on Improving Social Behavior

Kotschal and Ortbauer (11) investigated the impact of dog's presence in classroom on children's social behavior. After 1-month control period in the absence of dogs, one of the three dogs was present in the classroom during the 1-month experimental period. Twenty-four children's behavior in the classroom during

**TABLE 1** | Original studies included in the review of conventional animal-assisted education.

Reference	Study	Animal	Presence of the animal	Population/age group	N	Significant effect
Beetz et al. (42)	The dog as a stress modulator for children with insecure attachment	Dog	During experiment	Male children (age 7–11 years) with insecure attachment, having learning, emotional, and behavior disorders	47	Physiological stress response got lower and relaxed with the dog's support compared with other conditions
Beetz (9)	Socioemotional experiences emotion-regulation strategies	Dog	1 day/week during the experiment (one of three dogs)	Third-graders (age 8–9 years)	46	Positive attitude toward school and positive emotions concerning learning
Gee et al. (43)	Athletic performance tasks in the presence or absence of dog	Dog	During experiment	4–6-year-old preschooler (five typical and nine developmentally delayed)	14	In dog presence faster completion of the task and increased performance accuracy
Gee et al. (44)	Following instruction in motor skill tasks in the presence of dog, stuffed dog, or human	Dog	Chances to get familiar with dogs prior to the experiment	4–6-year-old preschooler (five typical and nine developmentally delayed)	11	Better adherence to instructions when a dog was a model performer
Gee et al. (45)	Adherence to instructions in the presence of dog, stuffed dog, or human	Dog	Multiple visits prior to the experiment	3–5-year-old preschool children (five typical and seven developmentally delayed)	12	Fewest prompts needed in real dog condition, most prompts in the human condition
Gee et al. (46)	Cognitive tasks in the presence of dog, stuffed dog, or human	Dog	Twice-weekly visits prior to the experiment	3–5-year-old preschool children (seven typical and five developmentally delayed)	12	Fewer irrelevant choices in the real dog condition
Hergovich et al. (47)	Before and after survey of the effect of presence of a dog	Dog	Every day during the experiment (one of three dogs)	First-graders (most of them were immigrants)	46	More empathy to the animal, more field independence, more social integration
Kotrschal and Ortbauer (11)	Before and after survey of observation of children in classroom	Dog	1 month, every day (one of three dogs)	Children (mean age: 6.7 years)	24	More social integration, less aggression, and hyperactivity, more attention toward teacher
Tissen et al. (12)	Three times before and after survey of social training with dogs, without dogs, and dog attendance (no social training).	Dog	90 min/week over 10 weeks	Third-grade children	230	Reduced the frequency of being the victims of open as well as relational aggression

both periods were videotaped and analyzed. It was found that social cohesion of the class increased when the dog was present when compared to that of the control period; behavioral extremes such as aggressiveness and hyperactivity decreased, withdrawn individuals became socially more integrated, and children paid more attention to the teacher. They suggest that children's contact with and interest in the dog lead to children's behavioral changes. But, the mechanisms that the dog's presence increased children's behavior are not made clear.

Tissen et al. (12) examined the effects of social training with/without a dog on social behavior, empathy, and aggression in 230 children. They employed three experimental conditions for the 10-week program; social training without dogs, social training with dogs, and dog attendance but no social training. Variables were assessed by teachers before the start of, after the completion of, and 3 weeks after the program. They found that, after program, children under the social training with dogs significantly reduced the frequency of being the victims of open as well as relational aggression. Social behavior and empathy were also improved over time, but there were no significant difference among program. This result suggests that, just the presence of the dog might have equivalent effect for children's social behavior,

empathy, or aggression with social training. But, more elegant research design that includes the group of children in the condition "no social training program, no contact with dogs" should be necessary.

### Effect on Relaxation after Stressful Tasks

Beetz et al. (42) examined the dog's possibility as a stress modulator. They hypothesized that children with insecure attachment can profit more from social support by a dog compared to a friendly human or a toy dog during stressful task. In the experiment, 47 insecurely attached male children with learning and emotional and behavior disorder underwent Trier Social Stress Test for Children in which children are asked to make a short presentation in front of a committee of unfamiliar adults and perform a mathematical task. Social supporters, including the dog, were present during and 30 min after the stress test. It was found that the physiological stress response of children supported by a dog get lower after the test compared to other conditions.

### Effect on Positive Attitude toward School

Beetz (9) investigated the effect of a school dog–teacher-team on depression, emotion regulation, and social and emotional school

**TABLE 2** | Original studies included in the review of Japanese animal-rearing education.

Reference	Study	Animal	Location and purpose	Program	Population/age group	N	Significant effect
Fujisaki (48)	Videotaping three age group children's animal rearing	Rabbits, guinea pigs	Kindergarten	Preschool education	Preschoolers (age 5–6, 4–5, and 3–4 years)	60/53/20	Older children had more biological knowledge about rabbits and personalized the rabbits more than younger children
Gunma Veterinary Medical Association (49)	Repeated survey on age different groups			Six-month rearing animals	First-graders and fifth-graders	22/26	Increase of sympathy toward others among first-graders, increase of prosocial attitude among fifth-graders
Gunma Veterinary Medical Association (50)	Repeated survey on keeping condition and age, different groups		Classroom, animal house in the school site	1 year rearing animals	Fourth-graders, fifth-graders, and sixth-graders	114/116/114	No significant difference among rearing conditions for sympathy for others and prosocial behavior
Iwama et al. (51)	The relationship between past experience of nature and present view on life			University students		411	The experience of animal rearing contribute to developing views on animal life
Nakagawa and Muto (52)	Differences of written essays between the two animal-rearing approaches	Rabbits, chickens, and goat	Animal house in the school site	Period for integrated study, committee activity	Fourth-through sixth-graders	191	Higher composition skills and socioemotional intelligence in study-based group compared to committee-based group
Nakajima et al. (53)	Repeated survey comparing animal rearing group and non-rearing group, animal rearing at school and at home	Rabbits, chickens	Animal house in the school site	Period for integrated study	Fourth-graders	768	Appropriate rearing leads to increase/less decrease of knowledge of animals, school adaptation, sympathy for animals, warmth toward people, and prosocial attitude
Maruyama et al. (54)	Before and after survey of experiment and control group, age difference	Guinea pigs	Classroom	11-month rearing animals	Second- and third-graders, fourth- and fifth-graders	443/410	Older experiment group improved empathy for school animals compared to control group

experiences of third graders. The data of intervention class (with a dog presence) and control class (with no dog) were collected twice; before the dog was introduced and 2 weeks before the school year. It was found that the 1 day/week presence of a school dog showed stronger improvement in a positive attitude toward school and positive emotions concerning learning compared to a control class over the course of a year. However, more study is needed as to whether these positive effects are due to the presence of the dog or due to other factors, including the relationship between school dog and the teacher.

### Effect on Cognitive and Social Development

Hergovich et al. (47) examined the effect of the presence of a dog in classroom on children's cognitive and social development. Of 46 participants, 43 of them were immigrants. Experiment class (with a dog presence everyday) and control class (with no dog) were surveyed twice; at the beginning of the dog presence and 3 months later. It was found that children in the experimental class showed enhancement of field independence and empathy with animals in comparison with the control class children. Further, after the 3-month presence of a dog, children in experiment class showed better integration into the class group, compared to the beginning of the dog presence.

However, more study is needed to elucidate especially the relationship between enhanced field independence and the presence of a dog.

### Effect on Reading Proficiency

Although empirical study was not obtained, it is reported that the presence of dogs help children with reading. Reading proficiency improves through reading practice (55). Poor readers, however, tend to be reluctant to read aloud, which can lead to a vicious cycle (56). In a canine-assisted reading program, children read aloud to well-trained supportive dogs, which enable children to relax and enjoy improving their reading performance (13). It has been reported that the program increased confidence, a feeling of comfort, and motivation for reading among children (57).

Due to the supportive environment that dogs provide, they are often brought into special educational classes to help children with disabilities. Anderson and Olson (58), for example, investigated the effect of AAT with a dog present in a class for six children with emotional disorders. Through qualitative analysis, the authors reported that the dog's presence improved the children's overall emotional stability and their attitudes toward school and their lessons.

## Japanese Animal-Rearing Education

### Effect on Intellectual Development

Fujisaki (48) investigated 133 preschoolers (60 5–6-year-old children; 53 4–5-year-old children, and 20, 3–4-year-old children) who raised rabbits at a kindergarten concerning their biological knowledge and understanding of rabbits' psychology. Fujisaki found that the 5–6-year-old children spent a significantly longer time with the rabbits, spent a longer time cleaning the rabbits' habitat, and communicated with the rabbits more frequently than did the younger children. The 5–6-year-old children also had significantly more biological knowledge about rabbits and personalized the rabbits more than did the younger children. Among the 5–6-year-old children, those who spent a longer time with the rabbits had significantly more biological knowledge about rabbits and personalized the rabbits more than did those who spent less time with the rabbits. Paradoxically the amount of biological knowledge is proportional to the amount of personalization. The personalization is considered a naïve belief characteristic to early childhood. However, analyzing the communication of university students and children's parents with rabbits, Fujisaki (48) found that these adults showed a significantly higher personalization in their communication than children, which suggests that children's personalization of rabbits might not be the manifestation of naive belief. It proves, rather, that children, based on rabbits' behavior, infer that rabbits have the same emotions as people and that rabbits are social living beings just like human beings.

These results might be partially brought by the effect of intellectual development of children. However, the participating children had reared animals continuously since they entered this kindergarten. It can be thought that such a rich experience to rear and interact with animals fostered the development of the knowledge about animals and the theory of mind. However, comparison with no rearing group should be necessary to examine the true effect of animal rearing.

### Effect on Composition Skills and Socioemotional Intelligence

Nakagawa and Muto (52) investigated whether differences in the animal-rearing approaches influence children's intellectual development. They compared two approaches to animal rearing in a school: committee-based animal rearing and animal rearing as the period for integrated study. While study-based animal rearing is included as a regular educational activity, committee-based rearing does not have a concrete educational goal or a syllabus. Nakagawa and Muto (52) hypothesized that educational goals should be one of the pivotal factors for children's intellectual as well as emotional development in raising animals. They evaluated such children's development through their essays about animal rearing. They analyzed 191 essays submitted for an essay competition concerning the raising of school animals; 94 essays written by children engaged in study-based animal rearing (study group) and 97 essays by children engaged in committee-based animal rearing (committee group).

The criteria for evaluating the essays were composition elements and emotional expression. It was found that the study group wrote more words as compared to the committee group.

The study group also showed higher composition ability and higher emotional expression compared to the committee group even when the number of words was controlled.

Basically, the daily responsibilities of children caring for animals did not differ between the period for integrated studies group and the committee group. They both fed the animals, gave them water, and cleaned their habitat. The data showed, however, concerning emotional expression, that the study group's scores were higher in terms of expressing animals' emotions and of insight into those emotions, in terms of sympathy and nurturance for animals, and in terms of identifying with friends and teachers who were caring for animals together.

Then, what created such difference between study group and committee group? Nakagawa and Muto (52) suggested two points. First is children's deep involvement with animals. In the period for integrated studies group, children have ample opportunity to play and interact with animals, which enabled children to take an interest in animals and feel intimacy with and attachment to each animal. Nakagawa and Muto (52) hold that such experiences in the period for integrated study help children foster an attachment to animals, which was embodied as significant emotional expression in the essays.

The second was the utilization of raising animals as an educational opportunity. Nakagawa and Muto (52) reiterated the importance of teachers' educational concerns in raising animals. In the case of period for integrated study, schools create a yearly syllabus for raising animals. Along with this syllabus, each of the raising activities is utilized with educational meanings. Children are, for example, to interact with animals so that the activity helps them become interested in animals, observe them, and feel an attachment to them.

Nakagawa and Muto (52) hold that such an educational involvement enables children to foster attachment and sympathy toward others. However, it should be taken into account that the background including school or their developmental stages, the type of animals they reared, the way of rearing animals are all different in the research of Nakagawa and Muto (52).

### Effect on Empathy for School Animals

Maruyama et al. (54) investigated the effects of classroom pets on Japanese children's empathy for school animals and other people. The participants were 853 pupils (in grades two through five) from nine elementary schools. Experiment groups were given two to three guinea pigs to keep in class for 11 months. The control group did not engage in raising animals. Children's empathic attitudes toward animals and humans were measured at the beginning and end of the 11-month period. Pupils were further divided to create two groups by grade. For younger children (second and third graders), their scores (pre- vs. post-test score) showed no significant improvement in empathy toward animals or humans. Among older children (fourth and fifth graders), those who reared guinea pigs showed significantly greater score improvement (pre- vs. post-test score) in empathy for animals as compared to the control-group children. The results of Maruyama et al. (54) indicate that the effect of rearing animals is useful in cultivating empathy for animals in older children.

## Effect on Sympathy, Prosocial Attitude, and School Adaptation

Nakajima et al. (53) conducted a repeated cross-sectional study with 768 fourth-grade elementary school children, from 12 schools. The study consisted of a questionnaire that was conducted: (i) prior to the intervention (Time 1; T1), (ii) at the end of the 1-year intervention (Time 2; T2), and (iii) 1 year following the conclusion of animal-rearing intervention (Time 3; T3). Five variables (knowledge of animals, sympathy for animals, warmth toward people, prosocial attitude, and school adaptation) were measured to investigate the impact of animal raising at school on children's psychological development. Because the outcome variables of the three groups at baseline were not comparable, Nakajima et al. (53) subtracted T1 value from T2 value or T3 value of each variable and used the variation of the five variables in order to examine the psychological development of the children.

In the investigation, importance was attached to the following two points. First is the quality of animal rearing carried out by the children. Visiting the animal houses at several schools, the authors found that the quality of care for the animals differed by school. Some schools did not clean the animal house sufficiently; some schools did not care for the animals well during holidays or vacation; or some schools did not consult veterinarians, which resulted in a poor living environment and the death of the animals. As Vidovic et al. (4) reported attachment to animals influences children's psychological development including consideration for others. Nakajima et al. (53) predicted that differences in the quality of animal care influences children's consideration for animals, which also affects differences in their consideration for their friends or other people. Children were classified into three groups according to the quality of animal rearing: appropriate-rearing group (247 children at four schools), inappropriate-rearing group (203 children at three schools), and non-rearing group, i.e., the control group (318 children at five schools), which did not rear school animals (see Table 3).

After a 1-year period in which animals were raised, it was found that appropriate-rearing group, compared to the control group, showed a lower decrease in school adaptation during T1 through T2. However, inappropriate-rearing group, as compared to appropriate-rearing group, showed a higher decrease in all five variables during T1 through T2. During T1 through T3, 1 year after the end of animal rearing, as compared to the control group, appropriate-rearing group showed a lower decrease in all variables except for knowledge of animals. However, inappropriate-rearing group showed the highest decrease in prosocial attitude in the three groups. It is reported that warmth to other people decreases as the grade in school advances and students approach puberty (59). The control group of Nakajima et al. (53) also showed a decrease of warmth toward others or prosocial attitude. It was found that animal rearing at school has the impact of diminishing this decrease when children raise animals appropriately.

The second point is whether children keep animals at home. Pets are considered as family members [e.g., Ref. (60, 61)]. Having contact with pets at home should have a considerable influence on children's psychological development, including consideration for others (3, 4). The ownership of pets at home—outside

**TABLE 3 |** Evaluation of the animal rearing [source: data adapted permission from Ref. (53)].

Group of the school (n)	Appropriate rearing (247)	Inappropriate rearing (203)
Average of the group's points	M	M
1. Involvement of pupils (total)	3.00	-2.00
1.1. Feeding	(1.00)	(0)
1.2. Care on holidays	(1.00)	(-1.00) <sup>a</sup>
1.3. Interaction with animals	(1.00)	(-1.00) <sup>b</sup>
2. Involvement of school (total)	1.75	-1.33
2.1. Degree of interest	(0.75)	(-0.33)
2.2. The box in the animal houses	(1.00)	(-1.00) <sup>c</sup>
3. Educational plans	1.00	-1.00
4. Education on animals' death	0.50	-0.67
5. Support from vets (total)	2.00	0.67
5.1. Introductory lecture	(1.00)	0.33
5.2. Visiting and support	(1.00)	0.33
6. Health condition of animals <sup>d</sup>	1.00	-1.00
Average of the total evaluation	9.25	-5.33

<sup>a</sup>According to the records of vets and narrative from teachers in charge, only security guards took care of animals on holidays.

<sup>b</sup>Pupils in some schools wore plastic gloves and masks when they took care of animals despite the advice of vets that such gears are unnecessary because bird flu outbreak was already over. Moreover, a school prohibited pupils not to visit the animal house other than cleaning the house because it was located at dangerous place.

<sup>c</sup>To protect animals against heat and cold, vets require schools to put shelter box in the animal house in the case the house is located outside the building.

<sup>d</sup>According to the records of vets, the health condition of the animals in these schools was poor.

of rearing animals at school—might also influence children's psychological development.

In order to examine the effect of keeping pets at home, Nakajima et al. (53) divided the three groups into six groups according to whether or not the child keeps pets at home.

It was found that, after 1 year of animal rearing, those who appropriately reared school animals but had no pets at home showed a lower decrease in the sympathy for animals and prosocial attitude compared to those who inappropriately reared school animals regardless of having pets at home. During T1 through T3, 1 year after the end of animal rearing, again, those who appropriately reared school animals but having no pet at home showed a lower decrease in sympathy for animals, school adaptation, and prosocial attitude as compared to those who were in control group and kept pets at home.

Nakajima et al. (53) clarified the impact of rearing animals at school on children's psychological development. In particular, Nakajima et al. (53) demonstrated that caring for animals at school may have an identical impact on children's psychological development with keeping pets at home. Moreover, Nakajima et al. (53) showed that, in contrast, inappropriate animal rearing might cause children to be insensitive toward having a prosocial attitude or sympathy for animals.

Nakajima et al. (53) should be one of the largest investigations on the impact of the school animal to children's psychological development. However, the design of the study makes it unclear if the conditions of the groups are comparable. There is, for example, a possibility that general learning environment or socioeconomic factor of each school is different. Also, the individual pupil's

attitude toward animals, including the attachment to animals or the like and dislike of caring animals, should critically affect the sympathy for animals and other variables. Thus, not just examining the differences of schools, more sophisticated grouping such as the degree of attachment or attitude of caring of each child should be necessary for a more thorough and elegant study.

### Replication of Nakajima et al. (53)

Gunma Veterinary Medical Association (49) partially replicated Nakajima et al. (53). In order to investigate the impact of animal rearing on prosocial attitude and sympathy for others, 22 first graders and 26 fifth graders participated in the study before and 6 months after starting animal rearing. They found that sympathy toward others among the first graders rose after animal-rearing activity. Meanwhile, prosocial attitude of the fifth graders also rose after the animal rearing.

Another research of Gunma Veterinary Medical Association (50) made a comparison on the effect of the difference of rearing conditions after one-year of animal rearing. The data were collected before and 1 year after starting the animal rearing. The rearing conditions were rearing in classroom, rearing in animal house located in school site, and control group (no rearing activity). Data were analyzed according to each grade. However, for each grader, no significant difference among the rearing condition was found concerning prosocial activity and sympathy for others.

### Long-lasting Impact of Rearing Animals

Furthermore, it has been found that such experiences in rearing and caring for school animals have an impact beyond childhood (51). Iwama et al. (51) investigated 411 university and graduate students concerning the relationship between nature experiences in childhood and their view of life. The authors found that experiences with animals, including raising school animals or keeping pets in childhood, had a significant relation to students' sense of life. Through the experience of rearing school animals or pets, students developed a realization of the significance of life by witnessing the birth of animals or seeing them rear their offspring.

## Common Effects between Two Educational Systems

As long as these empirical studies show, dogs are overwhelmingly popular in conventional AAE, while dogs are rarely kept in Japanese animal-rearing education. Also, in conventional education, dogs usually do not live in school. They are teachers' or handlers' pets and visit school. In order to take enough rest, most dogs do not go to school every day or multiple dogs go to school by turn (9, 47). Also, in most cases, teachers take care of the dogs. On the other hand, in case of Japanese animal-rearing education, animals live in the animal houses set in the site of the school. Children take care of animals, and teachers follow children. Teachers take an initiative on making an educational plan and work together with veterinarians.

Despite such environmental differences, animals in both educational systems commonly have the effect to help children adapt to school including school adaptation (53), enhancing positive attitude toward school and learning (9), social integration (11, 47), and a reduction in the stress response (42). The result of

Nakajima et al. (53) suggests the presence of animals in the "here and now" is crucial. They reported that the school adaptation of children caring for animals at school shows a lesser decrease when compared to the control group who did not care for animals at school. Also, children who properly cared for animals at school show less decrease of school adaptation compared to those who do not care for animals at school but keep pets at home. These findings suggest that even if children keep pets at home, the presence of animals at school is pivotal for adapting to school.

Another underlying reason for animals' impact on school adaptation would be that children feel animals do not evaluate them. Dogs, for example, provide a safe, playful, and caring learning environment (13). Because we feel that animals do not assess or despise us, we feel less stress when we are with animals compared to that of human friends (23). This sense of security helps children adjust to school environment and motivates them to learn.

## Difference of Both Animal Educations

Other than school adaptation, the effect of conventional AAE can be classified into two categories. The first is enhancement of cognitive and athletic ability. This includes enhancement of field independence (47), fewer irrelevant choices in cognitive tasks (46), enhancement of attention (44, 45), and faster and more accurate completion of the athletic task (43). The second is an enhancement in the social skill to get along with others at school, which includes less aggression and hyperactivity (11), more attention toward teacher (11), reduced victims of open as well as relational aggression (12).

Meanwhile, Japanese rearing animals has effect on two aspects other than school adaptation. The first is the enhancement of academic knowledge or skills including biological knowledge of animals (48, 52), theory of mind (48), composition skills (52). The second is the consideration for animals and other people, including sympathy or empathy for animals (53, 54), socioemotional intelligence (52), warmth or sympathy toward others, and prosocial attitude (49, 53). This leads to the respect of life.

Concerning the development of individual ability, conventional AAE has impact on the development of fundamental cognitive or physical ability that support academic learning. On the other hand, Japanese animal-rearing education is effective for enhancing academic achievement. One of the reasons for such a difference would be the difference of the educational goals. Especially, Japanese education expects that the experience of animal rearing lead to the acquisition of knowledge and skills in other subjects. The results of empirical studies show that such a goal of Japanese animal-rearing education is, though partially, attained.

Concerning the effects on the social relationship, conventional AAE emphasize on the change in an individual's behavior, such as reducing aggression and hyperactivity. Meanwhile, Japanese animal-rearing education rather focuses on psychological development such as sympathy and warmth for others or prosocial attitude.

There would be two reasons as to why Japanese animal-rearing education showed effect on the development of such a tender mind. One reason is the similarity of experience in keeping

animals at school and pets at home. It can be thought that since rearing animals at school is a similar experience to that of keeping and caring for pets at home, the same impact that pets have on child development was also found. Empirical studies show that the relationship with animals foster prosocial mind among children (3, 4). Investigating the parents of 701 preschoolers and elementary school children, Fogel and Melson (5) found that interaction with animals, especially for boys, would be a highly effective way for cultivating tenderness toward others. The high school students were asked why keeping animals is good for their development in the investigation by Robin et al. (62); to this, more than a half answered that it is because they learn responsibility through keeping. Nakajima (63) suggested that through rearing, caring for, and playing with school animals, children infer what makes animals happy and what makes them frightened. By inferring what is in an animal's mind, children cultivate consideration for others.

Another possible reason would be the cultural difference in terms of the sense of value. Markus and Kitayama (64) argue that western individualistic society, including United States, encourage people to be unique, express themselves, and promote their personal goals, while collectivistic society, including Japan, encourage people to adjust themselves to the group to which they belong, to infer what runs in one another's minds, and to be sympathetic toward others. Such a difference in the construal of self—*independent* and *interdependent*—was found, for example, to affect mothers' developmental expectation toward their children (65, 66). While American mothers highly expected their children to acquire social skill including taking leadership, being assertive, or getting along with friends, Japanese mothers especially expected their children to be obedient to others or not to bother others. It is suggested that such a social climate in Japan was reflected in the educational goal of rearing animals in each school, which foster sympathy for others or prosocial attitude in children.

## ACTUAL EFFORT OF SCHOOLS TO MAKE SCHOOL ANIMAL REARING EFFECTIVE

How then does rearing animals in school contributes to the development of children's mind? Analyzing the differences in appropriate-rearing and inappropriate-rearing groups, Nakajima et al. (53) suggested four factors that are pivotal to differentiating the effect of rearing school animals. Reports from school teachers and veterinarians depict their actual effort and ingenuity for these four factors.

### Clear Goal of the Study and Well-Thought-Out Learning Program for the Goal

It was found that the appropriate animal-rearing education often embeds animal rearing in the academic goals of the school (53). Maruyama et al. (67) and Saito et al. (32) reported their school's plan for a period for integrated studies class in which all children to have ample opportunity to be involved for a 1-year period in animal rearing during their time in elementary school. Suzuya Saitama Municipal Elementary School (68) researched how

children view animals before it wrote the guidelines. Based on the results of this research, teachers defined the structure, theme, and goals of the class for each month. Also, schools often utilize animal rearing by linking it with other subjects. Takahashi (69) showed that children learn the biology of an animal in science class and the importance of life in Japanese and in moral education class before taking the period for integrated studies class. With such prior knowledge, the experience of having contact with and raising an animal in the period for integrated studies class encourages children to realize what actual animals are like and the importance of life.

### Dedicated Involvement and Ingenuity of Teachers

Teachers' support and guidance are also essential for children's development through animal rearing. Fujii (70) reported that she made a handbook so that the children could write their findings, including physiobiological information, behavior, and the needs of the animals they were caring for. She also encouraged the children to write what they needed to do or what they could do for the animal. She found that the handbook helped the children summarize their scientific knowledge and reflect on their thoughts about this activity. Teachers also support children to develop autonomous and problem-based thinking. Saito et al. (32) as well as Mitsuhashi (71) depict the "taking-over meeting" that fourth graders hold with third graders at the end of the academic year. At the meeting, fourth graders teach third graders physiobiological and behavioral information about each animal. Annually, the fourth graders create materials to introduce each animal, tell the lower grades how to prepare food and clean the animal house, and make a presentation. They teach the third graders how to hold the animals, the DOs and DON'Ts of animal rearing, and invite the third graders for 1 month of on-the-job training in animal rearing.

### Learning from the Death/Sickness of Animals

Another difference between the appropriate-rearing group and inappropriate-rearing group was the lessons on the death of school animals. It is obvious that the response of the adults around the children regarding the sickness or death of animals has a significant impact on the children's psychological development. Yarrow et al. (72) reported that children learn to have concern for others through observing adults' behavior or emotion toward others. Ascione (73) also argued that children emulate adults' actions of violence or cruelty toward others. Nakajima et al. (53) suggested that adults' cruelty or apathy regarding animals' suffering or death should mar children's sympathy for animals.

Teachers report that holding a memorial ceremony for deceased animals, including writing letters or saying goodbye to them, soothes the sorrow of children, helps them realize the gravity of life, and aids them in understanding that the deceased will never come back [e.g., Ref. (67, 69, 71)]. Morishita (74) showed that when "Leo-kun," a guinea pig raised in the class for living environment studies, died, children discussed about the death of Leo-kun during moral class, which helped them see the rearing

of animals from the animals' perspective. Saito et al. (32) also reported that death and followed memorial ceremony of "Yellow," a chicken, changed children to read books or research on a computer to find out what they could do for animals or what was the best way to raise animals. Ishijima (75) also reported children's psychological development through taking care of a disabled rabbit. Experiencing the death/sickness of animals, children gain a deeper insight into life by themselves and learn to cooperate with their friend to autonomously cope with the difficulties.

## Support from Veterinarians, Families

Support from veterinarians is also an indispensable factor. Vets visit a school to give a class on the animal's biology and how to raise the animal (32, 76), examine the animals, and occasionally give support and advice to teachers (77). Some local vet associations produce a handbook (76) or a wall newspaper (78) on how to care for school animals so that children find rearing enjoyable. Families of children also help animal rearing during vacations by keeping the animals at their home (71) or by coming to the school with their children to take care of the animals (32).

## LIMITATION OF RESEARCH IN JAPANESE ANIMAL-REARING EDUCATION

It was found that Japanese animal-rearing education affects children's academic performance as well as prosocial attitude. However, for more sophisticated examination in the future, the next four points need improvement.

First, it is still unclear who benefits from raising animals at school. Some children care for the animals and some just say hello or goodbye to the animals when they see animals while arriving at or leaving school. Some pupils care for the animals eagerly and properly and some do not. The frequency of contact and intimacy with animals may therefore be different among these various groups. The effects of these differences on the amount of exposure to animals on children's development need to be investigated. Also, children's difference other than animal rearing such as character or scholastic aptitude need to be included into examination in order to demonstrate the impact of animal rearing on children's psychological development more accurately.

The second point is that there are developmental differences among children. Some pupils rear animals as part of living environment studies in first or second grade, some do so as the period for integrated studies study in the third or fourth grade, and some do so as an animal-rearing committee activity in fifth or sixth grade. Such differences in developmental stages should be made clear.

The third point has to do with the difference in types of animals. Some schools have reported on pupils caring for fish; some on small animals kept in the school building, including the classroom; and some on chickens or rabbits kept in an animal house located outside the school building. The method of rearing or the degree of intimacy with animals may be different when the species of animals are different.

The fourth point is the criteria for measuring the quality of animal rearing. Nakajima et al. (53) showed that inappropriate

animal rearing can have an undesirable effect on children's socioemotional development. They evaluated "inappropriateness" from the viewpoints of veterinarians' observations and educational aspects. The definition of inappropriateness is, however, still unclear and arbitrary.

## CONCLUSION

The goal of the present study was to examine a new possibility of AAE through focusing on Japanese animal-rearing education and its effect.

The empirical studies revealed that the effect of conventional AAE was mainly seen in terms of the enhancement of cognitive and athletic abilities as well as that of social skills at school, such as less aggression and hyperactivity or paying more attention to the teacher. On the other hand, the effect of Japanese animal-rearing education was seen in the enhancement of academic knowledge or skills as well as consideration for others, including sympathy for animals and others or prosocial attitude. Furthermore, it was demonstrated that the experience of raising animals affects children's development for a long time even after children stop raising animals.

Such a difference in effects stems from the different relationship with animals between these two educational systems—getting assisted by animals versus assisting and caring for animals. Adopting animal-rearing education, popular in Japan, would provide a new possibility for conventional AAE. Preadolescence is one of the periods in which animal rearing has the greatest impact on children's development (28, 54). Erikson (79) proposed that the elementary school years occur in the stage of industry, during which children enhance their potential through challenging and accomplishing tasks. It is suggested that through the program of raising school animals, conventional AAE obtain more variety of effects in interaction with animals.

In order to determine the effect of animal presence at school, more empirical studies with various viewpoints and sophisticated design are needed for both of conventional AAE and Japanese animal-rearing education. Attachment to animals, for example, is one of the pivotal factors that differentiate the impact of the bond between humans and animals (3, 4). Nakajima (80) reiterated the necessity to differentiate between rearing and attachment. Attachment and rearing are predicted to have a strong correlation. Even so, the relationship and functional difference between attachment and rearing should be investigated.

Further, the research on the balance between cost and effectiveness of using animals for education is necessary. Hatogai (39) reported that one of the most prevalent disadvantages found among schoolteachers concerning the caring for animals in school is the care that must be provided during holidays. Zasloff et al. (81), analyzing data from 37 teachers in 35 elementary schools, also found this same disadvantage of keeping animals in the classroom. Further, Matsuda (82) wrote more than 100 years ago about the difficulty of caring for animals during holidays. These data suggest that the disadvantages of caring for animals, especially providing care during holidays and vacation, have been historical as well as intercultural problem that must be coped with.

Nakajima (80) asks whether “easy-to-care” rearing truly has less value in terms of children’s development. She suggests that intellectual or socioemotional development is not the only or the absolute index of the merit of raising school animals. She proposed that just keeping and watching goldfish or crawfish should have some desirable impact if children are attached to them. Of course, animals should be cared for in close adherence to Act on Welfare and Management of Animals (1973, amended in 2012) (40). Based on animal welfare, the best balance between “easy rearing” and “beneficial rearing” should be investigated.

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## AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and approved it for publication.

## FUNDING

The author would like to express his gratitude to Dr. Tanaka at Otemae University for her insightful comments and suggestions. The author would also like to thank Enago ([www.enago.jp](http://www.enago.jp)) for the English language review.

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**Conflict of Interest Statement:** The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# Educational Possibilities of Keeping Goats in Elementary Schools in Japan

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## OPEN ACCESS

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**Specialty section:**

This article was submitted to  
Veterinary Humanities and  
Social Sciences, a section  
of the journal *Frontiers*  
in Veterinary Science

**Received:** 24 September 2016

**Accepted:** 12 December 2016

**Published:** 26 December 2016

**Citation:**

Koda N, Kutsumi S, Hirose T and  
Watanabe G (2016) Educational  
Possibilities of Keeping Goats in  
Elementary Schools in Japan.  
*Front. Vet. Sci.* 3:118.  
doi: 10.3389/fvets.2016.00118

Many Japanese elementary schools keep small animals for educational purposes, and the effects and challenges have been investigated. Although goats are medium-sized animals that are familiar to Japanese, few practical studies have been conducted on keeping goats in schools. This study investigated the effects and challenges of keeping goats in elementary schools and discussed its educational possibilities. A semi-structured interview survey was conducted with 11 personnel that were responsible for keeping goats in 6 elementary schools in urban areas. They described benefits, problems, and tips related to keeping goats. Participant observation was also conducted on daily human–goat interactions in these schools. The results indicated that children in all six grades were able to care for goats. Goats were used for various school subjects and activities. As a result of keeping goats, children developed affection for them, attitude of respect for living things, greater sense of responsibility, and enhanced interpersonal interactional skills. Stronger ties between the schools and parents and community were developed through cooperation in goat-keeping. Some anxieties existed about the risk of injury to children when interacting with goats. Other challenges included the burden of taking care of the goats on holidays and insufficient knowledge about treatment in case of their illness or injury. The results suggested similarities to the benefits and challenges associated with keeping small animals in elementary schools, although the responsibility and the burden on the schools were greater for keeping goats than small animals because of their larger size and the need for children to consider the goats' inner state and to cooperate with others when providing care. At the same time, goats greatly stimulated interest, cooperation, and empathy in children. Goats can expand educational opportunities and bring about many positive effects on child development.

**Keywords:** children, education, elementary school, goat, interview survey, development

## INTRODUCTION

To enrich the life experiences of children in Japan, elementary schools try to provide a variety of stimuli for their pupils such as an association with nature, as stipulated in the Education's Guidelines for the Course of Study from the Ministry of Education, Culture, Sports, Science and Technology (1). Japanese elementary schools have a tradition of keeping animals for educational purposes, and animals are emphasized in environmental and science education (2). Today, most Japanese elementary

schools keep animals (3), typically small animals such as rabbits, hamsters, birds, fish, and insects (4). Teachers tend to select these animals because they are discussed in textbooks and handbooks.

Various effects of keeping animals in elementary schools have been identified: nurturing children's respect for life, sense of responsibility, affection, compassion, and friendship; healing hurt feelings; imparting knowledge about creatures; and so on (3–7). Animal-keeping promotes children's psychosocial development and learning about subject such as living environment studies and science. However, proper management of animals is an important prerequisite, according to the 2001 declaration of the International Association of Human-Animal Organizations. Difficult aspects of animal-keeping in elementary schools include teachers' insufficient knowledge about how to keep animals, the burden of animal care on holidays, treatment for illness and injury, care at the time of death, and so on (3, 4, 6). For these reasons, handbooks for teachers have been published [e.g., Ref. (8)], and veterinary medical association supports keeping school animals by providing teacher training and professional care in some areas (9).

The concerns above pertain to small animals. Medium-sized animals are more similar to children in body size than small animals, and they tend to interact with children more equitably. Medium-sized animals are recognized as useful educational resources when children visit zoos and observe them (10), but these effects are temporary.

The present study focused on the use of goats (*Capra hircus*) as medium-sized animals in elementary schools. Goats are livestock that are easy to keep (11) and have long been familiar to humans (12, 13), but few practical studies have been conducted on keeping goats in schools. Although, keeping goats has become rare in urban areas, this is gradually being reevaluated (13, 14). Koda et al. (15) showed that the experience of taking care of goats in elementary school raised awareness of symbiosis with goats among fourth-graders (9 or 10 years of age). This suggests goats can be useful in curriculum that develops scientific interest. To accomplish this, it is necessary to provide teachers with information that will help them take responsibility for the management and use of the goats.

This study investigated various factors involved in keeping goats in elementary schools and compared the results with those of previous studies about keeping small animals. This report summarizes the benefits and challenges of keeping goats that were recognized by the school personnel and discusses the educational possibilities of using goats. The process and changes in one school

that replaced individual goats are reported, and recommendations for keeping goats in elementary schools are presented.

## MATERIALS AND METHODS

### Participants and Schools

The principals of six elementary schools in urban residential areas in Japan in which goats were being kept were asked permission to conduct this survey, and all accepted. In each school, teachers were in charge of keeping goats, and two schools used other staff members to assist the teachers. A total of nine teachers and two staff members identified as potential main informants were invited to participate in this study, and all accepted.

**Table 1** presents an overview of the schools. Grades of the children who took care of the goats differed among the schools, but across all six schools, children in all six grades of the Japanese elementary school system (6–12 years of age) participated in the care of goats. The children in the fifth and sixth grades who took care of the goats were members of animal care committees. At the start of the investigation, three schools were keeping goats for the first time. The other three schools were continuing to keep goats, and the participant teachers had taken over the workload from their predecessors. Among the experienced schools, one staff member participated who had been responsible for caring for the goats since the school started keeping them. The teachers were either classroom teachers whose students took care of the goats or advisers of the animal care committees. They were responsible for the practice of keeping goats and knew well the animals' situation and the children who were involved in the practice. About 20–40 children were in each class with 2–4 classes in each grade that was standard in the areas. Five were public schools, and one was private. The goats were Japanese native breeds (*Shiba yagi* and *Tokara yagi*), which are easy to handle because of their small size (20–35 kg for adults) and tameness. They were health-inspected and treated with ivermectin by veterinarians before joining the program. Goats' health were checked regularly by veterinarians during the program also.

### Data Collection

A semi-structured interview survey was conducted with the teachers and staff members in their schools. Survey items were divided into three parts according to the time that goats had been kept in the schools: past (procedures until goat-keeping began, sources of information about how to keep goats, and concerns

**TABLE 1 | Summary of elementary schools surveyed.**

School	Caretaker grade	Caretaker type	Number of interviewees	Interviewee's experience in keeping goats	Number of goats kept during survey period
A	1, 2, 5, 6	Grade (grade 1, 2), committee (grade 5, 6)	1	Novice	Two adults → one adult (one died), two babies (born)
B	2	Class	1	Experienced	One adult, two babies (born)
C	3 → 5, 6	Grade → committee	2	Novice	One adult → one adult (replaced), two juveniles
D	4	Grade	2	Novice	One adult
E	4	Grade	2	Experienced	One adult, two juveniles
F	5, 6	Committee	3	Novice, experienced	Two adults

before keeping goats), present (current situation of keeping goats, school topics and activities using or referring to goats, changes in children's attitude and behavior, tips about keeping goats, and problems of keeping goats to be solved), and future and other prospects (plans for using goats in education, appropriateness of the current grade levels to take care of goats and explanations for this, recommendations to other grades or elementary schools about keeping goats, and advice they wished to provide). Each interview was about 30–60 min in duration and was conducted at a time that depended on the participant's work schedule. The interview was conducted at several different times if necessary. All interviews were audio-recorded so that the content of the transcript could be analyzed. In addition, participant observations of daily human–goat interactions in these schools were conducted as a supplement to the survey.

## RESULTS

### Past

The teachers and staff who were responsible for keeping goats talked about the procedure that had been in place until their schools began keeping goats. All schools had experience in keeping small animals, such as rabbits, chickens, hamsters, and fish. They expected that the effects of keeping goats would be providing children the chance to foster relations with nature and create bonds with creatures, to think about what they can do, to increase interactions with friends and society, to develop their social skills, to enhance their self-esteem and self-efficacy, and to calm their emotions. All schools were provided goats by farms or universities with agricultural department. Thus, the schools were able to receive professional advice and support in caring for the goats and could return them when they could no longer continue to keep them. The duration of goat-keeping experience in the schools varied from 1 year to nearly 30 years.

The sources of information about how to keep and use goats were their predecessors and teachers who had experience of keeping goats in other schools, farms, universities, books, websites, zoos, etc. All participants had in some way achieved some degree of knowledge about goats in advance. However, they were uneasy beforehand about care of the goats and interactions with them, including the burden of daily care, especially during holidays (two schools), insufficient knowledge about daily care and veterinary treatment (three schools), the possibility of injury, fear, and allergies among the children in their interactions with the goats (four schools), risk of failure to form bonds between children and goats (one school), and vague anxiety due to lack of general knowledge about goats (four schools). After initiating care of the goats, they noticed a gap between their knowledge and actual practice, and they tried to solve the problems through study, class discussion, and advice from experts and teachers with experience in keeping goats.

### Present

All of the schools had arranged a care system in accordance with their situations. On school days, the children divided into several groups and took care of the goats, taking turns before

and after school and during break times between classes, and the teachers helped and supervised them. The children as a group cooperatively performed tasks such as cleaning the pen and paddock, preparing food, feeding, performing health checks, brushing, walking, and keeping written records. Children with allergies performed their tasks without direct contact with goats, for example, preparing food and recording. On holidays, other teams were formed of teachers, volunteer parents and children, and volunteers in the community, who took turns providing care. One school that was unable to devise a care system during a long vacation left the goats in the university that provided them. The pens and paddocks of the goats were fenced, but approach was not restricted, so that children who were not on care duty could watch the goats and interact with them during their free time, such as between classes.

The goats were used in various school subjects, for example, living environment studies (interaction, observation, sketching, etc.) in the first and second grades (three schools), science (body mechanism of animals and humans, environment, etc.) in the third grade or later (one school), Japanese (writing, diary-keeping, etc.; one school), integrated study (interdisciplinary classes; four schools), and moral education (bioethics, animal welfare, friendship, trust, etc.; two schools). Elements of various school subjects were involved in integrated study, and the children learned without noticing that they were studying. For example, they calculated the budget for goods necessary for their goat and measured the goat's body parts (arithmetic), they recorded temperature and reviewed documents on goat birth (science), and they recorded daily care and gave reports (Japanese). The goats were also used as a teaching tool in various educational activities, including being involved in the annual curriculum (four schools); being introduced into classes, school events (e.g., excursions), and school assemblies (four schools); and being used in classes in other grades (two schools). The teachers recognized that the goats were a familiar hands-on tool for the children that stimulated their interest and understanding.

The participants in all schools recognized positive changes in children through keeping goats. Many psychosocial effects were identified. Participants in all schools said that the children developed affection for the goats and a sense of responsibility through caring for them. They also pointed out that the children actively learned about and observed the goats (four schools), learned the importance of life and came to respect the lives of other creatures and interacted with them affectionately (five schools), came to understand the minds of the goats and tried to adjust their behaviors toward them because they did not respond to verbal cues (five schools), were concerned about the goats, and developed compassion and cooperation with their friends (four schools). The goats also facilitated conversation and strengthened unity within the classes and groups (three schools). Unity within the children's families and between school and families was also strengthened by children's conversations about the goats at home (one school). In the school that kept multiple goats, the children noticed different personalities in each goat through close observation, and they came to respect individuality. The children willingly took care of the goats, and they developed autonomy and initiative in their daily lives (three schools). The children

learned to tolerate excrement and dirt, and they actively began to help clean at home (one school).

The goats sometimes had therapeutic effects on the children. The frequency of problem behaviors in school decreased (one school), children who were reluctant to go to school became more positive and came to enjoy school (four schools), and the goats soothed hurt feelings when unpleasant things happened at school (two schools).

It appeared that the goats would have an impact on children's later lives. During the interviews, the participants mentioned the following possible long-term effects of goats. The children became more interested in creatures in general and in natural phenomena, and tried to understand them (four schools). The children showed interest in work related to animals and began to think about their future careers (one school). The children who took care of the goats also received higher overall evaluations in later grades (one school).

As for tips about keeping goats, all schools mentioned the importance of developing a system to cooperate and collaborate with parents, neighbors, and other personnel in schools so that they would understand goat-keeping as an educational activity and develop closer relationships. This contributed not only to the preventing problems in the neighborhood, such as noise and odor from the goats, but also to gaining voluntary support, for example, in caring for goats on holidays, maintaining facilities, providing information and instruction, contributing to the goats' food supply (waste vegetables from homes, food stores, and school lunches and produce from the school garden), and expanding children's interest and encouraging their learning with goats as common topics of conversation. At five schools, the participants recognized that their goats were outstanding features of the schools among members of the community. In keeping goats, the children had to make many decisions, such as negotiating their roles in the group and finding solutions when problems occurred. The participants explained that the teachers encouraged and supported the children to voluntarily notice the problems, examine and discuss the issues, and reach agreement and put it into practice, instead of the teachers making decisions and issuing commands (five schools). The teachers not only kept goats but also promoted their ripple effects in various educational activities. For example, a biotope and handmade nests for wild birds were located beside the paddock, and compost from goat excrement was used for produce in school garden.

On the other hand, participants also pointed out problems to be solved in keeping goats. These included the burden of maintaining the care system on holidays (two schools), concerns about coping with unusual bad weather (one school), constant worry about the animals (one school), the absence of livestock veterinarians in the neighborhood (one school), the risk of injury to children because of the goats' large size (one school), and some children's fear of the goats in the beginning (one school).

## Future and Other Prospects

The participants were asked about the prospects for goat-keeping in the future. Regarding new educational opportunities, teachers who had pregnant goats expected changes in children in response to the birth of the babies, and they also expected to give

the offspring to other schools and thus create connections with them (two schools). Other plans and desires included using the goats in grades and classes other than the caregiving grade (one school), usage in environmental education and career education (one school), and deepening exchanges with the university that provided the goats (one school). Some participants recognized various constraints but wanted to take the goats to a large area such as the school grounds in order to facilitate interactions between children and goats (two schools) and to use the goats for weeding or landscaping (one school). Two schools wanted to continue in their present situation for a while and did not offer new plans.

When asked about the appropriateness of the current grades to take care of goats, participants of five out of six schools said this was satisfactory. The reasons were that the practice of keeping goats went relatively well and followed the curriculum for the grades. Keeping animals was appropriate for living environment studies in the first and second grades, and the study of animal and human body mechanisms was appropriate for science in the fourth grade (two schools). The participants whose lower-grade-children took care of goats mentioned the advantages that children in this age range, who are protected both in school and at home, became aware that they should protect others, such as their goats, and that many things do not go as well as expected. This experience led them to behave considerately and nurtured their ability to communicate feelings with others. Participants said that there is not enough room in the upper-grade curriculum to insert goats, and older children are busy with school events, committee activities, and subject studies. On the other hand, participants whose upper-grade-children took care of goats stated that children in the lower grades are too small to carry heavy feeders and experience safety risks, whereas children in the upper grades can do more physical work, and in terms of their psychosocial development stage, they can be more active in providing care and can cooperate with more responsibility. However, the participants in all schools admitted that goat-keeping is advantageous and possible in any grade, although the type of work required should be selected according to children's developmental stage and curriculum. For example, if there is not enough room in the curriculum in the upper grades, goat-keeping can be offered as a committee or volunteer activity. Although the teachers of one school believed their goat to be unsuitable for the children in the current grade because of its large size, they thought that a smaller goat would be appropriate.

The final question was whether participants would recommend other grades or elementary schools that had not kept goats to begin this practice, and if they did recommend this, to state their reasons and provide advice. The participants in all schools said that they could not easily recommend this. Although they acknowledged many educational benefits of keeping goats, they recommended the practice only if an appropriate care system could be instituted, because the burden and responsibility were extensive and intense. The requirements were sufficient space for goats, a source of food and a water supply, and understanding and cooperation from the surrounding people, such as other personnel within the school, parents, neighbors, and experts (veterinarians or farmers with knowledge about goats). They

stressed that once these requirements were satisfied, goats have many educational benefits as unique living teaching materials that are familiar to children, and their positive impact will compensate for the greater effort required of teachers with respect to other educational activities. Although some children may want to play during break times between classes instead of caring for the goats, the advantage of keeping goats is great, for example, children need to learn that not everything goes well according to their own will; children's reactions to goat-related activities are clearly different from their reactions to other activities, such as arts and crafts; children can learn things they cannot learn at home; and children learn many things only from experience. Both goats and small animals have precious lives worth learning about, but the presence of goats is much more influential on children, and although burden of caring for goats is greater, their behavior is understandable, and they are tame livestock, resistant to disease and injury with a long life span.

### Improvement in Keeping Goats

All the schools prepared in advance and adjusted their methods of keeping goats by trial and error according to the situation and were able to use the goats in education. The participants recognized educational benefits and fulfillment while at the same time feeling some burden, and all wanted to recommend other grades or elementary schools to keep goats, if possible. In the interviews, only the participants of one school responded that their goat was unsuitable for the current caregiving grade. This school had an adult male goat for the first time, and because of its large size the school personnel felt it was a safety risk for the children in the current grade who were providing care. In addition, there were other teachers in the school who hoped to show children the birth of goats. After the initial survey, the school replaced the male goat with a pregnant goat. The male goat was given to a facility for adult people.

The effects of changing individual goats by this replacement were investigated in this school. Three years after the initial interview and participant observation, a similar survey was conducted. The informant in the interview was one of the teachers who had participated in the initial survey; he was asked to compare the current status with that of 3 years ago.

### Present (after Replacement)

The female goat gave birth twice in 3 years, and the school still had the goat and her two juveniles at the time of the second survey. An animal care committee was established in this school when the goat was replaced. On school days, the committee members in the fifth and sixth grades took care of the goats, taking turns performing the work before and after school, during break times between classes, and during cleaning time, and the teachers helped and supervised them. On holidays, other teams were formed with teachers and volunteer parents, and care was provided in the same ways as 3 years ago. At the time the goat was replaced, the school built a new hygienic pen, which was easy to clean and a fence around the paddock to ensure safety for children and goats. The teacher said that his concerns about the risks toward the children were considerably reduced, since

the new goat was smaller and tamer. As with the previous male, for safety reasons, the teacher sometimes took care of the goat instead of the children. After replacing the goat, the children were able to undertake more work by themselves, and the teacher was able to encourage them to consider voluntary behaviors that would improve the quality of life of the goats. The teacher volunteered to be the adviser when the animal care committee was established. The teacher was able to take advantage of his past experience and knowledge but also learned in the course of interaction with the goats. As the result of births, there were five goats at one time. Due to restrictions of food supply and space and the burden of their care, the offspring were given to other facilities. The present goats' vocalizations were sometimes different from those of the previous goat, and the teacher and children wondered what this meant. The teacher also felt regret that they gave up the male adult goat that the children had grown up with and felt affection toward, and he wondered if there had been something else they should have done for the goat instead of parting with it.

Regarding the changes in the children, the teacher reported his impression that the children came to feel that they took more care of the goats by themselves, compared to the former situation with the male goat, because the interactions between children and goats increased; for example, they came to be able to take the goats for a walk. The animal care committee was actually popular, and many children applied for membership, exceeding the committee capacity and requiring turnover among the members. Furthermore, although the official care was carried out by the animal care committee in the fifth and sixth grades, many other children, including those in the lower grades, came to visit the goats voluntarily and interacted with them freely in break times between classes. School subjects utilizing the goats were also expanded, such as sketching in drawing and manual arts, verbal expression in Japanese, and environmental education in integrated study.

### Future and Other Prospects (after Replacement)

As for the educational use of goats in the future, the teacher expressed the novel hope that the goats could participate with the children at athletic meets, although hygiene issues related to goat excrement on school grounds would have to be overcome in advance. Regarding the appropriateness of the current grades to take care of the goats, the teacher changed his judgment to appropriate because the children really enjoyed caregiving, and the size of the goats was appropriate for them. The teacher expressed his former opinion that he could not recommend that other graded or elementary schools that had not kept goats keep them unless the conditions of an adequate care system were satisfied, but he also wished to emphasize the benefits of keeping goats, if possible, because the positive impacts were great.

## DISCUSSION

The results of this study clarified that goat-keeping is possible in all six grades of elementary school, despite the differences in

children's developmental stages and different circumstances of the schools. The teachers showed strong interest in the project, and in addition to providing daily caregiving tasks, the goats were used for teaching of different school subjects and activities according to children's developmental stages.

## Effects of Keeping Goats

The teachers and school staff recognized the following effects of keeping goats: the children developed affection for the goats, attitudes of respect for living things, and a greater sense of responsibility, as a result of taking care of goats with others. They showed improvement in the quality of their school life and their interpersonal interactional skills, and their learning was promoted. Effects that were expected before the start of keeping goats were mostly achieved. These effects were consistent with previous reports on effects of keeping small animals in schools (3–7). Experience in interacting with animals offers children the opportunity to understand the similarities and differences between humans and animals and to learn non-verbal communication skills. Through a variety of real experiences, children who are physically and psychologically developing come to show interest in other creatures and non-living things, to understand relationships between the self and others and the environment, and to behave appropriately (16).

The advantages of keeping goats over keeping small animals included children's development of greater compassion and sense of accomplishment, as well as greater happiness through interactions with an animal that they could not easily control with their own power. Because goats are medium-sized animals whose facial height is close to that of children, pupils could easily interact with them and observe their facial expressions and behavior. Goats have social cognitive abilities that make it possible for them to communicate with humans without specific training (17). Furthermore, children could not take care of the goats alone but needed to cooperate with friends, which led to strengthening of group cohesion. The children worked efficiently, assigning roles within the group. Since caregiving continues across the years, the children transferred their tasks by teaching the lower-graders how to take care of the goats. In the process, children were able to foster leadership skills and self-efficacy (18).

To achieve their common goal to improve the welfare of the goats, the children enhanced their understanding of others and cooperation and unity with them. These are important social skills, especially in Japanese society, which values group-oriented behaviors (19). Keeping goats should be a valuable experience for modern children, who are accustomed to playing video games that they can control by themselves as they wish (20).

Unlike small animals that are typically kept in classrooms, goats are medium sized, kept outside, and novel in the urban community. The goats attracted attention both inside and outside the schools. This may bring about connections among schools, children's homes, and the community, developing stronger ties among them not only for keeping goats but also for other issues. This could lead to the formation of community schools. The schools in this study were located in urban areas, but there were senior neighbors who had lived on farms and kept goats

or seen them daily when they were children. For them, goats were nostalgic animals. By contrast, goats are novel animals for present-day children. Regardless of age, people tended to show interest in the goats. Some schools became meeting places for children and neighbors, triggered by goat caregiving on holidays. Today, with urbanization and fear of crime and traffic accidents, children have fewer opportunities to play outside freely and interact with people of various ages (20–22). Goats can become a social lubricant that connects children with their parents and community, although there were people who felt the burden of caregiving on holidays.

Goats are different from pets because they are originally farm animals. They can also be living teaching material about systems of agriculture and the natural environment. Thus, in addition to the well-known effects of small animals, goat-keeping can be expected to have a strong impact on children's learning about various fields, as well as a ripple effect in the community.

## Challenges of Keeping Goats

Common challenges between keeping goats and keeping small animals are the burden of caregiving on holidays as well as veterinary treatment in case of illness or injury (3, 4, 6). The differences are greater difficulty and responsibility in guaranteeing professional treatment in emergencies, in obtaining information about care, and in providing care to goats, which are unusual animals in urban areas. Generally speaking, the Japanese native breeds used in the schools in this study, *Shiba yagi* and *Tokara yagi*, are adapted to the environment in Japan and rarely need veterinary treatment. Moreover, unlike small animals (8), goats have a body size that reduces the risk that children will accidentally injure or kill them. All the schools in this study maintained cooperative relationships with farms or universities for professional treatment, but not all schools were located in areas that experts could immediately reach in case of necessity, unlike cases of health care for pets. In actuality, there were no reports in which experts were unable to arrive in time because of long distances, but the participants who were personnel responsible for goat-keeping were probably anxious in case of emergency.

Goats presented another risk different from small animals. There was the possibility that children would be injured by the goats' horns when they shook their heads or by goat stepping on the children's feet. Adults need to supervise when children are interacting with goats, and they must tell children to avoid accidents by always observing goats' behavior and refraining from frightening them (23). The possibility of accidents can be reduced if children do not crouch beside the goats and do not make loud sounds or run, which can create panic in the goats because of fear. Keeping goats also requires more consideration toward neighbors, compared to keeping small animals. Vocalizations and odor of goats kept outside might be a nuisance. It is important to set pens and paddocks away from neighboring houses and to groom the goats and clean up the keeping sites regularly in order to reduce the odor. One way of reducing vocalizations is to choose male goats, because females frequently make high-pitched vocalizations while in estrus. But since vocalization is a natural behavior of goats, it is necessary to take this into enough considerations

and ask neighbors' understanding. In terms of zoonotic disease risks, all schools were instructed by veterinarians or farmers in advance to wash hands both before and after interaction with goats, in addition to veterinarians' health check of the goats both before and during the program, and no case was reported about zoonosis.

The concerns that the participants expressed before they began keeping goats included the difficulty of maintaining a care system on holidays and the risk of injury to the children. However, it is possible to solve or reduce such problems. The schools in this study regarded the process of handling these issues as a positive part of education. A principal said, "If you encounter a problem, it is an opportunity. You can cope with problems one by one to come up with a solution, by thinking carefully. In the process, you can learn a lot." The school that had safety concerns due to the large size of its goat was able to produce better effects across the grades by replacing the goat and changing its care system. In this process, they encountered new challenges, such as the need for greater space and food supply due to the birth of offspring, but they solved these problems. The schools turned issues that might have been barriers into educational opportunities.

## Future Possibilities

There were common effects and challenges between keeping goats and keeping small animals in elementary schools. However, the responsibility and burden were greater for keeping goats than for keeping small animals. This derives from the fact that goats are larger and children have to care for them while considering their inner states, and while cooperating with others. However, this is why goats stimulate interest, cooperation, and empathy in children, and bring about greater benefits. Benefits and challenges are two sides of the same coin.

The results of the present study suggest key factors in the popularity of keeping goats in elementary schools. When schools and teachers actively send out information about goats around them, people learn about the states and efforts of the schools and come to understand and cooperate with them. People are curious to visit the schools and share experiences with children, strengthening ties of interpersonal relations and increasing cooperation. Schools and teachers can obtain support from other organizations, such as local governments and veterinary medical association, for public and professional assistance and consultation in their community. Understanding and cooperation of parents and neighbors are also indispensable. Such factors make these schools distinctive in their community.

Goats can be kept by any grades of elementary school children in accordance with the purpose of their learning. The juvenile period is important in life span development in terms of cognition (24) and interpersonal relationships (25). Goats can play roles for children as teaching tools for cognitive development, as objects of empathy in social development, and as promoters of caregiving in non-cognitive development. Goats can be expected to expand educational opportunities and bring about many synergistic effects on child development.

The characteristics of goats as a species are worthy of consideration in animal selection as school animals. Goats are diurnal animals and thus consistent with the time of school activities. This is also advantageous in terms of animal welfare. Goats are herbivorous and can easily derive food from residues (11), such as weeds, fallen leaves, and leftovers of school lunches, making them almost self-sufficient. Their excrement contains little moisture, and it is easy to clean up and make into compost, which can be used for growing plants: children can learn thus material recycling. In addition, goats are of a moderate size to interact with children. Children sometimes treat small animals carelessly, and adults must pay more attention to their welfare (8). Although large animals increase the budget and risks to children, goats are relatively tame and easy in terms of health management. Also, in urban areas, the small number of animals and distance from other goats reduce the risk of infectious diseases, such as aftosa.

Each animal species has its own characteristics, and we should choose appropriate animals according to educational purposes. Compared with pets that can be kept at home (which are not necessarily kept at schools), large livestock that can be kept only on farms and wild animals that can be kept only in zoos (which children can learn about by visiting), goats are livestock that are difficult to keep at home but can be kept at schools. Goats are a meaningful choice for school animals, but it is necessary to establish a care system and accumulate useful knowledge and practices. The present survey results provide a guide to goat-keeping in schools to reduce anxiety and risk.

This study was a survey focused on participant observation and subjective responses by teachers and staff members in charge of goat-keeping. In the future, it would be useful to objectively examine the effects of keeping goats on children using more rigorous designs. Direct comparison of keeping goats with keeping small animals would also be meaningful, if comparable control groups can be established.

## ETHICS STATEMENT

Informed written consent was obtained from each participant before the study. The procedure was in accordance with the Code of Ethics and Conduct of the Japanese Psychological Association and was approved by each elementary school.

## AUTHOR CONTRIBUTIONS

NK initiated the research, designed the study, and drafted the paper. SK performed the data analysis, wrote up the results, and revised the manuscript. TH proposed the idea and revised the manuscript. GW supervised the project and revised the manuscript.

## ACKNOWLEDGMENTS

The authors thank the participants and principals for their kind cooperation. The authors also thank Ms. S. Mori for her assistance.

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**Conflict of Interest Statement:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# Minor Immediate Effects of a Dog on Children's Reading Performance and Physiology

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## OPEN ACCESS

### Edited by:

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### Specialty section:

This article was submitted  
to Veterinary Humanities  
and Social Sciences,  
a section of the journal  
*Frontiers in Veterinary Science*

Received: 27 January 2017

Accepted: 26 May 2017

Published: 15 June 2017

### Citation:

Schretzmayer L, Kotrschal K and  
Beetz A (2017) Minor Immediate  
Effects of a Dog on Children's  
Reading Performance  
and Physiology.  
*Front. Vet. Sci.* 4:90.  
doi: 10.3389/fvets.2017.00090

Literacy is a key factor in occupational success and social integration. However, an increasing number of children lack appropriate reading skills. There is growing evidence that dogs have positive effects on reading performance. We investigated the short-term effects of dogs on reading performance in 36 third-graders and monitored physiological parameters [heart rate (HR), heart rate variability (HRV), and salivary cortisol] as well as behavioral variables. Each child took part in two test sessions at the presence of a tutor, in one of which a dog and its handler were present. To assess reading performance two reading tests were used: two subtests of the standardized "Ein Leseverständnistest für Erst- bis Sechstklässler", where the children have to carry out time-limited reading tasks, to assess sentence and text comprehension, and repeated reading (RR), where the children have to read the same text twice, to assess reading speed and short-term improvement. Although the dog had no effect on reading performance scores, within the first test session the children improved from the first to the second run of RR when a dog was present but not without dog. The behavior of the children indicated a calming effect of the dog in the first test session with less nervous movements and the children being less talkative. We found no impact of the dog on HR and HRV. However, the excitement about the dog in combination with the unknown situation in the first test session was reflected in a higher difference in the mean HR difference between the two test sessions for the children, who in the first test session had a dog present, compared to the children, who had the dog in the second test session. In the second test session, the children were more aroused with a dog present than with no dog present, as indicated by the area under the curve increase (AUCi) of salivary cortisol values. We conclude that the presence of a dog had a minor short-term positive effect on the children's motivation and reading performance. More substantial effects could probably be achieved with repeated sessions.

**Keywords:** human–animal interaction, animal-assisted interventions, reading, dogs, children, behavior, physiological effects

**Abbreviations:** ELFE, Ein Leseverständnistest für Erst- bis Sechstklässler (standardized reading test); RR, repeated reading (reading test); HR, heart rate; HRV, heart rate variability; AUCi, area under the curve increase.

## INTRODUCTION

Reading skills are key for success in school and society (1). The assessment of reading performance of elementary school children by the Programme for International Student Assessment (2012) showed that Austrian pupils scored below the Organisation for Economic Cooperation and Development average and other German-speaking countries. Thus, programs aiming at improving reading skills in children are needed. Reading with dogs has become particularly popular, though still not as a widespread approach in the German-speaking countries. Previous studies indeed substantiated that dogs may facilitate learning, based on physiological, psychological, emotional, and social effects (2). Interacting with a friendly, calm dog or animal may dampen stress and, thereby, favorably affect blood pressure, heart rate (HR), heart rate variability (HRV), and the level of the stress hormone cortisol (which also increases in positive arousal) as well as of neurotransmitters such as epinephrine and norepinephrine, potentially *via* a “biophilia effect” mediated by the activation of the oxytocin system (2, 3). For example, during an arithmetic task female subjects showed a lower increase in three out of four physiological measures in the presence of their pets than in the presence of their friends (4) and the presence of a companion animal reduced blood pressure in children, while they were resting or reading aloud (5). Furthermore, the presence of an animal may support specific arousal linked to motivation (6).

The interaction with a friendly dog or animal not only results in a decrease in physiological and subjective measures of stress but also improves mood and even reduces depression (2, 7). Dogs can promote social homogeneity in a group (8) and may facilitate interpersonal interactions by promoting verbal and non-verbal communication (9). These effects are also relevant in teaching and learning contexts. Physiological as well as psychological stress, for example, compromises performance by a negative impact on executive functions like impulse control, self-reflection, self-motivation, and meta-cognitive strategies for optimization of the working memory (10).

In the presence of a dog, elementary school children were quicker, more concentrated, autonomous, and exact while performing different tasks (11–13). They adhered to instructions more closely (14), made less irrelevant choices (15), and required fewer instructional prompts (16). Hediger and Turner (17) showed a significantly enhanced learning effect in a memory task in the presence of a dog and decreasing frontal brain activity in an attention test in its absence.

Smith (18) determined the impact of animal-assisted reading intervention on reading performance within a sample of 26 home-schooled students in the third grade who were asked to read aloud for 30 min a week, for 6 weeks, half of them in the presence of a dog, the other half alone. Children with a dog present significantly improved their reading rates, whereas the control group did not. However, the overall reading quotient (a combination of fluency and comprehension) did not significantly differ between the dog group and the control group. Comparing the effect of a real dog with a plush dog control group with only eight children per group, Heyer and Beetz (10) found that the

children who attended the real dog sessions reached higher scores in two of three subtests (sentence and text comprehension but not word comprehension) of the reading test “Ein Leseverständnistest für Erst- bis Sechstklässler” (ELFE). Their overall reading competence at the end of the intervention and after the 8 weeks of summer holidays was significantly greater than that of the control group. In addition, the authors found positive socioemotional effects of the dog on school-related motivation, self-confidence, and emotions concerning social atmosphere at school and in class. Wohlfarth et al. (19) compared four reading parameters in texts read by 12 second-graders to a therapy dog or to a human supporter in another session. In the presence of the dog the children’s reading performance improved in three out of four parameters in comparison to the human supporter. The authors state that all three parameters could be seen as indicators of concentration.

Among the hypotheses for explaining these positive effects of a dog on learning are anxiety and stress buffering (20), social enhancement (21), attachment promotion (22), emotional social support (23), enhanced self-efficacy (24) or motivation (25, 26), a specific arousal effect *via* the activation of the appetitive positive affect system (27), and attention and concentration promoting (17). Most of these hypotheses cover different levels of explanation and are not independent of each other. The mechanism connecting all or at least most of them was proposed to be the oxytocin system (2, 3, 28). Stress is known to inhibit learning, memory, attention, and concentration by inhibiting the executive functions (i.e., cognitive control functions like impulse control, self-reflection, self-motivation, or meta-cognitive strategies for optimizing performance of working memory) in the prefrontal cortex (29–33). Likewise, stress reduction facilitates learning, etc. The presence of, or interaction with, an animal also leads to an increase in dopamine and serotonin, alterations of which also correlate with attention and concentration (34) and the activation of the explorative/appetitive system in the brain (27, 35). Additionally, concerning motivation, implicit motives may be closely tied to regions of the “emotional brain” (36), interacting with cortisol (2), serotonin, and dopamine (34), thereby linking the motivational and the stress systems (37).

The aim of our study was to investigate spontaneous and immediate effects of dogs on reading performance in children with below average reading skills. Based on the results of previous studies and on the mechanistic hypotheses discussed we predicted that children would show better reading performance in the presence of a friendly dog and would show calming as expressed by psychophysiological parameters such as HR, HRV, salivary cortisol as well as by behavioral indicators. Although there are also reciprocal effects, in which the child influences the dog (38, 39), in our setting (see below) such effects should be minimal due to the very limited interaction between child and dog. Therefore, we excluded such effects from our analyses. We chose a crossover design with all children participating in two test settings (with/without dog), half of them starting in the setting with dog, half of them in the setting without, using standardized measures for the assessment of reading performance, non-invasive measures of HR parameters and salivary cortisol, and video recordings for behavioral investigations.

## SUBJECTS AND METHODS

This study is based on a master's project (40), thus sharing some results as well as methods and other contents with the master's thesis.

### Sample

Thirty-six children participated, 17 boys and 19 girls, in third grade, age 9–10 years, from three different schools in Vienna. The study was approved by the Vienna Municipal Education Authority as well as the head masters of the schools. The parents were fully informed in writing and gave written consent. Ethical consent, regarding the pupils and the animals, was given by the education board. Additional consent from an IRB/ethical review committee was not required, since no invasive measures and procedures were used with the children or animals and it was not expected that animals would be stressed, being selected from experienced reading dog teams. All dogs employed were certified visiting school dogs [by Institut für interdisziplinäre Erforschung der Mensch Tier Beziehung (IEMT) Austria]. Hence, such visits are part of their weekly routine. The teachers selected children with reading skills below average for the study. None of the children reported or showed fear of dogs, but a neutral to positive attitude.

### Setting

Each child was tested in two different test sessions (1 week apart), once with a dog and once without a dog present, in a counterbalanced order. For logistic reasons the inclusion of a further control group (e.g., with another animal, a picture of a dog or a toy dog) was not feasible. In both settings, the child sat on a blanket and a pillow on the floor. One of two investigators (female university students) was present in both settings, gave instructions, conducted the tests, and supervised saliva sampling. The test sessions were conducted in the same rooms at each school, which were not used by others during the time of testing. Four different dogs participated in the study: a Poodle, an Australian Shepherd, a Staffordshire Bullterrier, and a Staffordshire Bullterrier-German Shepherd mix. All dogs were certified for school visits by the association "Schulhund.at – Rund um den Hund"<sup>1</sup> in cooperation with the "IEMT."<sup>2</sup> During the test sessions they were first placed next to the child on the blanket, but then were allowed to move freely in order to enable interactions between child and dog. The child was encouraged to call or approach the dog during the task-free phases. The dog handlers also sat on the edge of the blanket but were instructed to turn away from the test situation and only interfere if necessary. In the setting without dog only the investigator was present and the times for interactions with the dog were substituted with drawing pictures or having no particular task.

### Procedure

After a short welcome the first saliva sample was taken and the HR belt and watch were adjusted. In a brief instruction the

investigator gave an overview of the test procedure. Then the children had 4 min to interact with the dog or draw and after that the second saliva sample was taken. Next, the first reading test, repeated reading (RR, see below) was conducted, followed by the third saliva sample. Then the second reading test, ELFE (see below), with its two subtests, sentence comprehension and text comprehension, was conducted, followed by the fourth saliva sample. At the end of the test session the children could interact with the dog or draw during the following relaxation phase, which was interrupted only by the fifth saliva sample and ended with the sixth saliva sample.

### Instruments

#### Ein Leseverständnistest für Erst- bis Sechstklässler

Ein Leseverständnistest für Erst- bis Sechstklässler (41) is a standar-dized test for children from first to sixth grade to assess reading performance *via* three different subtests: word comprehension, sentence comprehension, and text comprehension. The test is a widely used and well-validated measure in the German-speaking countries.

Due to time limitations we conducted only the subtests for sentence comprehension and text comprehension. In all subtests the children have to accomplish several similar tasks in a given time. In the sentence comprehension they have to choose the word, which best completes each sentence, out of four options. In the text comprehension they have to read short texts and mark one or more sentences that fit to each text with regard to contents. For each subtest the number of correctly solved tasks can be counted.

#### Repeated Reading

Repeated reading (42) was used as an additional, non-standardized reading test, which allows assessing spontaneous, short-term improvements in reading performance. For each of the two test sessions a short text passage was selected from an age-appropriate children's book and slightly modified to achieve the same number of words for both texts. The children had to read this short text out loud in a given time of 2 min and were instructed to make as few errors as possible and read as fast as possible. After a short training phase, in which the children could practice the words they did not read correctly and which had been written down by the investigator, they were asked to read the same text again. For the analyses the number of words the children achieved to read in these 2 min were divided by the time the children needed (words/second), since some children finished the text before the end of the 2 min. In the first session, all children were given text 1 and in the second session text 2, independent from the order of the setting the children were assigned to.

### Behavior Observation

All test sessions were videotaped and the duration of different behavioral variables was coded *via* Solomon Coder beta 15.02.08<sup>3</sup> (43) for 10 phases of the entire session, which were (1) instructions RR, (2) RR run 1, (3) training phase (including

<sup>1</sup><http://www.schulhund.at>

<sup>2</sup><http://www.iemt.at>

<sup>3</sup><http://www.solomoncoder.com>

writing down and practicing the words the child did not read correctly), (4) RR run 2, (5) ELFE instructions 1, (6) ELFE sentence comprehension, (7) ELFE instructions 2, (8) ELFE text comprehension, (9) relaxation 1, and (10) relaxation 2. During saliva sampling no behavior was coded. The observed behavioral variables were talking, nervous movements, and self-manipulation. Nervous movements included coughing, throat clearing, jiggling with foot or leg, playing or fumbling with objects, etc., self-manipulation included scratching, fumbling, fiddling, etc. (see Table S1 in Supplementary Material). For interobserver reliability a master student, who was trained in video coding with the program Solomon Coder, coded all 10 phases (of 10 different children) in the dog setting as well as in the no dog setting. Hence, each of the 10 phases was coded twice for interobserver reliability. “Durations of the behavioral variables coded by the two different observers were correlated *via* Spearman’s rank correlation coefficient and correlated well with correlations coefficients of at least 0.9 and *p* values of <0.001 for all behavioral variables.” (40) It was not possible to code the videos “blind” to condition because the dog was visible on the video if present in the setting.

### Salivary Cortisol

Six saliva samples were taken from the children over the entire test session. To stimulate salivation, the children drank some grape juice. Then they took a cotton swab in their mouth for 1 min, which then was returned into the salivette and put in a cooler box before finally being frozen in the laboratory at -20°C. At the end of data collection, all samples were analyzed *via* a biotin-streptavidin enzyme immunoassay developed by Palme and Möstl (44, 45).

The samples were run in duplicates with a coefficient of variance (CV) ≤15%. Based on pooled control samples the intraassay-CV was 9.34% and the interassay-CV 6.80%.

To control for daytime effects the children were tested at the same time of day. For analysis the area under the curve increase (AUCi) was calculated for the entire sampling time. The AUCi is a standard indicator for increase and decrease in cortisol levels in relation to the first measurement, which is set as the baseline, over the entire experimental period. By taking the cortisol level at the first measurement as a baseline, it takes the differences in initial cortisol level of each participant into account (46).

### Assessment of HR and HRV

Heart rate was measured with the HR belt plus watch-like data logger “polar pro trainer 5®”, which the children wore over the entire test session. Outliers were eliminated using the automatic correction of the associated software.

Mean HR (interbeat intervals in milliseconds) and HRV were assessed as a way to determine the children’s arousal (stress/excitement) for both test sessions (with and without dog) separately. HRV was calculated from the corrected HR data *via* the program Kubis HRV 2.2. Thus, the more exact variable, the root mean square of successive differences was chosen to describe HRV. To be on the safe side, the less exact but more robust variable pNN50 (the number of successive intervals which differ by more than 50 ms expressed as a percentage of

the total number) was calculated as well. For more information about HRV parameters see the study by Malik (47). HR and HRV for the entire test session were assessed. To get the same amount of measurements (i.e., duration of measurement) for all children, measurements were cut off at the end to make them the same duration as the shortest measurement of all participants. Even though this is mainly essential for HRV, we also used this approach for HR.

### Statistical Analysis

Comparisons were made within individuals with the dog present, or not, for the first and second test session separately. Also, independent from the setting, potential differences between first and second test session were assessed. The two subtests of the ELFE were analyzed separately. However, for the RR mean of the two runs was used for calculations. Data were analyzed with the software package PASW Statistics 18 (48). Using the Shapiro-Wilk test, data were tested for normal distribution. Statistical significance was set at an alpha level of 0.05. Alpha correction for multiple comparisons was not considered here because this generally increases the risk of type-II error at a comparatively low potential of decreasing type-I error (49). Instead, effect size was estimated by Cohen’s d (50) using the online effect size calculator<sup>4</sup> by Lee A. Becker, University of Colorado, Colorado Springs. Effect sizes are considered small at 0.2, medium at 0.5, and large at 0.8 and above. For correlations Spearman’s rank correlation coefficient (Spearman’s *r*) was employed.

## RESULTS

### Test Session 1 vs. 2

Comparing the two test sessions independent of whether a dog was present or not, we found no difference for the physiological variables (cortisol AUCi, mean HR, and HRV) or the behavioral variables (total durations of talking, nervous movements, and self-manipulation). Results for the two reading tests, however, did differ between the first and the second test session independent of the setting. On ELFE, the children performed better in the second test session than in the first test session, whereas in RR they read more words per second in the first test session compared to the second. (ELFE sentence comprehension, test session 2-1: *N* = 36; *Z* = 0.72; Wilcoxon: *p* = 0.001; Cohen’s *d* = 0.447; effect-size *r* = 0.218; ELFE text comprehension test session 2-1: *N* = 36; *Z* = 0.404; *T*-test for dependent samples: *T* = -3.335; *p* = 0.002; Cohen’s *d* = 0.301; effect-size *r* = 0.149; RR difference test session 2-1: *N* = 36; *Z* = 0.151; *T*-test for dependent samples: *T* = 2.765; *p* = 0.009; Cohen’s *d* = 0.140; effect-size *r* = 0.07).

### Ein Leseverständnistest für Erst- bis Sechstklässler

Neither in the first nor the second session, significant differences between the group that had a dog present and the group that had not was found with regard to the reading scores. Also in the

<sup>4</sup><http://www.uccs.edu/~lbecker/>

subtests sentence comprehension and text comprehension groups did not differ significantly.

## Repeated Reading

Neither in session 1 nor 2, there were significant differences between the dog group and the non-dog group in reading speed (words/second; mean of the two runs). However, in the first session (**Figure 1**), but not the second session, the children with a dog present showed a greater improvement from run 1 to 2 (difference run 2-1 test session 1: without dog:  $N = 16$ ;  $Z = 0.009$ ; with dog:  $N = 20$ ;  $Z = 0.103$ ; Mann–Whitney-U test:  $p = 0.048$ ; Cohen's  $d = 0.707$ ; effect-size  $r = 0.333$ ).

## Behavior

In test session 1, children in the dog setting showed less nervous movements and also tended to talk less than the children who had no dog present (**Figures 2 and 3**). However, they showed a similar amount of self-manipulation (talk: without dog:  $N = 16$ ;  $Z = 0.673$ ; with dog:  $N = 20$ ;  $Z = 0.073$ ; Mann–Whitney-U test:  $p = 0.075$ ; Cohen's  $d = 0.672$ ; effect-size  $r = 0.319$ ; nervous movements: without dog:  $N = 16$ ;  $Z = 0.583$ ; with dog:  $N = 20$ ;  $Z = 0.016$ ; Mann–Whitney-U test:  $p = 0.020$ ; Cohen's  $d = 0.790$ ; effect-size  $r = 0.367$ ).

In test session 2, children who had a dog present showed more self-manipulation than the children who had no dog present

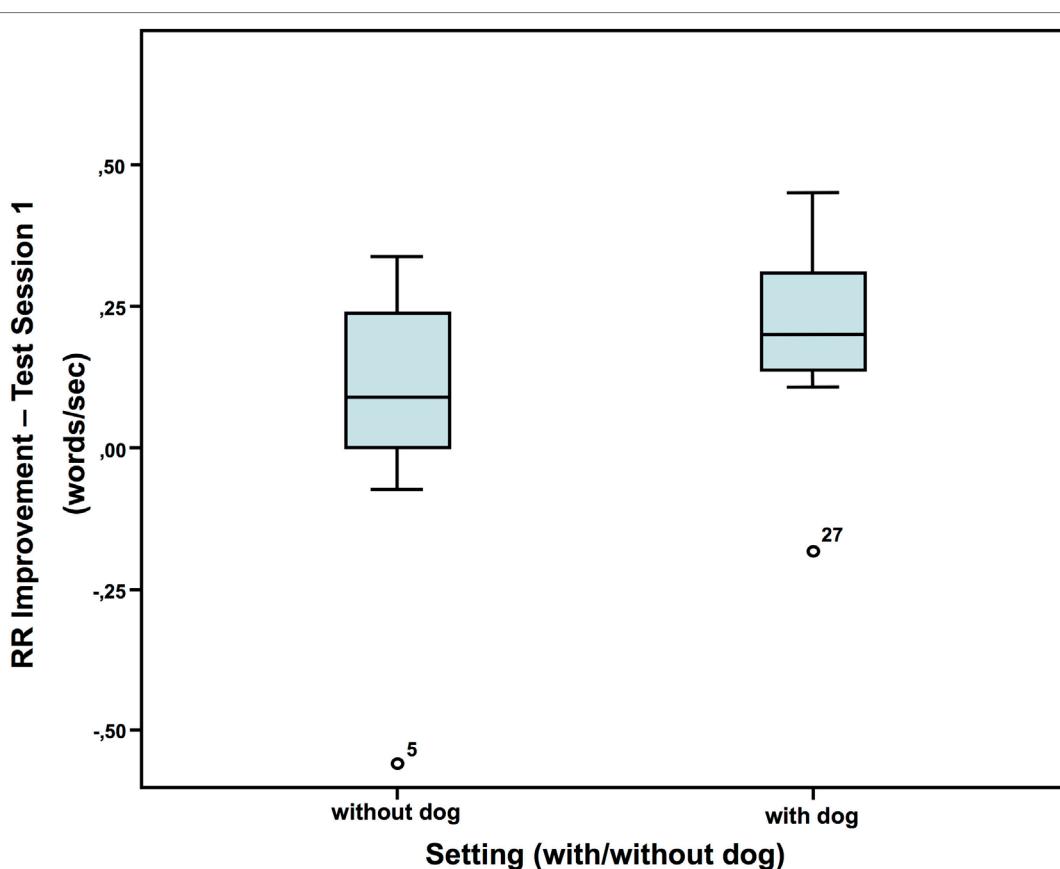
(**Figure 4**), but no difference regarding the two variables talk and nervous movements (self-manipulation: without dog:  $N = 20$ ;  $Z = 0.016$ ; with dog:  $N = 16$ ;  $Z = 0.390$ ; Mann–Whitney-U test:  $p = 0.012$ ; Cohen's  $d = 0.966$ ; effect-size  $r = 0.435$ ).

## Cortisol

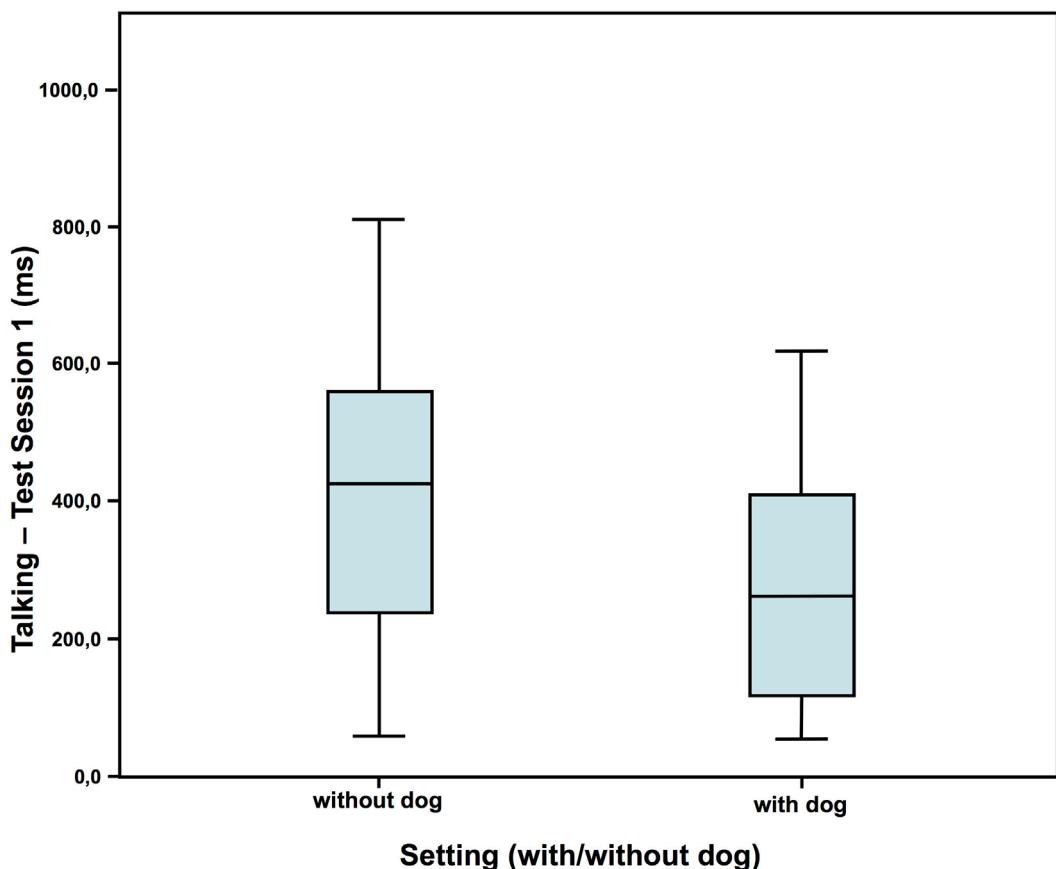
In test session 2, the children had a lower cortisol reaction [area under the curve increase = AUCi (MW pg/ $\mu$ l)] without a dog present than with dog (**Figure 5**). No such differences were found in the first test session. In the two settings, with and without dog, the children did not show differences in AUCi, when compared to themselves. AUCi was also independent from the individual dog (one of four dogs) employed in the setting [AUCi (MW pg/ $\mu$ l) test session 2: without dog:  $N = 20$ ;  $Z = 0.029$ ; with dog:  $N = 16$ ;  $Z = 0.146$ ; Mann–Whitney-U test:  $p = 0.028$ ; Cohen's  $d = 0.693$ ; effect-size  $r = 0.327$ ].

## HR and HRV

For neither test session 1 nor 2, we found a significant difference in the mean HR between the children, who had a dog present during the test session, and those, who had not. There was, however, a trend for a difference of the mean HR difference between the test sessions for the children, who in the first test session had a dog present, and those, who had not. The children, who in the first test session had a dog present, showed a larger difference



**FIGURE 1 |** Repeated reading improvement (40).



**FIGURE 2 |** Duration of talking in test session 1—comparison of the two settings (40).

between the two test sessions or the setting with dog and without dog than the children, who had the first test session without dog. With regard to mean HR, both groups had a lower HR without the dog than with the dog. Children who in the first session had no dog present, had a higher HR in test session 2 (with dog) than in the first session. Also, the children with the dog present in the first test session showed a higher HR in this session than in test session 2 without the dog. (Mean HR difference test session 2-1: the children, who had no dog present in the first test session:  $N = 16$ ;  $Z = 0.073$ ; the children, who had a dog present in the first test session:  $N = 18$ ;  $Z = 0.520$ ; Mann–Whitney-U test:  $p = 0.078$ ; Cohen's  $d = 0.508$ ; effect size  $r = 0.246$ .)

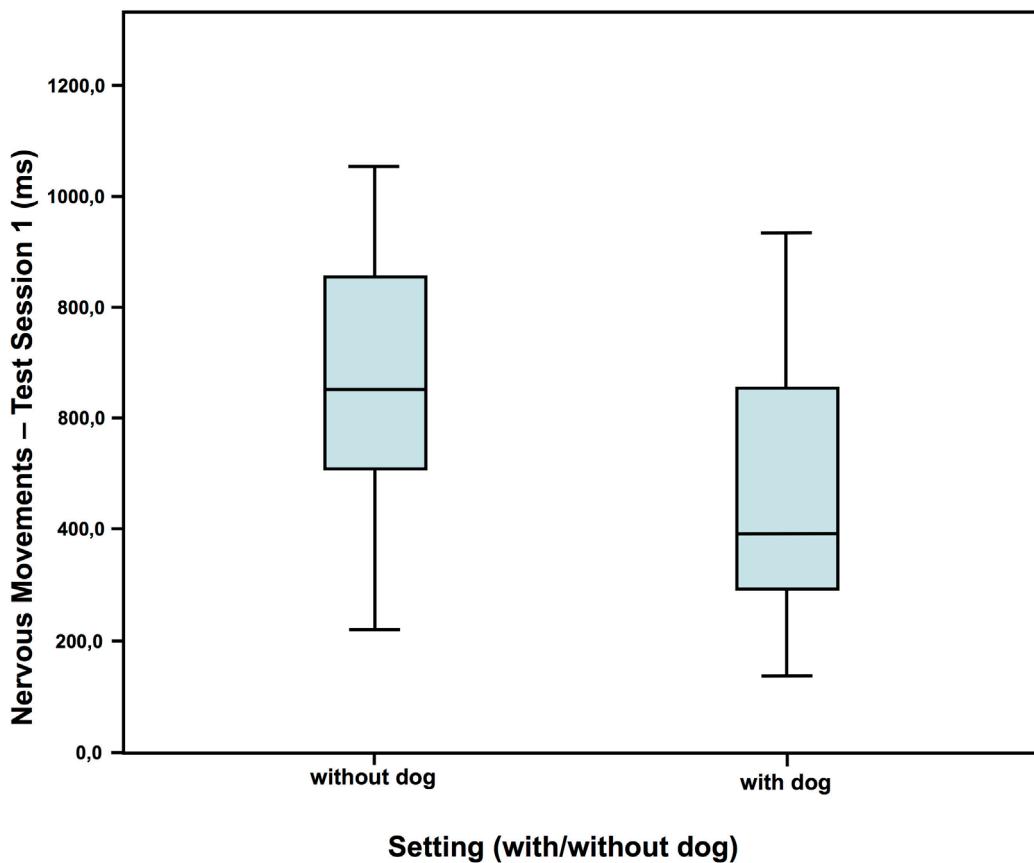
In none of the two sessions, the children's HRV differed significantly between those who had a dog present and those who had not.

## DISCUSSION

We were presently interested in immediate effects of dogs on the reading performance as well as on behavioral and physiological parameters of third-graders with low reading skills. In alignment with our initial hypotheses we found some short-term improvement of reading performance and minor effects on cortisol AUC<sub>i</sub> and behavior, as well as a trend in mean HR but none of the major physiological effects we expected.

In fact, we detected a short-term improvement of reading performance in RR when the situation was novel. One explanation might be the activation of the appetitive system, i.e., an arousing effect of the dog coupled with increased motivation (27). However, this was not true for the second test session. The children may by then have known what to expect, were less nervous, or the dog had less impact, either on relaxation *via* social support or *via* its motivational aspects.

Furthermore, we also found some effects on behavioral and physiological parameters, mostly indicating arousal. The presence of a dog tended to cause even more arousal than the confrontation with an unknown, new situation, since the children who in the first test session had a dog present, showed a higher difference in mean HR between the two test sessions (or the two settings, respectively) than the children, who in the first test session had no dog present. Therefore, the presence of a dog might have reinforced the children's already existing arousal in the first test session that is due to an unknown, new situation, which might be the cause for the especially high difference between the two test sessions in this group compared to the group that only had the dog in the second test session. This kind of excitement was also found by Kaminski et al. (51), where the HR of hospitalized children increased before and after animal-assisted therapy sessions, and might well be connected to the activation of the appetitive system (27).



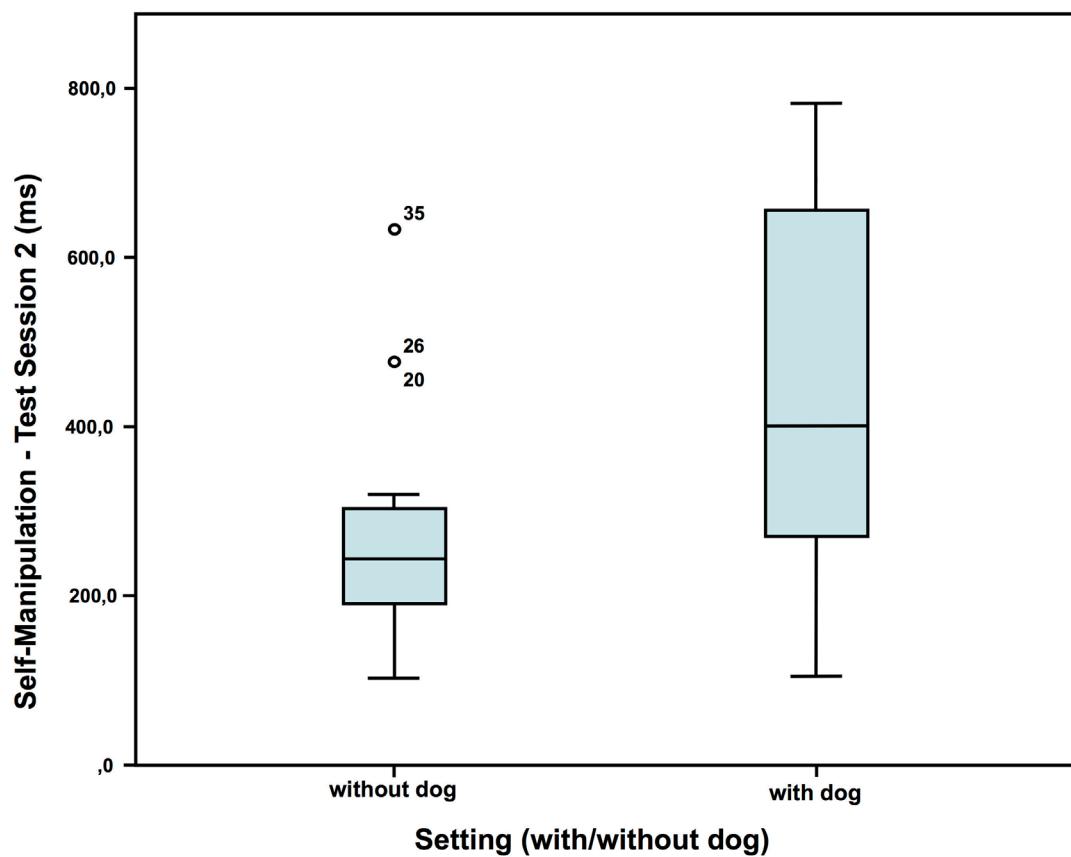
**FIGURE 3 |** Duration of nervous movements in test session 1—comparison of the two settings (40).

Although most studies found a calming effect (2, 52), an arousing effect of the dogs was also found in the cortisol AUCi in the second test session, but not in the first one. With a similar setup Jäger (53), however, found no differences in cortisol between the children, who had a dog present, compared to those, who had not. Also, the fact that the children who were with a dog showed more self-manipulation in the second test session than the children without suggests an arousing effect of the dogs as well, potentially by activation of the appetitive system. Contradictory to the arousing effects suggested by all these results, the children showed less nervous movements and talked less in the presence of a dog compared to without dog in the first test session, indicating a calming effect, or at least a decrease in internal conflict. Observations by Hansen et al. (54) too showed less behavioral distress of 2- to 6-year-old children undergoing a standard physical examination in the presence of a friendly dog compared to another group without dog.

In this study, we show some immediate effects of the presence of a dog, although main variables, like absolute values for both reading tests (number of solved tasks for ELFE and words per second for RR), HR and HRV were not affected. Concerning RR, it is likely that in the first test session an effect has been eliminated by calculating the mean of the two runs, since the children, who had a dog present, started out reading less words/second in the first run than the children, who had no dog present,

while in the second run the performance of the two groups turned around and the children, who had a dog present, read more words/second than the children, who had no dog present. It is not clear whether the difference in starting performance was due to the setting or some other factor. However, Wohlfarth et al. (19) did not find a significant influence of the presence of a dog on reading time either (compared to the presence of a friendly female student), but an improvement in correct word recognition, correct recognition of punctuation marks, and correct line breaks was evident. This is in line with the findings of Gee et al. who revealed a number of positive effects of the presence of a dog on the performance of several tasks in children (11–16). Repeatedly reading with a dog seems to produce robust positive effects (2, 10, 55, 56). Consequently, repeated exposure seems more effective because of learning mechanisms but probably also because the child gets socially accustomed to the dog and a bonding effect may take place, which again reinforces the effect *via* oxytocin.

Obviously, an experimental setting like the one we employed in this study has limitations, in particular regarding the transfer of the findings to the practice of reading with dogs, which is very popular and effective, as several studies confirmed (see above). To control confounding variables is only possible in such a very controlled experimental setting, but particularly important when employing physiological measures like the ones employed in our



**FIGURE 4 |** Duration of self-manipulation in test session 2—comparison of the two settings (40).

study (HR, HRV, and salivary cortisol). However, many factors may contribute to the success of reading with dogs, including the free interaction of child and dog. This factor was also relatively strictly controlled in our settings, maybe adding to the physiological arousal of the children. In a real life setting, neither dog nor handler behaves according to a set standard but rather according to the signals of the child.

However, we would also like to point out that we investigated the effects of reading with dog in a sample of children, who actually do have serious problems with reading (but were still good enough readers to produce meaningful scores on the reading tests). Mostly, other experimental studies have worked with children with normal reading skills or without assessing the reading skills first. Thus, our results produced new information which is important for understanding the underlying mechanisms and conditions of an effective pedagogical intervention to improve reading skills with the support of dogs. In particular, that not only physiological and behavioral relaxation and calmness seem to be important, but rather also an activating aspect (arousal of the appetitive system) of the dog presence, is a new insight. In particular, for children with low reading skills the common assumption seems to be that relaxation would be a key factor of reading with dogs, since those children usually become anxious when asked to read (10).

## CONCLUSION

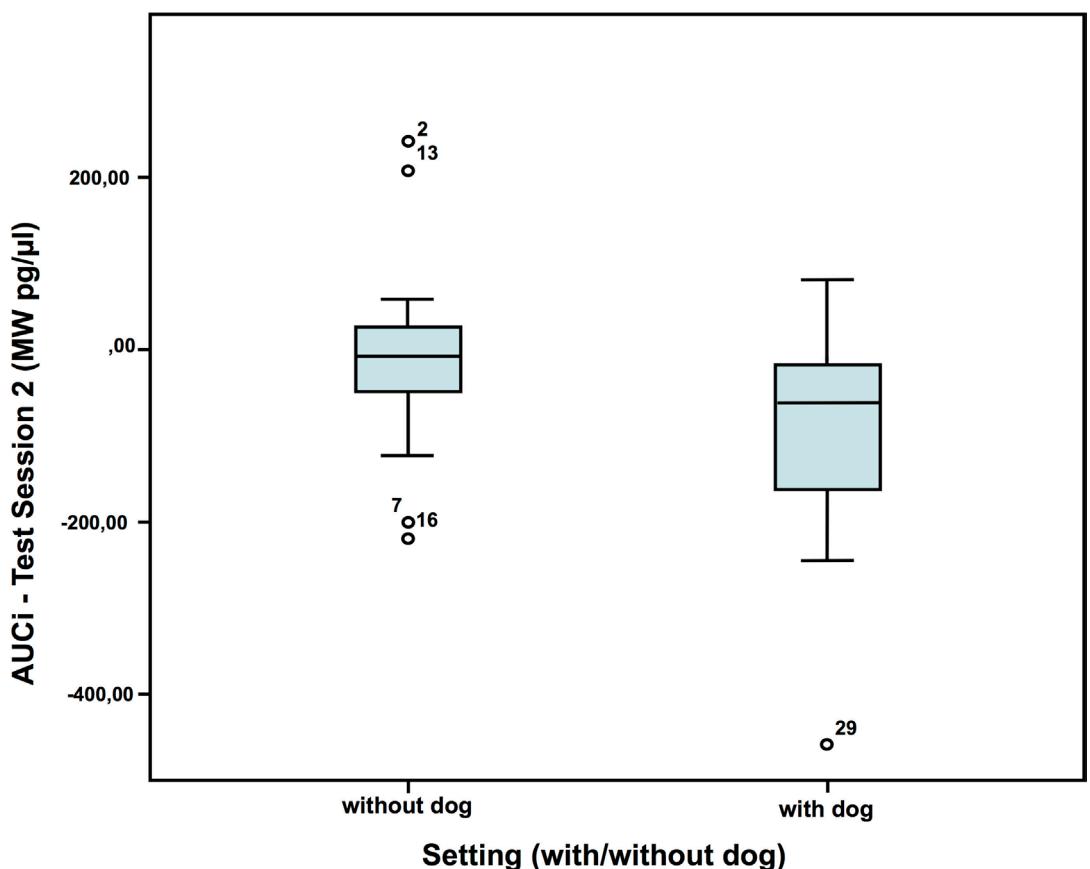
Our study was designed to test for acute, immediate effects of the presence of a dog on reading skills. We suggest that the dog present activated the appetitive system in the children and, thus, caused an arousal or excitement related to increased motivation and concentration. Reading performance *per se*, however, was only little enhanced, which contrasts with most other reading-with-dog studies, which consistently reported clear positive effects. Hence, it seems that repeated sessions with the dog are crucial to achieve substantial effects on reading performance.

## ETHICS STATEMENT

This study was carried out in accordance with the Vienna Municipal Education Authority as well as the head masters of the schools. The parents were fully informed in writing and gave written consent. Ethical consent was given by the education board.

## AUTHOR CONTRIBUTIONS

The idea for the paper was conceived by KK and AB. The experiments were designed by KK, AB, and LS and performed



**FIGURE 5 |** Cortisol AUCi in test session 2—comparison of the two settings (40).

by LS and Sigrid Amon. Data were analyzed and the paper was written by LS. Katrin Martens coded some videos for the interobserver reliability. All the authors revised and approved the paper.

## ACKNOWLEDGMENTS

We thank the Vienna School Board for granting permission to conduct this study in Vienna public schools. We are grateful to Elisabeth Mannsberger and her school-dog teams, the school principals and teachers as well as the participating pupils and their parents who all happily contributed their share to make this study possible. A big thank you also to Iris Schöberl for providing expertise, to Sigrid Amon for contributing to the data collection,

and to Katrin Martens for coding videos for the interobserver reliability.

## FUNDING

Minor expenses of the primary investigator (LS) were covered by a financial contribution by Mars, Austria. Materials were funded by the Austrian Science Foundation project FWF P 23345, to KK.

## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at <http://journal.frontiersin.org/article/10.3389/fvets.2017.00090/full#supplementary-material>.

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**Conflict of Interest Statement:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be

construed as a potential conflict of interest. Mars was never involved in any phase of this study, design, data taking, analysis, or interpretation.

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# A Birth Cohort Analysis to Study Dog Walking in Adolescence Shows No Relationship with Objectively Measured Physical Activity

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### Edited by:

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### Specialty section:

This article was submitted  
to Veterinary Humanities  
and Social Sciences,  
a section of the journal  
*Frontiers in Veterinary Science*

Received: 09 February 2017

Accepted: 19 April 2017

Published: 16 May 2017

### Citation:

Westgarth C, Ness AR, Mattocks C  
and Christley RM (2017) A Birth  
Cohort Analysis to Study Dog  
Walking in Adolescence Shows No  
Relationship with Objectively  
Measured Physical Activity.  
*Front. Vet. Sci.* 4:62.  
doi: 10.3389/fvets.2017.00062

Physical inactivity during childhood and adolescence is a serious health concern. There are few studies of the activity undertaken by adolescents when walking with the family dog, and the effect of this on objectively measured physical activity levels. Objective measures of physical activity using accelerometers were recorded at age 11–12, 13–14, and 15–16 years in the Avon Longitudinal Study of Parents and Children (ALSPAC) (ALSPAC, UK) birth cohort during the 2000s. Family pet ownership was collected retrospectively using a questionnaire at age 18 years, for the ages 7, 11, 13, and 15 years. In addition, approximate frequency per week of walks undertaken with dogs were also reported. Multilevel, multivariable modeling was used to investigate the relationship between dog ownership and dog walking status, and physical activity outcomes. There were a total of 4,373 complete data observations for use in 2,055 children. Reported participation in dog walking tended to increase during adolescence, as did dog ownership. The majority of who own dogs reported walking them either 2–6 times/week (range 39–46%) or never (range 27–37%). A small minority (7–8%) reported walking their dog every day. Most reported never walking any other dog either (94–87%). We found no evidence for an association between dog ownership or reported dog walking, and objectively measured physical activity (counts per minute,  $P = 0.3$ , or minutes of moderate-to-vigorous physical activity,  $P = 0.7$ ) during adolescence. This study provides no evidence to support a relationship between adolescent dog ownership and physical activity, and demonstrates the importance of using objective activity measures and considering dog walking rather than just dog ownership.

**Keywords:** Avon Longitudinal Study of Parents and Children, exercise, dogs, walking, adolescent, child, physical activity

## INTRODUCTION

Physical activity is important for optimal health and the prevention of chronic diseases; however, the proportion of children (5–15 years) meeting guidelines (minimum 1 h/day of moderate activity) is low (21% boys and 16% girls) (1). Therefore, it is crucial to gather evidence of effective intervention means that increase physical activity. Adults who own dogs have been shown to be more physically

active than those who do not own dogs (2). Further, owners who walk their dogs regularly may also have lower weight status (3). However, the benefit of dog walking for children and adolescents is less clear. This target group is particularly important given the increasing prevalence of childhood obesity and low levels of physical activity.

Two Australian cross-sectional studies (one self-reported, one objective accelerometer-measured) and one UK cross-sectional (accelerometer) study have demonstrated a small positive association between dog ownership and physical activity in children (4–6). However, a further US self-report study showed no evidence of an association in 4- to 10-year olds (7). One cross-sectional study also found evidence of some positive association between dog ownership and objectively measured physical activity in adolescents (8), however, another using diary reports found no association (9). In summary, previous studies have been limited to cross-sectional data and have used mainly self-reported as opposed to objective measures of physical activity with very little research on the adolescent age group.

Further, no previous analyses of child/adolescent physical activity outcomes have accounted for reported dog walking specifically, which has been shown to be a key concerning increased physical activity levels in adults, rather than ownership (2). In fact, very few studies have actually examined the extent of involvement of young people in dog walking (5, 10, 11).

In summary, there are no studies of the role adolescents take in walking with the family dog, and the effect of this on objectively measured physical activity. This study aims to fill this gap using longitudinal data from a well-characterized UK birth cohort. The objective of this study was to examine the association between dog ownership and involvement in dog walking with objectively measured physical activity during adolescence. We hypothesized that adolescents who reported walking their dogs would have higher physical activity levels than those who did not own a dog, or did but did not walk it. We also hypothesized that a dose-response effect would be seen with more frequent dog walking associated with increasing levels of activity.

## MATERIALS AND METHODS

### Data Collection

The Avon Longitudinal Study of Parents and Children (ALSPAC) is a prospective study, described in full elsewhere (12), which recruited 14,541 pregnant women resident in Avon, UK, with expected dates of delivery between 1st April 1991 and 31st December 1992. Of the initial 14,541 pregnancies, all but 69 had a known birth outcome and, of these, 195 were twin, three were triplet, and one was a quadruplet pregnancy meaning that there were 14,676 fetuses in the initial ALSPAC sample; 14,062 were live births and 13,988 were alive at 1 year. At approximately 7 years, a further enrollment phase added more children. The total sample size for analyses using any data collected after the age of seven is, therefore, 15,247 pregnancies, resulting in 15,458 fetuses. Of this total sample of 15,458 fetuses, 14,775 were live births and 14,701 were alive at 1 year of age. The study website contains details of all the data that is available through a fully searchable

data dictionary (<http://www.bris.ac.uk/alspac/researchers/data-access/data-dictionary/>). Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and the Local Research Ethics Committees and the participants provided written informed consent.

Objective measures of physical activity using Actigraph accelerometers were recorded at age 11–12, 13–14, and 15–16 years and have been described in detail elsewhere (13). Children were asked to wear an Actigraph accelerometer on their right hip for 7 days; data were valid if the children had worn it for at least 10 h/day for 3 days. Outcomes recorded were average counts per minute (CPM) of overall physical activity per day, and average minutes per day spent in moderate-to-vigorous physical activity (MVPA) using an Actigraph cut point of >3,600 CPM as previously developed and validated on a subsample (14).

Family pet ownership information was collected retrospectively at age 18, for the ages 7, 11, 13, and 15 years, by questionnaire survey. Participants were asked whether they had any pets in their household when they were that age and how many cats, dogs, rabbit, rodents, birds, fish, tortoises/turtles, and horses. In addition, approximate frequency per week of walks undertaken with the pet dog were also reported, as were approximate frequency per week of walks undertaken with any other dog (e.g., belonging to a friend or family member). At age 13–14 years, children were asked to complete a computer-based activity recall session indicating activities that occurred on the previous day, which included walking the dog (15).

### Data Analysis

There were a total of 4,373 complete data observations for use in 2,055 children (age 11–12 years had 1,821; 13–14 years had 1,547; and 15–16 years had 1,005). Five-hundred eight children were observed at one time point only, 776 twice, and 771 at all three time periods.

For each time point, the variables of dog ownership (yes/no) and of reported frequency of dog walking were further categorized into a combined dog ownership/walking variable: non-dog owner; never walks dog, walks dog once a week, walks dog 2–6 times/week, or walks dog 7 or more times a week. Non-dog owners comprised 3,214 (73.5%) observations, dog owners who walked 0/week 286 (6.5%), 1/week 258 (5.9%), 2–6/week 531 (12.1%), and ≥7/week 84 (1.9%) of observations.

The association of dog walking with CPM and MVPA were assessed using random effects linear regression models in order to account for clustering of data within individuals across all three time points. The outcome MVPA was skewed and so was logged ( $\log_{10}$ ) prior to analysis. Variables considered as potential confounders included: age at physical activity data collection (days), gender, season of data collection (months), maternal social class by occupation, and maternal education level at gestation.

Initially, for each outcome, all variables were compared using univariable random effects models. Linearity of the relationship between continuous variables and the outcomes was assessed using GAM models (mgcv package in R). For each analysis (CPM and MVPA), datasets that only included variables with data for the outcome and all input variables were constructed. In all cases,

the form of the relationship was considered suitable to be modeled as linear.

For each outcome, model building commenced with construction of a maximal model that included the main dog ownership/walking explanatory variable and all potential confounders. In addition, two- and three-way interactions between dog walking, season, and gender were assessed. Because of considerable collinearity between maternal education and maternal SES, only maternal education was considered in the maximal model. Subsequently, a backward elimination procedure was used with the significance of each term assessed by evaluating the change in deviance (LRT) associated with their removal from the model. The main variable of interest, dog walking, was retained in the final model irrespective of its significance. Model fit was assessed by visual examination of residuals against predicted values. All analyses were undertaken using the *R* language for statistical computing using the lmer function, in the lme4 package. Due to the complexity of the novel analysis method, sample size calculations could not be performed.

## RESULTS

### Pet Ownership and Role in Dog Walking

Age 7 pet ownership collected retrospectively was highly associated with pet ownership reported by the carers at the time the child was age 7 ( $P < 0.0001$ ), suggesting accurate recall. Reported pet and dog ownership, and frequency of participation in dog walking, across all four retrospective and one current time points is reported in **Table 1**. Reported participation in dog walking tended to increase during adolescence, as did dog ownership. The majority of adolescents who own dogs reported walking them either 2–6 times/week (range 39–46%) or never (range 27–37%). A small minority (7–8%) reported walking with their dog every day. Most reported never walking any other dog either (87–94%) (**Table 1**). In the activity-recall coding of the previous day's activities at age 13, 510 (8.9%) reported that they had walked a dog.

### Counts per Minute

The final model for CPM (**Table 2**) included dog walking frequency, gender, month, age, and maternal education level. There was no evidence of a difference among participants with different dog walking frequencies ( $P = 0.3$ ). Despite this, there appeared to be a tendency among dog owners toward increasing CPM as dog walking frequency increased.

### Moderate-to-Vigorous Physical Activity

The final adjusted model for MVPA (**Table 2**) demonstrated no evidence of an association between dog ownership/walking and level of MVPA ( $P = 0.7$ ). In fact, only the most frequent dog walkers even had MVPA estimates above those of non-dog owners.

## DISCUSSION

We found no evidence of an association between dog ownership or reported role in dog walking and objectively measured physical activity during adolescence. This suggests that family dog walking during adolescence is low and does not impact on physical activity levels. Our findings are in line with those of Mathers et al. (9) who found no association between dog ownership or time spent playing/caring for pets and physical activity calculated via a self-reported diary. In regards to MVPA, our findings also agree with the only other study of dog ownership using objectively measured PA in adolescents, although they did find a small association with CPM (8). There are no previous studies detailing the role of adolescents in dog walking activities; however, only 7–8% reported walking approximately daily with the dog compared to 35% in 9- to 10-year olds (11). Previous studies suggest that involvement in pet dog walking may decrease as a child gets older (4–6); however, our data showed that reported dog walking increased at least through adolescence, both for with their own dog or someone else's dog.

This study has a number of strengths compared to previous studies. It uses a large dataset from a well-characterized UK

**TABLE 1 | Retrospective reporting (at age 18 years) of pet ownership and dog walking at age 7, 11, 13, 15, and 18 years.**

		Retrospective				Current
		7 years	11 years	13 years	15 years	18 years
		n (%)	n (%)	n (%)	n (%)	n (%)
Pet	No	714 (23.1)	647 (21.1)	727 (23.5)	783 (25.8)	854 (27.6)
	Yes	2,732 (76.9)	2,416 (78.9)	2,333 (76.5)	2,251 (74.2)	2,244 (72.4)
Dog	No	2,357 (76.4)	2,215 (72.3)	2,122 (69.5)	1,996 (65.8)	1,965 (63.4)
	Yes	729 (23.6)	848 (27.7)	931 (30.5)	1,039 (34.2)	1,136 (36.63)
Freq dog walks own dog	Never	432 (48.4)	351 (36.8)	314 (31.3)	298 (27.3)	395 (33.0)
	Once a week or less	124 (13.9)	161 (16.9)	202 (20.1)	200 (18.3)	246 (20.6)
	2–6/week	290 (32.5)	376 (39.4)	417 (41.5)	504 (46.1)	451 (37.7)
Freq dog walks any other dog	7/week+	46 (5.2)	66 (6.9)	71 (7.1)	91 (8.3)	105 (8.8)
	Never	1,769 (93.6)	1,782 (92.2)	1,800 (90.4)	1,820 (88.5)	1,835 (86.8)
	Once a week or less	71 (3.8)	85 (4.4)	89 (4.5)	128 (6.2)	148 (7.0)
	2–6/week	42 (2.2)	56 (2.9)	86 (4.3)	97 (4.7)	115 (5.4)
	7/week+	8 (0.4)	10 (0.5)	16 (0.8)	12 (0.6)	16 (0.8)

Data collected for the 2000s in the Avon Longitudinal Study of Parents and Children (ALSPAC), UK.

**TABLE 2 | Association between dog ownership/dog walking and counts per minute (CPM) of physical activity in adolescence and  $\log_{10}[\text{moderate-to-vigorous physical activity (MVPA)}]$  in adolescence (4,373 observations in 2,055 children).**

	Unadjusted estimate	Unadjusted CI	Adjusted <sup>a</sup> estimate	Adjusted <sup>a</sup> CI	P
<b>CPM</b>					
(Intercept)	534.44	527.25–541.64	902.12	860.71–943.53	
Dog ownership/walking					0.3
Non-dog owner	Ref		Ref		
Never	−14.00	−36.20–8.20	−3.80	−24.16–16.57	
Once a week or less	−23.67	−46.60–0.74	−0.13	−21.18–20.92	
2–6/week	−9.60	−26.94–7.80	9.01	−6.99–25.02	
7/week+	21.69	−17.33–60.72	35.14	−30.22–12.29	
<b>MVPA</b>					
(Intercept)	1.25	1.24–1.27	1.43	1.36–1.52	
Dog ownership/walking					0.7
Non-dog owner	Ref		Ref		
Never	−0.03	−0.08–0.01	−0.02	−0.07–0.02	
Once a week or less	−0.02	−0.06–0.02	−0.00	−0.04–0.04	
2–6/week	−0.02	−0.05–0.02	−0.01	−0.04–0.03	
7/week+	0.03	−0.04–0.11	0.03	−0.04–0.10	

Data collected during the 2000s in the Avon Longitudinal Study of Parents and Children, UK.

<sup>a</sup>Adjusted for month, gender, age, and maternal education. Observation point set as level 1 and child as level 2 in hierarchical model, as children provided data from approximately ages 11, 13, and 15.

birth cohort, including objectively measured physical activity outcomes. The predictor variable consisted of frequency of walking with the dog, not simply ownership or time spent with it, and adjustment for key confounding variables was performed. The model used allowed ownership and dog walking to vary across observation time points for each child that contributed to the analysis of overall effect of dog ownership/walking at the observation level. In addition, although we did not interpolate missing data, the use of multilevel modeling does have the advantage of enabling incorporation of the data for each child for each time point. Hence, if a child only had data for some but not all time points that would still be included in analysis, maximizing data usage.

There are some limitations, in that, the ownership and dog walking frequency data were estimated retrospectively rather than concurrently, although, a previous study has shown that recall of childhood pet ownership by young adults is accurate (16). In addition, we tested recall accuracy in our dataset for age 7 and the findings were consistent. Therefore, it is likely that dog ownership recall is accurate, and that previous dog walking habits are likely to be recalled with reasonable accuracy. Further, no data were collected regarding the type of dog owned. For example, size of the dog can influence how often it is walked (17). As our independent variable included reported dog walking frequency, this should not overly affect our results. However, smaller dogs that are walked may plausibly be walked shorter distances, leading to less physical activity recorded, and our study could not examine this. This survey only examined frequency, not length of dog walks, and also only examined dog walking, not other physical activity that might result from owning a pet dog such as playing or caring for them. However, the frequency of participation in dog walking is likely the primary influence of the dog on physical activity of dog owning children (6). The effect of dog ownership on physical activity in children besides dog walking such as active play requires further investigation.

In conclusion, we found no evidence of an association between dog ownership or walking and physical activity in adolescence. This study used objectively measured physical activity rather than self-report and highlights the importance of assessing dog walking directly rather than using dog ownership as a proxy. Future cohort studies should collect more detailed information about interactions with pets if analysis of the effects of pet ownership on human health is to be worthwhile, including detail on frequency, duration, and distance of walking with the pet dog, preferably using objective measures. Given that child involvement in dog walking has been shown to be associated with the strength and type of relationship with the dog (11), measures of attachment to the pets should also be studied.

## AVAILABILITY OF DATA AND MATERIALS

The dataset(s) supporting the conclusions of this article are available via application to the ALSPAC Executive Committee.

## ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the ALSPAC Law and Ethics Committee and the Local Research Ethics Committees with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and the Local Research Ethics Committees.

## AUTHOR CONTRIBUTIONS

CW designed the pet ownership data collection. CW and RC designed the analysis, conducted the analysis, and drafted the

paper. AN and CM collected the physical activity data, assisted with the analysis, and commented on the manuscript.

## ACKNOWLEDGMENTS

We are extremely grateful to all the families who took part in this study, the midwives for their help in recruiting them, and the whole ALSPAC team, which includes interviewers, computer and laboratory technicians, clerical workers, research scientists, volunteers, managers, receptionists and nurses. We would also like to thank Jane Murray for contributing to initial

development of this research study and the design of the pet ownership questions.

## FUNDING

The UK Medical Research Council and the Wellcome Trust (Grant ref: 102215/2/13/2) and the University of Bristol provide core support for ALSPAC. This research was specifically funded by a Medical Research Council Population Health Scientist Fellowship (Grant ref: G1002402) held by CW.

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**Conflict of Interest Statement:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. Funding bodies had no role in design, collection, analysis, and interpretation of data; in the writing of the manuscript; or in the decision to submit the manuscript for publication.

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# Caregiver Reports of Interactions between Children up to 6 Years and Their Family Dog—Implications for Dog Bite Prevention

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## OPEN ACCESS

### Edited by:

Mary M. Christopher,  
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Andie Thompkins,  
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### Specialty section:

This article was submitted  
to Veterinary Humanities  
and Social Sciences,  
a section of the journal  
*Frontiers in Veterinary Science*

Received: 29 May 2017

Accepted: 28 July 2017

Published: 30 August 2017

### Citation:

Arhant C, Beetz AM and Troxler J  
(2017) Caregiver Reports of Interactions between Children up to 6 Years and Their Family Dog—Implications for Dog Bite Prevention.  
*Front. Vet. Sci.* 4:130.

doi: 10.3389/fvets.2017.00130

In children up to 6 years, interactions such as interfering with the dog's resources and also benign behaviors (e.g., petting) commonly precede a bite incident with the family dog. Therefore, the aim of the present study was to explore the development of everyday interactions between children up to 6 years and their family dogs and whether parents' attitudes to supervision are related to those interactions. Additionally, we investigated whether behavior of dogs that had lived in the family for longer than the child differed from those that grew up with children. A self-selected sample of caregivers living with a child up to 6 years and a family dog was surveyed via an online questionnaire ( $N = 402$ ). Frequency of observed child behaviors directed toward the dog and dog behaviors directed toward the child were scored on a six-point scale (1—never and 6—very often). Data on characteristics of the caregiver, the child, and the dog were collected, and a section surveying attitudes to supervision of child–dog interactions was included. Additionally, we asked whether the dog already injured the child. Benign child behaviors toward dogs were most frequently reported (mean  $\pm$  SD:  $4.1 \pm 1.2$ ), increased with child age ( $r_s = 0.38$ ,  $p < 0.001$ ), and reached high levels from 6 months on. Overall, resource-related interactions were relatively infrequent ( $2.1 \pm 1.1$ ). Most common was the dog allowing the child to take objects from its mouth ( $4.1 \pm 1.7$ ). This behavior was more common with older children ( $r_s = 0.37$ ,  $p < 0.001$ ). Reported injuries during resource-related interactions occurred while feeding treats or taking objects from the dog during fetch play. Dogs that had lived in the family for longer than the child showed less affiliative behaviors toward the child (e.g., energetic affiliative:  $U = -7.171$ ,  $p < 0.001$ ) and more fear-related behaviors ( $U = -3.581$ ,  $p < 0.001$ ). Finally, the caregivers' attitudes to supervision were related to all child behaviors (e.g., allow unsafe behaviors—benign child behavior:  $r_s = 0.47$ ,  $p < 0.001$ ). The results of this study underline the need for a dog bite prevention approach directed toward the caregivers very early in the child–dog relationship, taking into account the child's age and individual needs of the dog.

**Keywords:** child–dog interaction, supervision, parents, dog bite, injury prevention, child safety

## INTRODUCTION

Dogs are one of the favorite animals of preschool children (1). Many children are attracted to dogs, see them as their friends and especially like to cuddle with dogs (2). Children attribute to dogs sentience almost comparable to human beings and especially children who have pet dogs attribute high sentience to them (3). Growing up with a dog can have developmental benefits for children [for review see Ref. (4, 5)]. However, dogs are also the species that causes most injuries in humans (6–8). Although there are no global statistics of dog bite incidents, the WHO estimates that dog bites account for tens of millions of injuries annually and children are most at risk of being bitten (9). Dog bites to children are a significant public health problem (10, 11) and include some serious injuries (12, 13). The overall prevalence of dog bites in children in a telephone survey was 22 per 1,000 children per year and about 40% of those bites were minor, needing no medical care (14). A rise of 63% in dog-related injuries presenting to hospitals between 1998 and 2008 in the UK causes increasing concern (15). In younger children, most dog bites occur at home; often the bite is located on the face, head or neck and is inflicted by a familiar dog (14, 16–18). These incidents are most often preceded by a child-initiated interaction with the dog (16, 19) and one study found that parents were often present (17). These results show that having a family dog with young children poses a risk to the child and even parents might not be able to prevent a bite. Our own research about intervention of parents in child–dog interactions showed that in more than half of the cases, parents do not intervene in a potentially risky interaction with the family dog, whereas they would do so with an unfamiliar dog (20). Parents seem to trust their dog not to act aggressively with their child independent of the context of the interaction. Furthermore, even adults have problems understanding dog body language (21, 22), and dog owners were actually found to be *less* likely than non-owners to recognize dog behaviors indicating fear during an observed child–dog interaction (23).

There is only a very limited number of studies on child–family dog interactions: observations of 2- to 5-year-old children interacting with their family dog lasting about 20 min showed that the initiative came mostly from the child and that the interactions were of short duration compared to interactions with humans (24). In contrast to interactions with other children, the child more often sought body contact to the dog by touching the dog with the hand, petting, or hugging the dog. The tactile behaviors of children toward the dog were less diversified than those of adults. In response to tactile behaviors, the dogs commonly did not react or they approached the child, approached body parts of the child with their muzzle, or retreated from the child. Similarly in a study comparing interactions with a robot dog and a live dog, social touch was the most commonly observed child behavior with the live dog (2). Other common child behaviors were to give an object to the dog or retreat from the dog (24). Clearly threatening or painful child behaviors toward the dog were also observed. The child behavior that led to most attempts to bite was pulling on the dog's tail, hair, or paw but in general, manifestly aggressive dog behaviors were seldom observed (24). However, more subtle dog behaviors that might indicate that a dog does not feel comfortable

in an interaction such as ear and tail movements, body position, yawning, nose licking, or blinking (25) were not coded. The most commonly observed dog behaviors were to sniff the child, to take an object the child presented to the dog or to retreat from the child (24). Observations of child–family dog interactions have also revealed that the types of behaviors observed were related to the age of the child: children aged 2–3 years displayed more agonistic/aversive behaviors toward the dog, children aged 3–4 years more appeasing and linking behavior, and children aged 4–5 years more object-related interactions (24). Another possibly relevant link of child age with dog age was that children were often bitten by dogs that were older than the child (19).

Most dog bites by familiar dogs are preceded by a child–dog interaction (17, 19). Tactile child behaviors toward the dog that are intended to be friendly are also referred to as benign behaviors and can be precursors of a dog bite (16, 17). This type of interaction was found to be associated with an increased risk of a face or head bite (17). Other child–dog interactions preceding dog bites in children younger than 6 years were object- or resource-related interactions, disturbing the resting dog, painful interactions and other interactions that are aversive for the dog (16, 17). Although child–dog interactions are an essential factor contributing to the risk of being bitten, no studies about child–dog interactions in children younger than 2 years are available. We also have a shortage of knowledge about child–family dog interactions occurring during everyday life, how they develop depending on age of the child, and how they relate to the parent's attitudes to supervision.

The aims of our exploratory study were to survey the occurrence of everyday child–dog interactions in children up to 6 years living with a family dog; to investigate how interactions with the dog develop depending on the age of the child; to explore the relationships of child–dog interactions with caregiver attitudes to supervision; and to investigate whether being accustomed to living with children impacts on the dogs behavior toward the child.

## MATERIALS AND METHODS

### Questionnaire

To explore the daily lives of parents and other caregivers living with a child up to 6 years and a family dog, a questionnaire with a total of 160 questions in German was developed based on literature review, dog bite prevention programs, experiences of dog owners and experts working in dog bite prevention. Additionally, to identify relevant child–dog interactions, 35 YouTube videos showing child–dog interactions were viewed. The search terms were child dog, child plays with dog, child dog funny, kids and dogs, and 4-year-old plays dog. Selection criteria were that the child should be in the study's age range and that only one child interacted with a single dog. A maximum of 3 min were screened for interactive behaviors (mean length of the videos: 141 s; range: 26–495). Based on these videos, on informal discussions with dog owners living with small children in their home and relevant literature [e.g., (16, 17, 24, 26)], a list of possible interactions was generated. It included child behaviors directed toward the dog and dog behaviors directed toward the child. The questions were kept as short and as simple as possible and did not distinguish

between situations where children initiated an interaction on their own or situations where caregivers encouraged an interaction. Sample questions are “My child pulls on body parts of the dog, e.g., tail, ears”; “My child pets the dog on the head”; “My dog jumps up on the child”; and “My dog barks at the child.” These questions regarding the observed frequency of child–dog interactions were scored on six-point scales with the extremes labeled “Never” (score = 1) and “Very often” (score = 6). Further sections relevant to this work are characteristics of the participant, the child, and the dog. Child age was collected with the following categories: 0.25, 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, and 6 years. Dog characteristics included the question whether the focal dog had already lived in the family (and grown up without children) before the focal child or a sibling was born. Additionally, we asked whether the caregiver had ever considered finding a new home for the dog because living with child and dog was too challenging, and whether this dog had already injured this child and in which context. The latter question was an open-ended question. Results on caregiver attitudes to supervision and daily management of child and dog are presented elsewhere (20). However, for two of the supervision attitudes subscales identified *via* principal component analyses—“attentiveness,” “allow unsafe behaviors”—relationships with child and dog interactive behavior and child age are explored in the present article. The items of these subscales were scored on a six-point scale ranging from “do not agree at all” (score = 1) to “totally agree” (score = 6). The “attentiveness” subscale represents the mean of six items such as “I always have an eye on the child and dog if they are in the same room.” The “allow unsafe behaviors” represents the mean of six items such as “as long as the child is nice to the dog, they can play or cuddle with the dog as much as they want” [for details see Ref. (20)]. A draft version of the questionnaire was tested with persons from the target group. Test persons needed about 30 min to complete the revised final questionnaire.

## Survey

The survey was carried out as an online survey *via* “Survey Monkey.” It was open from July 21 to November 26, 2014. The questionnaire was advertised *via* facebook (e.g., facebook page of the Vetmeduni Vienna), newsletters (e.g., Royal Canin Austria), and a German dog magazine. Participants had to own a dog (“family dog”) and be living with a child 6 years old or younger. If respondents had multiple children or dogs, they were asked to choose a focus child and dog, namely the child and dog that they observed to have the most interactions.

## Data Analyses

All statistical analyses were carried out with IBM SPSS Statistics 20 or 22 (SCR\_002865). For the descriptive presentation of the frequency of observed child–dog interactions in the text of the results section scores 5 and 6 were grouped and termed “frequently.”

As principal component analyses did not result in easily interpretable subscales, the items concerning child interactive behaviors were grouped according to the grouping of antecedents of dog bites in children from Reisner et al. (16) (**Table 1**). We added a scale for dog care activities but left grooming within the

original classification of Reisner in the aversive non-painful activities scale. Dog interactive behaviors were grouped according to functional or emotional similarities in behavior and potential risk for the child (**Table 2**). The scores of the “scales” were obtained by calculating the mean of the items in each of the scales.

To assess relationships with child age as collected in the questionnaire, Spearman rank correlations were calculated for the averaged scales and the individual items of child and dog interactive behaviors. Additionally, child age was categorized (up to 6 months, 6–12 months, 1.5–2 years, 2.5–3 years, 3.5–4 years, 4.5–5 years, and 5.5–6 years) and Kruskal–Wallis tests were used to assess differences in child–dog interactions related to child age. The use of the two different tests was considered suitable to also identify non-monotonous relationships between child age and interactive behaviors.

Relationships between child and dog interactive behaviors and the two subscales assessing attitudes to supervision in caregivers were analyzed using Spearman rank correlations. Finally, we explored whether being accustomed to live with children before the focal child was born, differently effects on dog interactive behavior using a Mann–Whitney *U*-test. Due to the explorative nature of this work, we did not correct for multiple testing and only interpret significant correlations  $\geq 0.2$ .

## RESULTS

### The Participants

Most of the respondents ( $N = 402$ ) were mothers (82.4%) followed by grandmothers (7.1%), fathers (5.3%), other women (3.4%), grandfathers (1.5%), and one other man. The mean age of the participants was  $33 \pm 9$  years (mean  $\pm$  SD). A high proportion of participants had an academic degree (47%). Two persons 15 years and older (“adult”) lived in 82.5% of the households (one adult: 4.4%, three or more adults: 13%). In 61% of the households, there was one child, two children were present in 32%, and three or more in 7% of the participating households. Of the children chosen as focus child, 53% were girls and 47% were boys and their mean age was  $2.5 \pm 1.7$  years. The households were situated in rural (55.6%), provincial (22.4%), and metropolitan (22%) areas with half of the participants living in Austria, 46.3% in Germany, and the remaining participants in other European countries.

### The Dogs

Of the dogs chosen as focus-dogs, 56% were females (67% spayed) and 44% were males (54% neutered). The mean age of the dogs was  $5.5 \pm 3.3$  years and their mean weight was  $23 \pm 13$  kg. The most common breeds were mixed breeds (26%) followed by Labrador Retriever (9.4%), Golden Retriever (4%), Australian Shepherd (4%), Rhodesian Ridgeback (3%), Jack Russell Terrier (3%), and 80 other breeds. A large majority of the dogs had lived in the household before the child was born (70.4%). Only one respondent admitted that she often thought about finding a new home for the dog because living with child and dog was very difficult. Another 3% thought about this possibility sometimes and 9% rarely. The majority of the participants (87%;  $N = 325$ ) had never considered rehoming the dog.

**TABLE 1** | Caregiver reports of child behaviors toward the family dog and Spearman rank correlations with child age (N ranges between 347 and 365).

	<b>Mean</b>	<b>SD</b>	<b>Min</b>	<b>Perc. 25</b>	<b>Median</b>	<b>Perc. 75</b>	<b>Max</b>	<b>Child age <math>r_s</math></b>
<b>Child—benign</b>	4.14	1.18	1.00	3.43	4.29	5.14	6.00	0.38***
Speak to dog	4.48	1.66	1.00	3.00	5.00	6.00	6.00	0.51***
Pet dog on body	5.05	1.26	1.00	5.00	6.00	6.00	6.00	0.42***
Pet dog on head	4.74	1.46	1.00	4.00	5.00	6.00	6.00	0.43***
Hug dog	3.78	1.94	1.00	2.00	4.00	6.00	6.00	0.47***
Kiss dog	3.07	1.82	1.00	1.00	3.00	5.00	6.00	0.29***
Reach for dog	3.95	1.71	1.00	2.00	4.00	5.00	6.00	-0.23***
Approach or follow dog	4.05	1.70	1.00	3.00	4.00	6.00	6.00	0.03ns
<b>Child—resting</b>	2.27	1.10	1.00	1.33	2.00	3.00	6.00	0.19***
Wake sleeping dog	1.97	1.25	1.00	1.00	2.00	2.00	6.00	0.17**
Lay down near to resting dog	2.73	1.76	1.00	1.00	2.00	4.00	6.00	0.29***
Leave resting dog alone <sup>a</sup>	4.88	1.38	1.00	4.00	5.00	6.00	6.00	0.05ns
<b>Child—resources</b>	2.07	1.06	1.00	1.00	1.75	2.75	6.00	0.27***
Attempt to take away dog food or bowl	1.56	1.21	1.00	1.00	1.00	1.00	6.00	-0.03ns
Attempt to pet feeding dog	1.73	1.26	1.00	1.00	1.00	2.00	6.00	0.09ns
Take child toys from dog	2.92	1.89	1.00	1.00	3.00	5.00	6.00	0.37***
Attempt to take dog toys/chews from dog	2.07	1.48	1.00	1.00	1.00	3.00	6.00	0.12*
<b>Child—aversive non-painful</b>	2.10	0.80	1.00	1.57	2.00	2.57	5.29	0.45***
Restraint by collar	2.76	1.68	1.00	1.00	2.00	4.00	6.00	0.20***
Grooming	2.33	1.60	1.00	1.00	2.00	4.00	6.00	0.52***
Child yells or screams during interaction	3.29	1.67	1.00	2.00	3.00	5.00	6.00	0.00ns
Verbal scolding	2.05	1.24	1.00	1.00	2.00	3.00	6.00	0.45***
Dress dog	1.21	0.70	1.00	1.00	1.00	1.00	5.00	0.25***
Involve dog in child play, e.g., doctor game	1.79	1.30	1.00	1.00	1.00	2.00	6.00	0.37***
Lift dog	1.35	0.95	1.00	1.00	1.00	1.00	6.00	0.30***
<b>Child—aversive painful</b>	1.86	0.77	1.00	1.20	1.70	2.40	4.60	-0.01ns
Sit, lie or ride on dog	2.15	1.60	1.00	1.00	1.00	3.00	6.00	0.08ns
Pull on body parts of dog, e.g., tail, ears	2.34	1.55	1.00	1.00	2.00	3.00	6.00	-0.18***
Inflict pain accidentally, e.g., stepping on	2.08	1.00	1.00	1.00	2.00	3.00	6.00	0.06ns
Inflict pain deliberately, e.g., hitting	1.40	0.75	1.00	1.00	1.00	2.00	5.00	0.20***
Throw objects on dog	1.37	0.77	1.00	1.00	1.00	2.00	6.00	0.00ns
<b>Child—dog care</b>	3.27	1.44	1.00	2.00	3.33	4.33	6.00	0.59***
Feed dog	3.64	1.77	1.00	2.00	4.00	5.00	6.00	0.25***
Lead dog on leash	2.62	1.71	1.00	1.00	2.00	4.00	6.00	0.53***
Request obedience from dog/give commands	3.51	1.87	1.00	1.00	4.00	5.00	6.00	0.65***

<sup>a</sup>Has been reversed scored for inclusion in scale "child—resting."

\* $p > 0.05$ ; \*\* $p \leq 0.01$ ; \*\*\* $p \leq 0.001$ ; \* $p \leq 0.01$ ; \* $p \leq 0.05$ .

## Child Behaviors Directed toward the Dog

The commonest observed interactions between children and dogs can be assigned to the category benign behaviors (**Table 1**). Petting dogs on the body (scores 5 and 6: 75%) and on the head (67%), speaking to the dog (60%) and approaching or following the dog (49%) were frequently observed by caregivers. Child behaviors considered as more problematic from a dog bite prevention point of view, such as hugging (scores 5 and 6: 46%) and kissing the dog (27%) were somewhat less frequent and 21 or 32% of the caregivers, respectively, never observed them (score 1). All these behaviors, except approaching or following the dog, were positively correlated with age of the child (**Table 1**). A Kruskal–Wallis test showed a significant effect of child age categories on benign child behaviors and graphical inspections revealed an increase in frequency in particular in the first 2 years of life ( $\chi^2 = 70.41$ ,  $p < 0.001$ ; **Figure 1**). Only reaching for the dog showed a small negative correlation with age of the child (**Table 1**). Overall, 46% frequently observed their child reaching for the dog.

Child behaviors toward a resting dog or a dog interacting with resources were observed rarely by most respondents (**Table 1**). 49% of the caregivers never observed the child waking the dog,

while 7% observed this frequently, and 39% never observed the child lying down near to/beside the resting dog, though 21% observed it frequently. Similarly, 71% reported that the child leaves the resting dog alone frequently (never: 2%). A small positive correlation with child age was present for lying down near to the resting dog (**Table 1**) and overall children at the age of 1.5–2 years and 5.5–6 years interfered more often with the resting dog ( $\chi^2 = 35.31$ ,  $p < 0.001$ ; **Figure 1**).

Interfering with the dog's food or food bowl and attempting to pet the feeding dog were rare, being never observed by 76 and 65% of respondents, whereas 6% of caregivers observed these behaviors frequently. Taking child toys from the dog was more common, observed frequently in 27% of the children, but 39% never observed the child retrieving its toys from the dog. About half of the participants (53%) reported that the child never took dog toys or chews from the dog and 10% observed this behavior frequently. The child taking its own toys back from the dog was seen more frequently in older children (**Table 1**). The other resource-related interactions were at most marginally related to child age. Children were observed interfering with dog resources from the second half of their first year of life onward, with an

**TABLE 2** | Caregiver reports of dog behaviors toward the child and Spearman rank correlations with child age ( $N$  ranges between 338 and 352).

	<b>Mean</b>	<b>SD</b>	<b>Min</b>	<b>Perc. 25</b>	<b>Median</b>	<b>Perc. 75</b>	<b>Max</b>	<b>Child age <math>r_s</math></b>
Dog leaves alone/ignores child	4.24	1.65	1.00	3.00	5.00	6.00	6.00	0.05 <sup>ns</sup>
<b>Dog—affiliative calm</b>	<b>4.21</b>	<b>1.26</b>	<b>1.00</b>	<b>3.33</b>	<b>4.33</b>	<b>5.33</b>	<b>6.00</b>	<b>0.06<sup>ns</sup></b>
Sniffs child	4.65	1.36	1.00	4.00	5.00	6.00	6.00	-0.05 <sup>ns</sup>
Lick hand or feet	4.08	1.75	1.00	2.00	4.00	6.00	6.00	-0.10 <sup>ns</sup>
Lies down with body contact to child	3.91	1.72	1.00	3.00	4.00	5.00	6.00	0.23***
<b>Dog—affiliative energetic</b>	<b>2.44</b>	<b>0.91</b>	<b>1.00</b>	<b>1.83</b>	<b>2.33</b>	<b>3.00</b>	<b>5.67</b>	<b>0.33***</b>
Runs toward child	4.17	1.57	1.00	3.00	4.00	6.00	6.00	0.21***
Runs after child	3.55	1.80	1.00	2.00	4.00	5.00	6.00	0.34***
Gentle mouthing	2.01	1.46	1.00	1.00	1.00	3.00	6.00	0.18**
Sits or lies on child	1.48	1.04	1.00	1.00	1.00	1.00	6.00	0.14*
Jumps up	1.74	1.38	1.00	1.00	1.00	2.00	6.00	0.25***
Knocks child over	1.73	1.04	1.00	1.00	1.00	2.00	6.00	0.09 <sup>ns</sup>
<b>Dog—resources</b>	<b>2.13</b>	<b>0.74</b>	<b>1.00</b>	<b>1.60</b>	<b>2.00</b>	<b>2.60</b>	<b>5.60</b>	<b>-0.27**</b>
Takes food away from child	2.34	1.54	1.00	1.00	2.00	3.00	6.00	0.01 <sup>ns</sup>
Takes child toys from environment	2.00	1.33	1.00	1.00	1.00	3.00	6.00	-0.06 <sup>ns</sup>
Takes child toys away from child	1.44	0.93	1.00	1.00	1.00	1.00	6.00	0.01 <sup>ns</sup>
Allows child to take things from dog mouth <sup>a</sup>	4.08	1.73	1.00	3.00	5.00	6.00	6.00	0.37***
<b>Dog—fear</b>	<b>1.92</b>	<b>1.04</b>	<b>1.00</b>	<b>1.00</b>	<b>1.50</b>	<b>2.50</b>	<b>6.00</b>	<b>-0.15**</b>
Withdraw from child	2.32	1.48	1.00	1.00	2.00	3.00	6.00	-0.17**
Startled by child	1.52	0.88	1.00	1.00	1.00	2.00	6.00	-0.05 <sup>ns</sup>
<b>Dog—aggression</b>	<b>1.17</b>	<b>0.40</b>	<b>1.00</b>	<b>1.00</b>	<b>1.00</b>	<b>1.20</b>	<b>3.60</b>	<b>0.08<sup>ns</sup></b>
Barks at child	1.33	0.75	1.00	1.00	1.00	1.00	6.00	0.11*
Growls during frontal approach	1.15	0.62	1.00	1.00	1.00	1.00	6.00	-0.08 <sup>ns</sup>
Growls during passing by	1.08	0.38	1.00	1.00	1.00	1.00	5.00	-0.07 <sup>ns</sup>
Growls with resources	1.18	0.70	1.00	1.00	1.00	1.00	6.00	-0.04 <sup>ns</sup>
Snaps at child	1.11	0.43	1.00	1.00	1.00	1.00	5.00	0.04 <sup>ns</sup>

<sup>a</sup>Has been reversed scored for inclusion in scale "Dog—resources."

<sup>ns</sup> $p > 0.05$ ; \*\*\* $p \leq 0.001$ ; \*\* $p \leq 0.01$ ; \* $p \leq 0.05$ .

increase until the second year of life ( $\chi^2 = 55.10$ ,  $p < 0.001$ ; **Figure 1**).

The most commonly reported child behavior classified to be aversive for the dogs was the child yelling or screaming during an interaction (frequently: 28%, never: 20%). Very rare behaviors were dressing the dog (frequently: 1%, never: 89%), involving the dog in child play (frequently: 6%, never: 66%), and lifting the dog (frequently: 3%, never: 84%). Attempts to lift the dog were mostly reported for children 4 years and older (Supplementary Material). Intermediate numbers of respondents reported children restraining the dogs by the collar (frequently: 21%, never: 33%), grooming (frequently: 12%, never: 49%), and verbal scolding (frequently: 5%, never: 46%). All these behaviors, except yelling or screaming during an interaction, correlated positively with child age (**Table 1**). Weak associations were found for restraining the dog by the collar, dressing the dog, and lifting the dog. A more pronounced increase with age was found for grooming, verbal scolding, and involvement of the dog in child play. Overall, aversive interactions increased until the age of 3.5–4 years and then their occurrence seems to remain stable until the age of 6 years ( $\chi^2 = 80.83$ ,  $p < 0.001$ ; **Figure 1**).

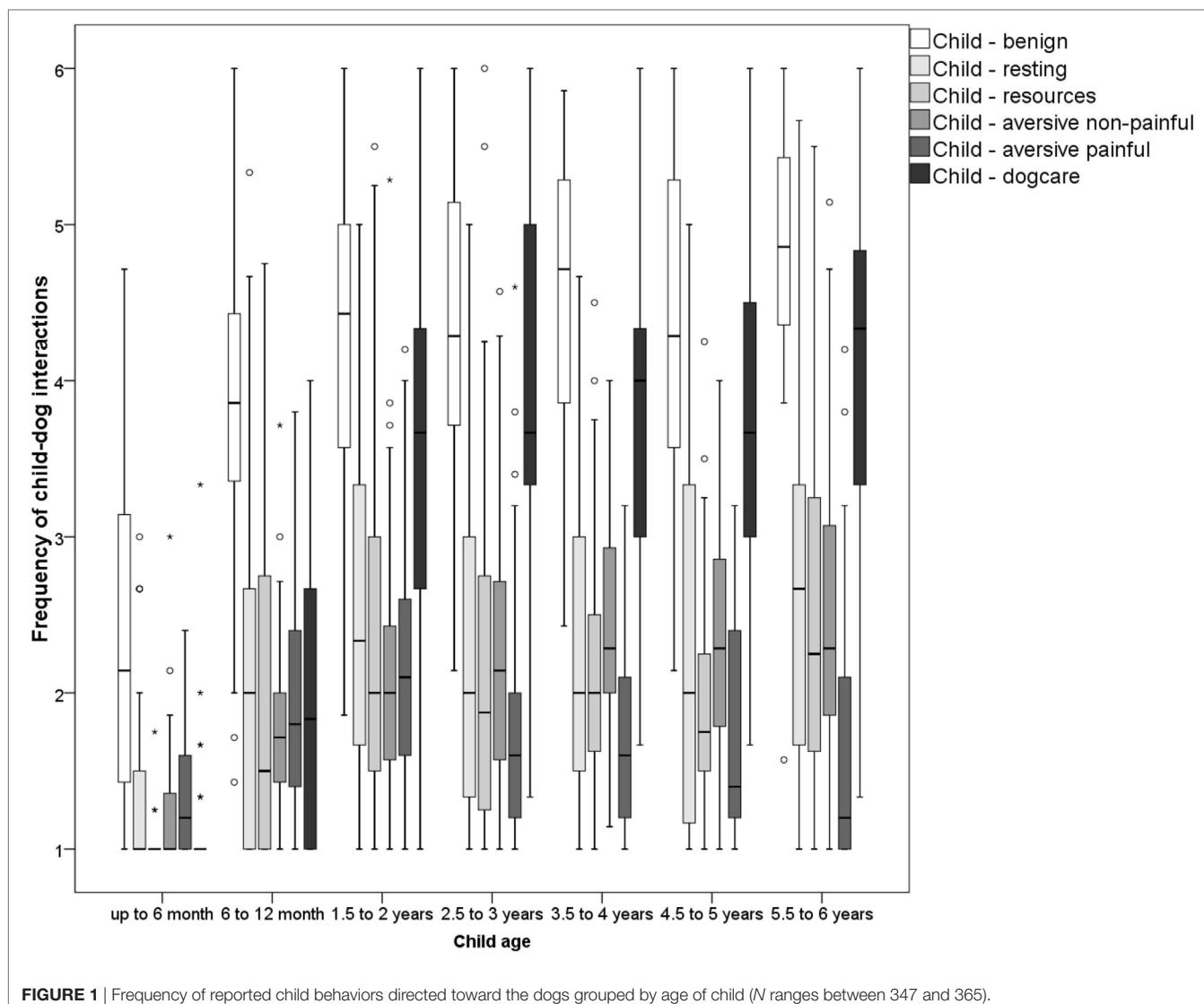
Child–dog interactions with a high risk of inflicting pain on the dog were rarely observed child behaviors. Least commonly reported was throwing objects at the dog (frequently: 2%, never: 75%) and deliberately inflicting pain, e.g., by hitting or kicking the dog (frequently: 1%, never: 71%). More frequently observed were to pull on body parts of the dog such as the tail or ears (frequently: 15%, never: 42%), to sit, lie, or ride on the dog (frequently: 14%, never: 55%), or to inflict pain accidentally

by stepping on the dog (frequently: 1%, never: 31%). Painful interactions were barely correlated with age—only deliberately inflicting pain correlated somewhat with child age (**Table 1**). This child behavior is most prominent in children between 1.5 and 5 years (Supplementary Material). Overall, a significant effect of age was found ( $\chi^2 = 29.68$ ,  $p < 0.001$ ; **Figure 1**): graphical inspection revealed that painful interactions rise in frequency until the age of 1.5–2 years and decline afterward until the age of 6 years.

Involvement of children in dog care correlated strongly with the age of the child (**Table 1**). The median peaked with 5.5–6 years and a sharp rise was already found in the second year of life ( $\chi^2 = 146.77$ ,  $p < 0.001$ ; **Figure 1**). The more common behaviors reported were feeding the dog (frequently: 37%, never: 19%) and giving commands to the dog (frequently: 39%, never: 27%). Leading the dog on a leash (frequently: 19%, never: 41%) was less common and barely present in children 1 year and younger. For data on grooming, see aversive non-painful interactions.

## Dog Behaviors Directed toward the Child

The most common interactions directed by the dog toward the child were calm affiliative behaviors or non-interaction, i.e., ignoring the child (**Table 2**). Most commonly reported was sniffing the child. Only 2% never observed this behavior and 62% of the participants observed it frequently (scores 5 and 6). A small positive relationship with child age was found for lying with body contact to the child (**Table 2**) whereas overall there seems to be no relationship of calm affiliative dog behaviors with child age ( $\chi^2 = 8.072$ ,  $p = 0.233$ ; **Figure 2**).

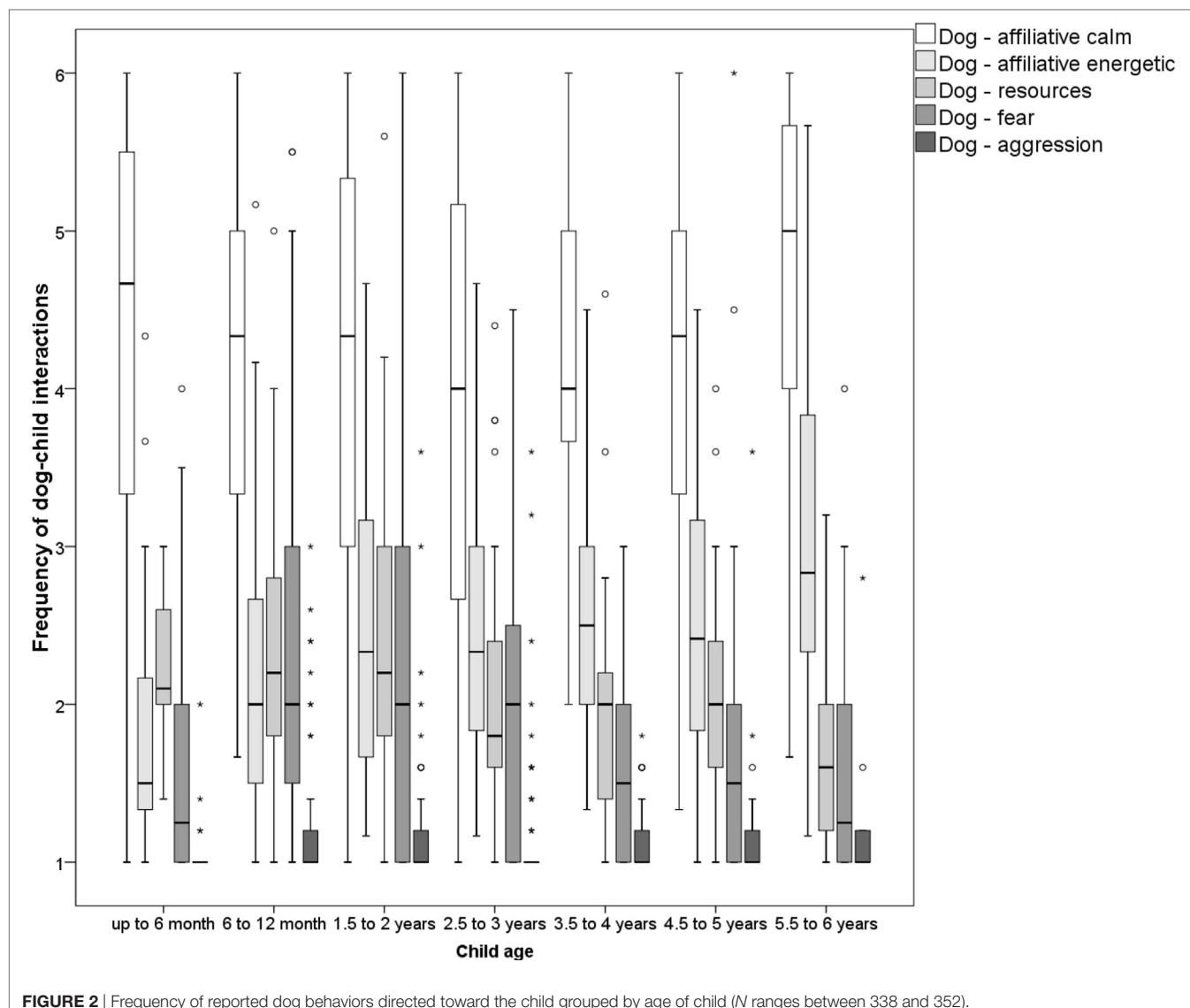


More energetic affiliative behaviors of the dog directed toward the child observed rather frequently were running toward (frequently: 48%, never: 5%) and after the child (frequently: 36%, never: 20%). Running after the child was more often observed with older children (Table 2). Potentially risky dog behaviors such as jumping up (frequently: 8%, never: 69%) or knocking the child over (frequently: 3%, never: 55%) were reported at low levels. Jumping up seemed to increase with child age whereas knocking the child over was not related to child age. Again, intense body contact initiated by the dog such as sitting or lying on the child (frequently: 3%, never: 76%) or even contact with the dogs' mouth (frequently: 10%, never: 57%) was rarely observed by our participants. Overall, energetic affiliative behaviors were more common with older children ( $\chi^2 = 37.540$ ,  $p < 0.001$ ; Figure 2).

Turning to resource-related behaviors, respondents reported on average that dogs sometimes steal food from the child (frequently: 13%, never: 43%). They are less often observed taking

child toys from near the child (environment: frequently: 7%, never: 50%) and even more rarely take them directly from the child (frequently: 2%, never: 75%). The most commonly reported behavior in this category was the dog allowing the child to take objects out of the dogs mouth (frequently: 51%, never: 14%). This behavior was more often observed with older children; and this association resulted in an overall correlation of resource-related dog–child interactions with child age ( $\chi^2 = 34.249$ ,  $p < 0.001$ ; Figure 2); interfering with the child's food or toys did not correlate with child age (Table 2).

Fear-related dog behaviors during interactions with the child were not common, but 12% of the dogs frequently withdrew from the child (never: 39%) and 2% frequently exhibited a startle reaction during a child–dog interaction (never: 64%). A small non-monotonous relationship between child age and fear-related dog behavior was found ( $\chi^2 = 23.662$ ,  $p = 0.001$ ; Figure 2). Graphical inspection showed a peak of fear-related dog behavior toward children during child age of 6 months to 3 years.



Aggressive behavior toward the child was very rarely observed. The most common behavior that may indicate aggression was barking at the child (frequently: 1%, never: 79%). Although rarely observed, growling at the child occurred more often during a frontal approach of the child (frequently: 1.1%, never: 92%) and in the context of resources (frequently: 1.9%, never: 91%). Growling when the child was passing by was the least often observed context of growling at the child (frequently: 0.5%, never: 95%). Snapping at the child was reported with similar frequencies (frequently: 0.5%, never: 92%). No relationship with child age was found (Table 2;  $\chi^2 = 8.156$ ,  $p = 0.227$ ; Figure 2).

### Injuries Resulting from Child–Dog Interaction

Of the dogs, 53 (16%) had already injured the focus child ( $N = 326$ ). All these injuries were minor and did not need medical attention according to the respondent. Most of the injuries were scratches from the dog's paws or hematomas when the dog

knocked the child over. 11 (3%) instances of biting were reported which resulted in scratches or hematomas: four of these involved disturbing the resting dog, three resulted from a resource-related interaction, two from a painful interaction, and two were reported as occurring during play with the dog as a puppy. None of the reported injuries during resource-related interactions were due to aggression: they were injuries to the child's fingers and occurred while feeding treats or playing fetch games.

### Relationships between Child and Dog Behavior

All child behavior scales were found to be positively related to the dog behavior scale energetic affiliative dog behavior (Table 3). The strongest relationship was found with benign child–dog interactions ( $r_s = 0.58$ ). The weakest relationship of energetic affiliative dog behaviors was found with aversive painful child–dog interactions ( $r_s = 0.26$ ). Calm affiliative dog behavior was also related to

**TABLE 3** | Relationships (Spearman rank correlations<sup>a</sup>) between child behaviors directed toward the dog and dog behaviors directed toward the child.

		Child—benign	Child—resting	Child—resources	Child—aversive non-painful	Child—aversive painful	Child—dog care
<b>Dog—affiliative calm</b>	<i>r</i> <sub>s</sub>	<b>0.39</b>	<b>0.26</b>	<b>0.23</b>	<b>0.26</b>	0.15	0.18
	<i>p</i>	<0.001	<0.001	<0.001	<0.001	0.006	0.001
	<i>N</i>	346	359	353	347	356	356
<b>Dog—affiliative energetic</b>	<i>r</i> <sub>s</sub>	<b>0.58</b>	<b>0.44</b>	<b>0.44</b>	<b>0.54</b>	<b>0.27</b>	<b>0.43</b>
	<i>p</i>	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	<i>N</i>	343	354	349	341	351	351
<b>Dog—resources</b>	<i>r</i> <sub>s</sub>	-0.15	0.02	-0.01	-0.17	0.11	-0.17
	<i>p</i>	0.007	0.678	0.811	0.002	0.038	0.001
	<i>N</i>	341	355	348	341	352	351
<b>Dog—fear</b>	<i>r</i> <sub>s</sub>	-0.17	-0.02	0.01	-0.08	0.13	-0.13
	<i>p</i>	0.002	0.679	0.794	0.151	0.018	0.014
	<i>N</i>	348	361	355	349	359	358
<b>Dog—aggression</b>	<i>r</i> <sub>s</sub>	0.13	<b>0.22</b>	0.18	<b>0.25</b>	<b>0.22</b>	0.17
	<i>p</i>	0.014	<0.001	0.001	<0.001	<0.001	0.001
	<i>N</i>	342	353	349	342	351	349

<sup>a</sup>Results with correlation coefficients  $\geq 0.2$  are in bold type.

most of the child behavior scales; only aversive painful interactions and dog care activities resulted in correlations smaller than 0.2. Correlations of child behavior with aggressive dog behavior toward the child resulted in three positive relationships larger than 0.2: these were the child interfering with the resting dog ( $r_s = 0.22$ ), aversive painful ( $r_s = 0.22$ ), and aversive non-painful child behaviors ( $r_s = 0.25$ ) (Table 3).

## Relationships with Attitudes to Supervision in Caregivers

All reported child behaviors toward the dog were related to the caregivers' attitudes to supervision (Table 4). Participants who reported being more attentive during supervision overall reported less frequent child–dog interactions. The strongest negative relationships with attentiveness were found for aversive non-painful interactions ( $r_s = -0.35$ ) and dog care activities ( $r_s = -0.36$ ). Respondents who reported allowing more unsafe behaviors toward the dog reported all child behaviors toward the dog to be more frequent. The strongest relationships were found with the child interfering with the resting dog ( $r_s = 0.55$ ) and with benign child–dog interactions ( $r_s = 0.47$ ). Least related to this parent supervision subscale were dog care activities ( $r_s = 0.23$ ).

The caregivers' attitudes to supervision were markedly less related to dog behavior directed toward the child than to child behavior directed toward the dog (Table 4). We found that participants who rated themselves as supervising more attentively reported lower levels of energetic affiliative dog behaviors ( $r_s = -0.27$ ), while caregivers who allowed more unsafe behaviors reported more calm ( $r_s = 0.23$ ) and energetic affiliative ( $r_s = 0.39$ ) dog behaviors toward the child.

## Child Age and Attitudes to Supervision

Attentiveness during supervision of child–dog interactions decreased with age of the child ( $r_s = -0.38$ ,  $p < 0.001$ ,  $N = 325$ ;  $\text{Chi}^2 = 47.673$ ,  $p < 0.001$ ) whereas allowing unsafe interactions

**TABLE 4** | Relationships (Spearman rank correlations<sup>a</sup>) between caregiver attitudes to supervision of child–dog interactions and child and dog interactive behaviors.

		Attentiveness	Allow unsafe behavior
<b>Child—benign</b>	<i>r</i> <sub>s</sub>	-0.30	0.47
	<i>p</i>	<0.001	<0.001
	<i>N</i>	322	318
<b>Child—resting</b>	<i>r</i> <sub>s</sub>	-0.29	0.55
	<i>p</i>	<0.001	<0.001
	<i>N</i>	335	326
<b>Child—resources</b>	<i>r</i> <sub>s</sub>	-0.31	0.43
	<i>p</i>	<0.001	<0.001
	<i>N</i>	330	324
<b>Child—aversive non-painful</b>	<i>r</i> <sub>s</sub>	-0.35	0.43
	<i>p</i>	<0.001	<0.001
	<i>N</i>	322	318
<b>Child—aversive painful</b>	<i>r</i> <sub>s</sub>	-0.21	0.35
	<i>p</i>	<0.001	<0.001
	<i>N</i>	331	325
<b>Child—dog care</b>	<i>r</i> <sub>s</sub>	-0.36	0.23
	<i>p</i>	<0.001	<0.001
	<i>N</i>	330	323
<b>Dog—affiliative calm</b>	<i>r</i> <sub>s</sub>	-0.10	0.23
	<i>p</i>	0.080	<0.001
	<i>N</i>	338	330
<b>Dog—affiliative energetic</b>	<i>r</i> <sub>s</sub>	-0.27	0.39
	<i>p</i>	<0.001	<0.001
	<i>N</i>	333	325
<b>Dog—resources</b>	<i>r</i> <sub>s</sub>	0.09	0.01
	<i>p</i>	0.106	0.850
	<i>N</i>	333	324
<b>Dog—fear</b>	<i>r</i> <sub>s</sub>	0.19	-0.17
	<i>p</i>	<0.001	0.002
	<i>N</i>	341	332
<b>Dog—aggression</b>	<i>r</i> <sub>s</sub>	0.03	0.08
	<i>p</i>	0.625	0.143
	<i>N</i>	331	323

<sup>a</sup>Results with correlation coefficients  $\geq 0.2$  are in bold type.

with the dog was not associated with child age ( $r_s = 0.09, p = 0.102, N = 318; \text{Chi}^2 = 11.475, p = 0.075$ ).

## Do Dogs That Lived in the Family Earlier Than the Children Behave Differently?

Dogs that had lived with the family before the child or the children were present were reported to display less calm affiliative ( $U = -5.238, p < 0.001, N = 365$ ; before child: mean  $\pm$  SD:  $4.0 \pm 1.3$ , with child:  $4.7 \pm 1.1$ ) and energetic affiliative behaviors ( $U = -7.171, p < 0.001, N = 358$ ; before child:  $2.2 \pm 0.8$ , with child:  $3.0 \pm 1.0$ ) and to show more fear-related behavior toward the child ( $U = -3.581, p < 0.001, N = 368$ ; before child:  $2.1 \pm 1.1$ , with child:  $1.6 \pm 0.9$ ). No differences were found for aggressive behavior ( $U = -0.216, p = 0.829, N = 356$ ; before child:  $1.2 \pm 0.5$ , with child:  $1.1 \pm 0.3$ ) and resource-related dog behavior ( $U = -1.853, p = 0.064, N = 358$ ; before child:  $2.2 \pm 0.7$ , with child:  $2.0 \pm 0.9$ ).

## DISCUSSION

This exploratory study reporting data from a self-selected sample recruited *via* facebook (e.g., Vetmeduni Vienna), newsletters (e.g., Royal Canin Austria), and a German dog magazine shows that a wide range of interactions are already observed in infants of up to 6 months; only interactions related to resources and dog care were almost never present at this age. A steep rise in the frequency of most interactions is seen in the second half of the first year of life. Specific child–family dog interactions such as hugging the dog, grooming the dog or taking objects from the dog's mouth were found to increase with the child's age in our sample of children up to 6 years. All the child's behaviors directed toward the dog were related to the caregivers' attitudes to supervision. This suggests that parental supervision quite effectively shapes the child's interactive behavior. Dog interactive behavior seems to depend, besides individual characteristics, on prior experience with children and did show some relationships with child behavior and caregiver supervision. A limitation of this exploratory study might be that respondents admitted leaving their child and dog alone for a moment (20) and this might result in underreporting of interactive behaviors occurring during their absence. In particular, behaviors that are not tolerated by the caregivers might occur more commonly when they are not looking.

Child motor development proceeds quickly and our results show that even in the youngest age group up to 6 months benign interactions are reported. Overall, benign interactions are the most commonly reported child behaviors and they already occur quite frequently in children 1.5 years old. Most of the benign behaviors are more often observed in older children, except reaching for the dog, which was reported less in older children. More than half of the participants in this survey reported allowing the child to interact with the dog as long as she or he is nice to the dog (20) which implies that they do not see benign behaviors as a risk for a bite incident. However, hugging the dog, for example, is a child behavior that is considered to cause discomfort or even fear in many dogs. In a study observing child–dog interactions, about 18% of observed instances of hugging or kissing the dog

and about 10% of petting interactions led to the dog retreating (24). Benign behaviors were the third most common type of interactions preceding a dog bite in children 6 years or younger (16) and the risk of a bite to the face was found to be three times higher when a benign interaction preceded a dog bite (17). Benign interactions preceding a bite are seldom initiated by the dog (only 16%) and when the bite incident was preceded by petting, parents were present in about four-fifth of the cases (17). As benign interactions are the most common interactions observed by our respondents, only a minority of them seem to lead to a bite incident. The outcome of a child–dog interaction depends on how the dog perceives the situation. Therefore, a key to avoiding bites during this type of interaction might be the ability to recognize the dog's emotional state. With young children, parents have to guide any interaction and it is their duty to recognize the dog's warning signals and intervene in or even prevent a benign (or other) child–dog interaction. However, it has been shown that in particular low-intensity warning signals such as yawning, nose licking, turning or walking away are frequently not recognized even by adults (21). Although experience can improve perception and recognition of fearful dog behaviors (22), in a study asking participants to categorize the emotional state of a dog in a child–dog interaction, non-dog owners actually identified fear-related dog behavior more accurately than dog owners (23). Our own study results showed that most parents trust their family dog in contexts that experts would recommend avoiding (20). Children have even more difficulties in recognizing dog facial expressions and body language (27, 28). Children from about 3 years on can be trained to interpret dog body language (21, 29, 30) but recognition of the low-intensity signals (21) long-term retention of the knowledge (29) were problematic. Therefore, it remains a priority to train parents and dog owners to recognize dog body language and to intervene in or prevent an interaction with the child if a dog signals that it feels uncomfortable.

Although low compliance with the probably best known general recommendation "Never leave the child alone with the dog" was found in this sample (20), more of the respondents seem to be aware of and want to follow the recommendation that a resting dog should not be disturbed: the child interfering with the resting dog was seldom reported by our participants. However, a similar child behavior, lying down near the resting dog (with body contact), was reported with higher frequency, although this has the same effect of disturbing the dog. This could be a result of poor attention to contextual cues of interactions. During this survey, participants were also asked to rate pictures of child–dog interactions and whether they would intervene in these interactions (20). One of them depicted a child sitting in the dog's basket with the dog. Most participants stated that they would not intervene with their family dog but would do so if the child interacted with an unfamiliar dog. Familiarity of the dog was more important to the respondents than the context of the picture, although interfering with a resting dog is a common precursor of bite incidents (16). One effort to educate parents and 3- to 6-year-old children to be attentive to the context of a child–family dog interaction and how to act is "The Blue Dog" dog bite prevention program (31–33). Being attentive to contextual cues of interactions instead of the child's intent (e.g., disturb versus lie down near resting dog)

seems to be another important aspect of guiding interactions between children and dogs.

Interactions involving objects that might be considered as resources by the dog occur at rather low levels. However, resource-related interactions were found to be the most common interactions preceding a dog bite in children younger than 6 years, so that this type of interaction involves a high risk of injury (16). Our respondents reported the lowest frequencies for the child interfering with dog food or dog food bowls, attempts to pet the feeding dog and attempts to take chew objects or dog toys from the dog. More frequently, children retrieved their own toys from the dog (median: 3) and even more frequently, respondents stated that the dog allowed children to take objects from its mouth (median: 5). The latter two behaviors were more often observed in the older children in our sample. Similarly, during observations of child–dog interactions more object-related interactions were found in children between 4 and 5 years (24). An activity that might account for this higher frequency of resource-related interactions in older children could be playing fetch games with the dog. Repetitive fetch games are considered to cause high arousal in the dog (34) and this might be a factor increasing the risk of a bite incident. Sometimes, it is recommended to play food-related games instead. However, this does not necessarily reduce the risk, as it could lead to resource-guarding aggression by the dog (35). Also, in our sample minor injuries of the child's fingers occurred during feeding treats or playing fetch games. Therefore, the only resource-related "interactions" that can safely be recommended to parents are indirect interactions. For example children can prepare food stuffed toys or cardboard boxes with treats for the dog and then watch the dog exploring the toy they prepared, safely separated by a baby gate.

In general, aversive interactions, in particular those that might cause pain, were rarely observed by our respondents. The two types, non-painful and painful interactions show different patterns of development in our study sample. The aversive non-painful interactions steadily rise and are most frequent in children from 2.5 years on. In contrast, the aversive painful interactions reported by our respondents were most frequent in children between 6 months and 2 years old and declined thereafter until the age of 6 years. This decline of aversive painful interactions might reflect the development of motor skills and/or empathy on the part of the children [for review see Ref. (36)]. Although infants in their first year of life show emotional arousal in reaction to distress of others humans (37), the cognitive appraisal of pain has been shown to increases in children aged between 3 and 9 years (38). Because young children might inflict pain inadvertently by pulling the dogs' hair, tail or ears, dog bite prevention programs such as "Dogs and Toddlers" recommend guiding the hand of the child during petting (39). In our sample, this child behavior was most prevalent from 6 months to 1 year. Also, providing dogs with resting places separated (but not isolated) from child play areas, can prevent incidents of inadvertent falls on the dog. Our data confirm that this seems particularly important in children up to 2 years. Consistent with our study, data from an observational study showed that the youngest observed age group, namely children aged between 2 and 3 years showed the highest frequency of aversive behaviors

toward dogs—comparable to the frequency of aversive behaviors toward other children (24). Additionally, Millot et al. reported that it seems that young children tend to pass aggression on to the dog. Dogs were more likely to retreat from such encounters than other children and were considered to serve as an outlet for the child's emotions (24). Although aversive painful interactions were more common in younger children, intentionally inflicting pain was most commonly reported for children between 1.5 and 5 years in our sample. At this age, children show behaviors that are harmful for animals out of "curiosity about and exploration of their natural world" (40). Ascione states that it is very unlikely that these behaviors are intended to be cruel and that they should be seen as opportunities to teach children how to treat animals kindly (40). Another factor that might contribute to these behaviors is that aversive child behaviors elicit the most reactions in the dogs (24). The dogs either reacted by retreating from the child, with appeasing behavior or with aggressive behavior. From the child's point of view any reaction of the dog might be more rewarding than a non-reaction and this might positively reinforce risky child behavior. However, aversive painful interactions were the second most common type of interactions preceding a dog bite in children up to 6 years (16). An aggressive response due to pain can be very fast and intense (41) and this may leave very little time for an intervention to protect the child. It also causes a stress response in the dog (42). Therefore, the goal should be to prevent all pain-related interactions by management and guided interactions.

In the older children of our sample, higher levels of benign and aversive non-painful interactions, and in particular, increased dog care activities were reported. Correlations of benign and aversive non-painful interactions resulted in the highest relationships with affiliative energetic dog behaviors and these dog behaviors were also observed more often with older children. These results might reflect the emergence of a more complex overall repertoire of interaction. Indeed, parents often report that children of this age group develop more complex relationships with dogs, involving more affectionate attachment and also making more demands on the dog. Correlations with single items support this view, as behaviors like speaking to the dog, hugging the dog, grooming the dog, leading it on a leash as well as behaviors such as requesting obedience or scolding the dog verbally are more often present. As the child grows older, its interest in social play grows (43) and this might lead to inclusion of the dog in role play activities of the child which were observed by our respondents more often in children from 2.5 up to 6 years. Another aspect of playing with the dog—attempting to dress it—was rare overall but observed most often in 5.5- to 6-year-old children. Dog care activities reached high levels by the time the children were 2.5 years old and the dog allowing the child to take objects from its mouth was more prevalent in the 2.5–6 years old. All these behaviors can induce emotions such as fear in dogs and many of them have the potential to inflict pain. Nevertheless we found that parental attention decreases with increasing age of the child. Taken together, in particular the older age groups of our sample might be at risk from interactions that are from the child's perspective playful, caring or "just necessary" but are potentially aversive or even painful to the dog. Parents should be prepared

for this change in child–dog interactions. Beginning from the age of about 2.5 years on, guiding play activities of the child and the dog might be even more challenging as the play becomes more complex. There does not seem to be any justification for reducing attentiveness. Activities that both child and dog enjoy but are not too arousing will be highly individual and care should be taken to provide resting times and to respect the dog's body language and needs.

Fear-related dog behaviors probably play a very important role for bite incidents with family dogs. We found that parents of children from 6 month to 3 years reported the highest levels of avoidance of the child and being startled by the child in their family dog. At this age, children start to explore their world, first crawling, then by uncoordinated walking, emitting sounds of pleasure or anger that can be quite different from adult human behavior. We found that dogs that experienced the focal child as the first child in the family and that had lived in the family before children arrived more frequently showed fear-related behaviors toward the child. These dogs had also an overall lower level of dog-initiated interactions with the child (calm and energetic affiliative dog behaviors). Study results support our finding that growing up without a child and being fearful or anxious might be a risk for dog bites, as dogs that bit children were often older than the child they bit (19) and more than two thirds of dogs that had bitten a child exhibited anxiety in other contexts such as separation from the owner or thunderstorms (16). Overall, this shows that these dogs might need more time, possibilities to withdraw and proactive supervision to cope with the arrival of the new family member and that caregivers should learn to recognize and respect the emotional state of their dog. The common assumption that, in dogs that are fearful of children, frequent (benign) interactions with the child will lead to habituation, might even be a factor leading to exacerbation of the fear (44). In fact, a fearful dog encountering the stimuli that cause the fear might even sensitize the dog, and sooner or later the growing fear and “forcing” the dog into an interaction with the child might lead to a bite incident that effectively terminates the fear-inducing interaction (45). The two most important principles of behavior modification in fearful dogs are to avoid exposing the animal to the (full intensity) fear-inducing stimuli and to use the techniques of desensitization and counterconditioning to change the emotional state of the animal (44). The consultation of a professional, e.g., a veterinary behaviorist, which always should include a risk assessment and implementation of safety measures (46), can identify the most suitable treatment options for an individual case. One treatment option might also be rehoming of the dog if risk to the child or animal welfare necessitates (44, 47). In particular, if the dog has already displayed aggressive behavior toward family members, immediate measures to assure safety of the people involved have to be taken (10, 35) and the dog owner should be aware that lifelong management may be required (44, 47, 48).

The dogs in our sample generally showed low levels of aggressive behavior toward the child. Many kinds of aggressive behavior such as growling are normal signaling behavior (25) that should be seen as valuable, easy-to-recognize warning signals that should never be punished (49). It is important to note that young children can misinterpret showing teeth as friendly dog behavior

(28). However, underlying causes of aggressive behavior such as growling should be addressed with the help of a professional (35, 50). Our study results show that a number of child behaviors could contribute to increased irritability of the dog toward the child, e.g., more frequent disturbance of the resting dog, aversive painful and aversive non-painful interactions. This underlines the need to prevent those child behaviors even if the dog seems to be very tolerant toward the child in general. Also, in our sample a frontal approach by the child was more likely to elicit growling than just passing by. This is in accordance with the recommendation that children should avoid approaching a stationary dog and instead should call the dog and leave it alone if it does not approach (17).

The respondents of our survey stated that minor injuries needing no medical attention were inflicted by about one fifth of the dogs. Scratches by the dog's paws or hematomas from being knocked over by the dog were more common than injuries caused by the dog's teeth. About 3% of the child–dog pairs were involved in bite incidents causing minor injuries. This number is similar to the total number of bites in another report (51) although our self-selected sample did not report medically attended dog bite incidents. The low total number of bite incidents (11 in total) does not allow a direct comparison of causes to other studies (16, 17, 52). Most common were incidents of aggression involving a resting dog that could easily have been prevented if the resting place of the dog had been inaccessible to the child. Interestingly the resource-related incidents were all not due to aggressive dog behavior but occurred while feeding treats or playing fetch games with the dog. Also, our respondents did not report incidents during benign child–dog interactions. Overall, these reports of minor injuries support the need for educating parents to use temporal and/or spatial separation of child and dog (e.g., during resting or at times when the dog is exited, e.g., during greeting) and to teach dogs calm behaviors around children to prevent jumping up or knocking the child over. To avoid injuries by the paws, items used for separation should have openings small enough to prevent the dog reaching through with its paws and footwear can be used to protect the child's feet from the dog's claws.

On the one hand, there is evidence that children profit regarding their development from contact with pets and in particular pet dogs (5, 52); on the other hand children interacting with dogs at this young age are at risk of being bitten and the consequences of the bite can be serious, e.g., facial scarring or post-traumatic stress disorders (11, 15, 18, 53). Obviously, there is a trade-off between limiting interactions for safety reasons and the opportunity for developmental benefits from contact with the dog. Therefore ways need to be found to enhance positive effects that at the same time minimize the risk of being bitten. Humans have an affinity to nature and animals (biophilia) (54) and the presence of a calm dog seems to signal a safe environment and was found to promote relaxation (5, 55). Therefore, measures that promote relaxation in the dog such as a safely separated but not isolated resting place, structured positive interactions, and fulfillment of other needs are likely to have relaxing effects on the child and probably the whole family.

Benign behaviors such as petting a dog, in particular if a familiar animal is involved, can activate the oxytocin system

(56). Even visual contact with the dog can lead to an increase of oxytocin in the dog's owner, facilitate affiliative behavior toward the dogs, and in turn increase oxytocin in the dog (57, 58). Oxytocin correlates with affiliative behaviors (59, 60) and was found to buffer stress responses (34, 35). Therefore, it seems reasonable that this type of interaction can be beneficial to the child. However, the positive effects will outweigh the risks only if parents are trained to recognize the dogs signaling and are able to guide interactions in such a way that the dog also enjoys the interaction, and recognize when the dog needs a rest. Caregiving behaviors also activate the oxytocin system and are generally associated with positive emotions (5, 61). Together with benign behaviors these interactions likely promote attachment to the pet (62) and pet attachment was found to be more important than ownership in terms of developmental benefits in many studies (4). "Indirect" dog care activities such as preparing food or food stuffed toys or getting an additional blanket for resting times or the dogs leash before a walk can be carried out safely while the dog is separated by a baby gate. Under the supervision of dog-competent parents, it might be possible to involve even preschool children more in dog care activities. However, possible risk factors have to be considered every time the child is involved in the activity. Examples for relevant aspects are: could it cause pain to the dog; might the dog feel threatened; are valuable resources of the dog involved; what is the dog's emotional and health state at present; how compliant is the child, etc. These same aspects have to be considered for every child–dog interaction and supervision of children in the studied age group is recommended at all times (33). Involving children in activities that can induce pain, fear, anger, or high arousal (negative and positive!) in the dog or that may startle the dog should always be avoided.

Although the current evidence does not allow definite conclusions, positive effects of young children growing up with pets and in particular with a dog have been shown for empathy and perspective taking, self-esteem, anxiety, cognition and problem solving, social competence, and positive attitudes toward pets (4). Parental guidance in pet care promoted pet attachment and positive effects on cognition in 10- to 14-year-old children (63). A similar effect with younger children would also be plausible: teaching them about dog behavior and needs and carefully guiding interactions might enhance positive effects of having a dog in the family. Parental input was found to be particularly important for retention of knowledge up to the age of 3 years (31). Presumably, the best outcome can be expected when children and dogs are supervised and guided by knowledgeable, emphatic, and responsible adults.

Parent attitudes to supervision were highly correlated with and probably shape the child's behavior toward the dog. Especially child behaviors potentially aversive for the dog were highly related to parent attitudes. As the score on the attitude subscale "allow unsafe behaviors" was not related to the child's age, we assume that allowing or not allowing unsafe behaviors might be based on general beliefs. These beliefs could be targeted by dog bite prevention programs. It seems important to teach parents that no interaction can be considered safe as everything depends on the circumstances. To be effective, dog bite prevention programs

should be widespread and caregivers should be engaged at early stages of the child–dog relationship. Fatal incidents with dogs can already occur in newborns and were most common in children of up to 4 years (13, 64). Besides involvement of caregivers in dog bite prevention, there are programs that attempt to teach children from the age of 3 years on safety with dogs (29, 31, 65) and how to read dog body language (21, 30). Evaluating behavior changes with dogs in real-life contexts and low participation in the programs seem to be some of the challenges that still have to be resolved (31, 32, 65, 66).

Recommendations on the age of the child at which it seems safe to get a dog differ: one example says that the child should be at least 4 years old (67), another that a combination of a dog younger than 1 year and a child younger than 5 years should be avoided (48) or that having a dog should be postponed until the children are of school age (18). However, it seems difficult to give a global recommendation, as everything depends on the individuals involved and their ability to handle the situation.

## CONCLUSION

Interactions between children and family dogs begin very early in a child's life and most of the behaviors are already reported at high levels in 1-year-old children. Supervision by caregivers seems to have a strong influence on the behavior of the child toward the dog. Therefore, our results underline that in the first place parents must be educated about supervision of child–dog interactions and monitoring of dog body language at a very young age of the child or ideally even before a child is born or a dog is acquired. Parents and dog owners should also learn to pay attention to contextual cues of interactions and which interactions should be totally avoided. Another important aspect is that management measures to increase safety when active supervision is not possible should be promoted. Regarding the dog, notably those that did not grow up with children might need more time to adapt to living with children and they should be carefully observed for signs of fear or stress in particular when the child begins to explore the environment on its own. The results of this exploratory study further underline the need for an early dog bite prevention approach directed toward the caregivers that is tailored to the child's age and to particular needs of individuals involved.

## ETHICS STATEMENT

The study did not include live animals, therefore the ethics committee of the University of Veterinary Medicine Vienna stated that the study did not require a vote. The study involved self-selected anonymous human respondents on aspects of living with children and dogs, therefore the ethics committee of the University of Medicine Vienna stated that the study did not require a vote. The survey included no mandatory questions and participants could quit at any time.

## AUTHOR CONTRIBUTIONS

The study was designed by CA, AB, and JT. The data collection was carried out by CA. The data were analyzed by CA. The article

was drafted by CA. It was revised and critically discussed by AB and JT. All authors approved the final version and are accountable for all aspects of the work.

## ACKNOWLEDGMENTS

We are very grateful to dog owners who participated in our study. We thank Bina Lunzer, Hildegard Jung, and Tiny De Keuster for their comments on the questionnaire. Finally, we are very grateful to Ricarda Landenberger for her contribution to this article: she did substantial work by participating in setting up the

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online-questionnaire and she was involved in descriptive analyses of parts of the data.

## FUNDING

This work was self-funded.

## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at <http://journal.frontiersin.org/article/10.3389/fvets.2017.00130/full#supplementary-material>.

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**Conflict of Interest Statement:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# Factors Associated With Bites to a Child From a Dog Living in the Same Home: A Bi-National Comparison

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## OPEN ACCESS

### Edited by:

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### Specialty section:

This article was submitted to  
Veterinary Humanities and  
Social Sciences,  
a section of the journal  
Frontiers in Veterinary Science

Received: 04 June 2017

Accepted: 20 March 2018

Published: 04 May 2018

### Citation:

Messam LLMcV, Kass PH,  
Chomel BB and Hart LA (2018)  
Factors Associated With Bites to a  
Child From a Dog Living in the Same  
Home: A Bi-National Comparison.  
*Front. Vet. Sci.* 5:66.  
doi: 10.3389/fvets.2018.00066

We conducted a veterinary clinic-based retrospective cohort study aimed at identifying child-, dog-, and home-environment factors associated with dog bites to children aged 5–15 years old living in the same home as a dog in Kingston, Jamaica (236) and San Francisco, USA (61). Secondarily, we wished to compare these factors to risk factors for dog bites to the general public. Participant information was collected via interviewer-administered questionnaire using proxy respondents. Data were analyzed using log-binomial regression to estimate relative risks and associated 95% confidence intervals (CIs) for each exposure–dog bite relationship. Exploiting the correspondence between X% confidence intervals and X% Bayesian probability intervals obtained using a uniform prior distribution, for each exposure, we calculated probabilities of the true (population) RRs  $\geq 1.25$  or  $\leq 0.8$ , for positive or negative associations, respectively. Boys and younger children were at higher risk for bites, than girls and older children, respectively. Dogs living in a home with no yard space were at an elevated risk (RR = 2.97; 95% CI: 1.06–8.33) of biting a child living in the same home, compared to dogs that had yard space. Dogs routinely allowed inside for some portion of the day (RR = 3.00; 95% CI: 0.94–9.62) and dogs routinely allowed to sleep in a family member's bedroom (RR = 2.82; 95% CI: 1.17–6.81) were also more likely to bite a child living in the home than those that were not. In San Francisco, but less so in Kingston, bites were inversely associated with the number of children in the home. While in Kingston, but not in San Francisco, smaller breeds and dogs obtained for companionship were at higher risk for biting than larger breeds and dogs obtained for protection, respectively. Overall, for most exposures, the observed associations were consistent with population RRs of practical importance (i.e., RRs  $\geq 1.25$  or  $\leq 0.8$ ). Finally, we found substantial consistency between risk factors for bites to children and previously reported risk factors for general bites.

**Keywords:** dog bite, child, home, risk factor, cohort study, anthrozoology, human–animal interaction

## INTRODUCTION

Children, particularly those younger than 10 years old, are generally considered to be at highest risk for dog bites. The immediate consequences of such events include both physical and mental trauma as well as infection by zoonotic agents (1–6). Studies have reported that children are more likely to be bitten in the face, neck, or head than adults, sometimes resulting in permanent scars and/or loss of function to sensitive areas of the body (2, 4–6). Posttraumatic stress disorder is also a potential sequel to a bite event, with some child-victims requiring psychological treatment and displaying emotional

distress for extended periods (3, 4, 7). Quite likely because of their relatively small size, children are also over-represented among persons who are hospitalized or die consequent to a dog attack (2, 4–6, 8–11). A dog bite also threatens the welfare of the offending animal, as consequences often include removal from the home due to relinquishment to a shelter (12).

Most dog bites to children seem to occur at home by the family's own dog (6, 13–15). This is not surprising given that the home is where both child and dog spend most of their day and, consequently, the most likely place where children who have dogs would interact with one. It is likely that characteristics of the home determine the types of contact occurring between child and dog, and whether these lead to a bite. Factors such as the presence or otherwise of yard space, the number of hours per day the dog is confined, leashed, or allowed into the house, and where it sleeps are all likely to affect the frequency and nature of daily child–dog contact. Additionally, other human- and canine-related home-environmental factors such as the presence of other children, other dogs, and the ages of both child and dog might contribute to the frequency and quality of daily child–dog interactions.

Given these observations, surprisingly, little research has focused on the home environment as a risk (or protective) factor for dog bite injuries, and no studies focusing on factors associated with dog bites to children in the context of the family home were found in the literature. From a prevention point of view, it is important to know to what extent home-environment characteristics are associated with family dog bites to the family child.

Previously, we reported on a retrospective cohort study comparing risk factors for general dog bites in Kingston, Jamaica, and San Francisco, USA (16–18). We now report on an investigation of a sub-cohort of 297 persons, from both cities, who resided in a household along with a child and dog. The aims of this particular analysis were threefold: first, to quantify associations between selected home-environment factors and the risk of a dog biting a child living in the same home; second, to evaluate the practical importance of these associations in the context of dog bites and third, to compare them to previously reported associations between these factors and dog bites in general (hereafter referred to as "general bites"). In maintaining the bi-national nature of the investigation, we also hoped to identify differences in risk (protective) factor—dog bite associations attributable to city of origin.

## MATERIALS AND METHODS

### Study Protocol

This study was authorized by the University of California Davis' Human Subjects Institutional Review Board and respondents provided verbal informed consent. Most aspects of the materials and methods are identical to those previously reported in detail (16–18). This report focuses on information gathered from a subset of persons (hereafter referred to as the respondents) who lived in a home with at least one child–dog pair (hereafter referred to as the participants).

Study respondents were clients interviewed in the waiting rooms of eight veterinary clinics in Kingston (KGN), Jamaica

(May 30th - August 9th 2003), and three veterinary clinics in San Francisco (SF), USA (20th October 2003 - 10th January 2004) using identical questionnaires (16). Respondents were required:

- (a) To be 18 years or older,
- (b) To have a dog present with them in the waiting room with which they lived 7 days a week, and
- (c) To be living 7 days a week in the same home as a child aged 5–15 years of age for whom they were either a parent or guardian.

Whenever more than one dog was present, their names were ranked in alphabetical order and the dog with the first-ranked name was chosen. Similarly, when more than one child aged 5–15 years of age lived in the same home as the respondent, the children's names were ranked alphabetically and the child with the first-ranked name was chosen for participation. This was done to reduce the possibility of selection bias resulting from preferential enrollment of either the dog- or child-participant based on the perceptions of the respondent. We restricted the age criterion to 5–15 years of age in order to render the child-participants' age range as narrow as possible without limiting our ability to obtain a reasonably large sample. The presence of the child in the clinic was not a requirement for participation. If a respondent was accompanied by another person, that person was allowed to contribute to answering the interviewer's questions, if the respondent wished. We chose to use proxy respondents rather than the index participants for several reasons; first, we wished to ensure that data obtained for younger children were of comparable quality to that obtained for older children. Second, study enrollment of minors (a vulnerable population) necessitates additional study participant-related safeguards that would have rendered data collection more time-consuming without any guaranteed increase in data quality. Third, in lieu of the index participant, this was the most efficient way to ensure that information was obtained from a person who could reliably report on both child and dog, as well as on the home environment. This was particularly advantageous, given that a substantial proportion of veterinary consultations occur while children are at school and unavailable.

### Outcome Determination

Dog bite categories were determined based on responses to the following questions:

- (a) During play, in the last 2 years, did the dog ever hold onto or catch a part of the child in question's body with its teeth and cause a wound?
- (b) Not during play, in the last 2 years, did the dog ever hold onto or catch a part of the child in question's body with its teeth and cause a wound?
- (c) Not during play, in the last 2 years did the dog ever hold onto or catch a part of the child in question's body with its teeth and not cause a wound?

The outcome was considered a bite if the respondent replied in the affirmative to one or more of a, b, or c, and a non-biter if the respondent replied in the negative to all three questions. When the respondent answered in the affirmative to more than one of the questions, the event that occurred earliest was chosen as the

outcome. “During play” in this context referred to the behaviour of the child; no assumptions were made regarding whether or not the dog was playing. We assumed that respondents could accurately report on whether a child was playing with the dog but felt that this was not necessarily the case for when the dog was playing. We based this view on reports suggesting that dog-owners often misread the body language of dogs (19, 20).

## Exposure Information

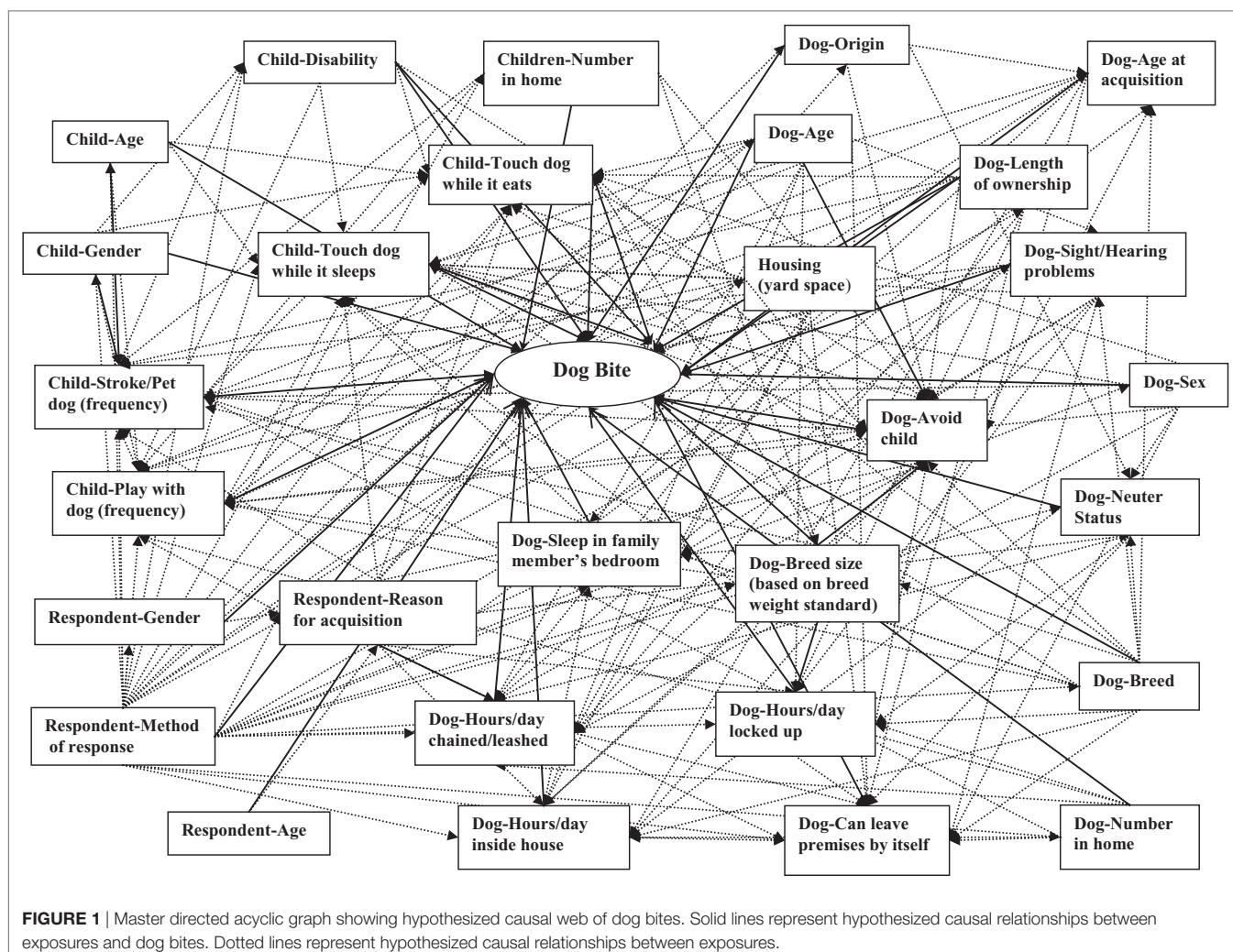
Exposure information included characteristics of the respondent (e.g., age and sex), the 5 to 15-year-old child (e.g., age, sex, presence of disabilities) living in the same household as the dog, the child–dog interactions (e.g., whether the dog routinely avoided the child, frequency of energetic play, etc.), the dog (e.g., age, sex, and neuter status), and the child–dog home environment (e.g., number of children/dogs in home, presence of yard space, dog’s habitual sleeping location).

## Analysis

Data for 297 participants were used for final analyses in SPSS version 24. This included 22 bite victims with 13 children bitten

during, and 9 bitten outside of play with the dog. In a previous report comparing bites occurring during and outside of play, we demonstrated that, from a point of view of the exposures examined, the two types of bites were not etiologically distinct (18). As the outcome and the majority of exposures used in this analysis were identical to those used in that report, bites that occurred “during play” and bites that occurred “not during play” were grouped together for analysis (hereafter referred to as “bites” or “child bites”).

First, a comprehensive directed acyclic graph (DAG) (21) was created incorporating all exposures of interest and potential confounders for which information was available (Figure 1). We then used Dagitty version 2.3 (22) to identify minimally sufficient sets of potential confounders for each exposure of interest (Table 1 and example in Figure 2). In each sufficient set, we included a variable indicating whether or not the respondent had answered alone, as this was thought to be a confounder, i.e., a determinant in identifying a dog bite and also related to the exposures under consideration (23). Log-binomial regression was then employed to estimate the relative risks (RRs) and 95% confidence intervals (CIs) for the association of each exposure



**TABLE 1** | Variables included in each hypothesized minimally sufficient set of confounders during the regression procedure analyzing risk factors for bites to a child from the family dog.

Exposures	Hypothesized sufficient set of potential confounders
<i>By characteristics of the child and child-dog interactions</i>	
Child's gender	r3
Physical or mental disability	c1, r3
Major reason for getting dog	d7, r1, r2, r3
Dog avoids child?	c1, c3, c4, c5, c6, c7, d1, d3, d4, d5, d6, d7, d8, e1, e3, e4, e6, e7, r3
<i>By characteristics of the dog</i>	
Dog's origin	r3, r4
Dog's sex and neuter status	r3
Breed	r3
<i>By characteristics of the child-dog home environment</i>	
Number of dogs in home	e3, r3
Housing	
Dog in house?	d2, d3, d4, d5, d6, d7, d8, e2, e3, e6, r3, r4
Dog sleeps in family member's bedroom?	d3, d4, d6, d7, d8, r3, r4
Dog chained?	d2, d4, d5, d6, d7, d8, e2, e3, r3, r4
Dog locked in kennel, pen, crate, or room?	d2, d4, d5, d6, d7, d8, e2, e3, r3, r4
Dog can leave premises unaccompanied?	d2, d4, d5, d6, d8, e2, e3, e4, e6, e7, r3, r4

r1-respondents age; r2-respondents gender; r3-method of response; r4-reason for dog acquisition; c1-child's gender; c3-physical/mental disability?; c4-frequency of energetic play with dog; c5-frequency of petting dog?; c6-touch dog's food while eating; c7-touch dog while asleep; d1-dog's origin; d2-dog's sex/neuter status; d3-dog's age at acquisition; d4-dog's current age; d5-length of ownership; d6-dog breed; d7-dog size; d8-dog sight/hearing problems; d9-dog sleeps in family member's bedroom; e2-number of dogs; e3-housing; e4-dog in house?; e6-dog chained?; e7-dog locked up?; e8-number of dogs in home; e9-dog avoids child?; e10-dog can leave premises unaccompanied.

of interest with dog bites (24). Using forward selection and the change-in-estimate procedure (25), for each exposure of interest, we selected potential confounders one at a time from its respective DAG-based set (**Table 1**) for inclusion in the model. For retention in a model, addition of a potential confounder had to result in a change in the RR estimates of at least 10% (26). All continuous variables were added to models as linear terms, as initial analyses using fractional polynomials (27) confirmed that this form produced the best model fit. In estimating the RR of child bites for a given exposure of interest, we excluded all individuals who had missing values for any variables in its DAG-based subset of potential confounders. This was necessary to ensure that changes in RR estimates did not result from changes in numbers of missing observations, as potential confounders were added to or deleted from the model (28). In order to test for differences in exposure-dog bite associations attributable to city of origin, an interaction term consisting of the exposure of interest and city of origin was included in each model. This was retained if the *p*-value was 0.1 or less and the differences in RR between cities were substantial. Where there was no evidence of differences attributable to city of origin, we estimated a pooled RR. In order to test the assumption that risk factors for bites occurring "during play" and bites occurring outside of play

were etiologically similar, we re-fit all final models, omitting data from participants bitten outside of play and compared the resulting RRs to those from the models based on both types of bites. The RRs from both models were similar in magnitude and direction and the limits of each 95% CI obtained from a model based on both types of bites were completely nested within the corresponding model based solely on just bites occurring "during play." We, therefore, used the models with both types of bites for inferences.

We used a magnitude-based approach to inferences as suggested by Braitman (29) and Batterham and Hopkins (30). We selected thresholds of the RR, which we felt would be of practical importance in the context of dog bites to children in the home. RRs of magnitudes consistent with a 25% or more increase in dog-bite incidence ( $RR \geq 1.25$ ) and less than 0.8 (the inverse of 1.25) were considered of practical importance. Thus, we used the following classifications:

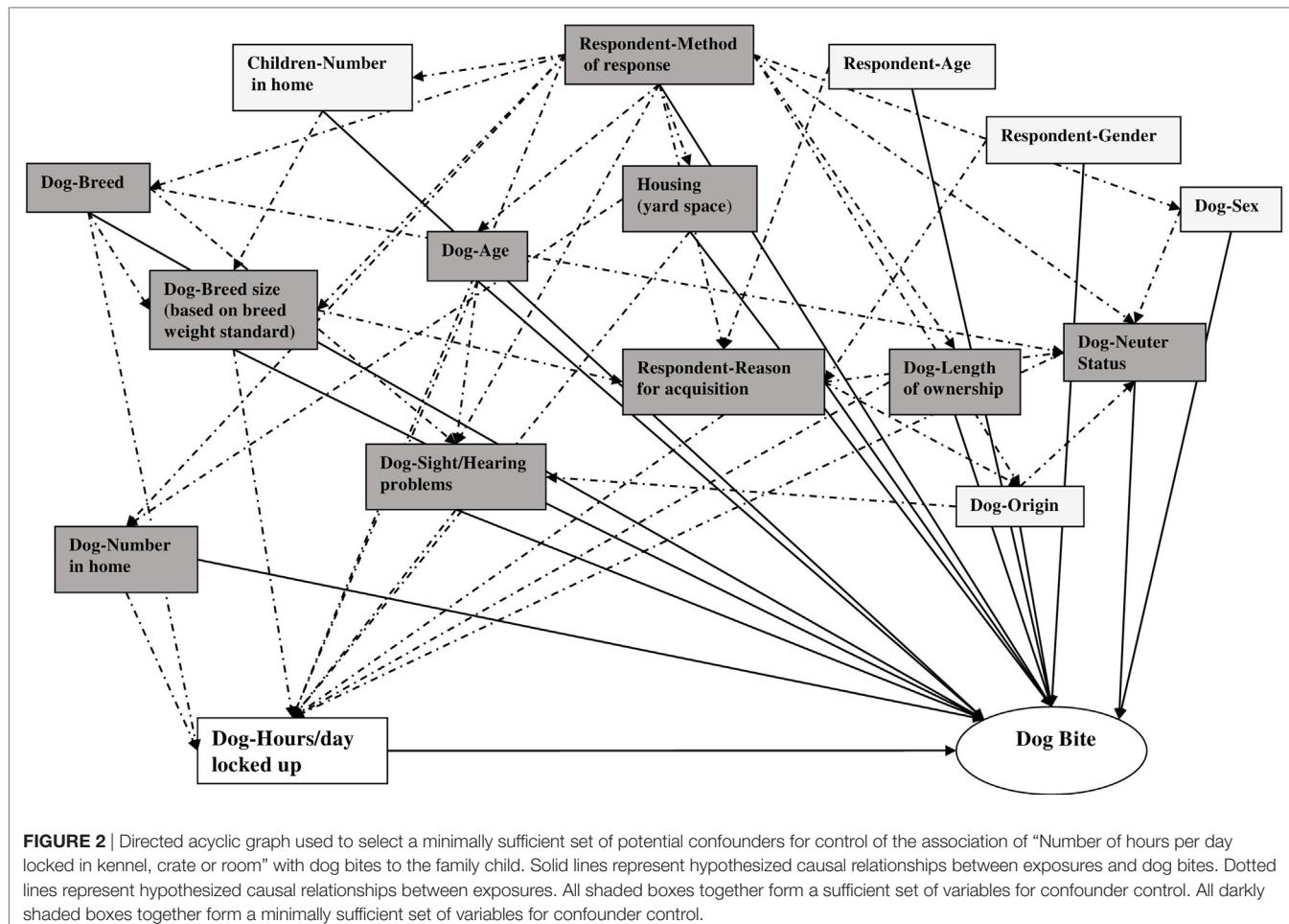
- (a)  $RR \geq 1.25$ —substantial positive association (of practical importance)
- (b)  $0.80 < RR < 1.25$ —weak association (of no practical importance)
- (c)  $RR \leq 0.80$ —substantial negative association (of practical importance)

While RRs  $\geq 1.25$  or  $\leq 0.80$  might not be considered practically important in every context, we based our categorizations on the following reasoning:

1. The victim of the bite is a vulnerable individual, a minor.
2. The injury occurs in the child's home, where the child should be safe from harm.
3. The perpetrator of the injury, the dog, is a member of the child's household.
4. The consequences of the injury negatively affect the welfare of the dog, in addition to the wellbeing of the victim.

To derive our inferences:

- (a) First, we compared the magnitude of the estimated RRs, and the location and width of each 95% CI to the RR threshold (**Figure 3**). Specifically, we qualitatively evaluated the extent to which each 95% CI contained RR values, which were or were not consistent with RRs of practical importance.
- (b) Second, we used the results of our frequentist analysis to estimate the probability (Prob) that, based on our data and vague prior information on the magnitude of the exposure-bite relationships, the population RRs were at least 1.25 [Prob( $RR \geq 1.25$ )] or no greater than 0.80 [Prob( $RR \leq 0.80$ )], for positive and negative associations, respectively. To estimate these probabilities, we used a MS Excel spreadsheet [Available at: <http://www.sportsci.org/resource/stats/xcl.xls> ("3. Rate Ratio and other Log-Normally Distributed Effect Statistics")] (31). The spreadsheet makes use of the result that for a given likelihood function a conventional X% confidence interval corresponds directly to a Bayesian X% probability interval when the Bayesian analysis is conducted using a uniform prior distribution (32–34). This direct congruence



**FIGURE 2 |** Directed acyclic graph used to select a minimally sufficient set of potential confounders for control of the association of "Number of hours per day locked in kennel, crate or room" with dog bites to the family child. Solid lines represent hypothesized causal relationships between exposures and dog bites. Dotted lines represent hypothesized causal relationships between exposures. All shaded boxes together form a sufficient set of variables for confounder control. All darkly shaded boxes together form a minimally sufficient set of variables for confounder control.

legitimizes the use of confidence intervals to generate probabilistic statements under assumptions of vague prior knowledge (32, 33, 35).

- (c) Third, for each exposure-dog bite relationship, we qualitatively described the probability of the population RR exceeding the specified value, applying a modification of the scheme (Table 2) proposed by Hopkins (36). Thus for example, if  $\text{Prob}(\text{RR} \geq 1.25) = 78\%$ , the positive association was deemed "likely of practical importance" and if  $\text{Prob}(0.80 < \text{RR} < 1.25) = 97\%$ , the association was deemed very likely of no practical importance (Table 2).

## RESULTS

### Demographic Information

Data for 236 (79%) Kingstonian and 61 San Franciscan (21%) child-dog pairs were analyzed. Over the 2-year period, the incidence of bite events was 9 and 11 per 100 dog-child pairs in KGN and SF, respectively. Demographic information for both the respondents and participants is displayed in Table 3. Slightly more than half of the respondents were females, with approximately equal distributions in both cities (KGN: 55%, SF:

57%). San Franciscan respondents were older than Kingstonian respondents (67%  $>40$  years vs. 42%  $>40$  years) and slightly fewer answered with the help of another person (34 vs. 38%, respectively). Almost all Kingstonian (97%) and San Franciscan (90%) respondents answered by themselves or jointly with another member of their household (Table 3). Among respondents reporting a bite, this percentage was 100% in both jurisdictions (Table 3). Homes in KGN tended to have more children below the age of 18 years than those in SF, with median (M) and inter-quartile ranges ( $Q_1-Q_3$ ) of  $M = 2$ ;  $Q_1-Q_3 = 1-3$  and  $M = 2$ ;  $Q_1-Q_3 = 1-2$ , respectively. Kingstonian child participants were older ( $M = 10.9$  years;  $Q_1-Q_3 = 7.9-12.8$  years) than their SF counterparts ( $M = 9.5$  years;  $Q_1-Q_3 = 7.4-13.0$  years). KGN homes also had more dogs than SF homes ( $M = 2$  dogs;  $Q_1-Q_3 = 1-4$  dogs vs.  $M = 1$  dog;  $Q_1-Q_3 = 1-2$  dogs). Compared to those in SF, dogs in KGN homes generally were acquired earlier (93 vs. 78%  $\leq 6$  months), were younger (59% vs. 37%  $\leq 6$  months), and had been owned for slightly less time (35 vs. 34%  $\leq 2$  months). Additionally, fewer Kingstonian (46%; 95% CI: 39–52%) compared to San Franciscan (70%; 95% CI: 59–82%) dogs were acquired for reasons that included companionship but not protection.

## Location and Widths of 95% CIs With Respect to the Hypothesized Population RR

RR estimates for most exposure–bite relationships were imprecise, though consistent with population RRs  $\geq 1.25$  or  $\leq 0.8$  (**Figure 3**).

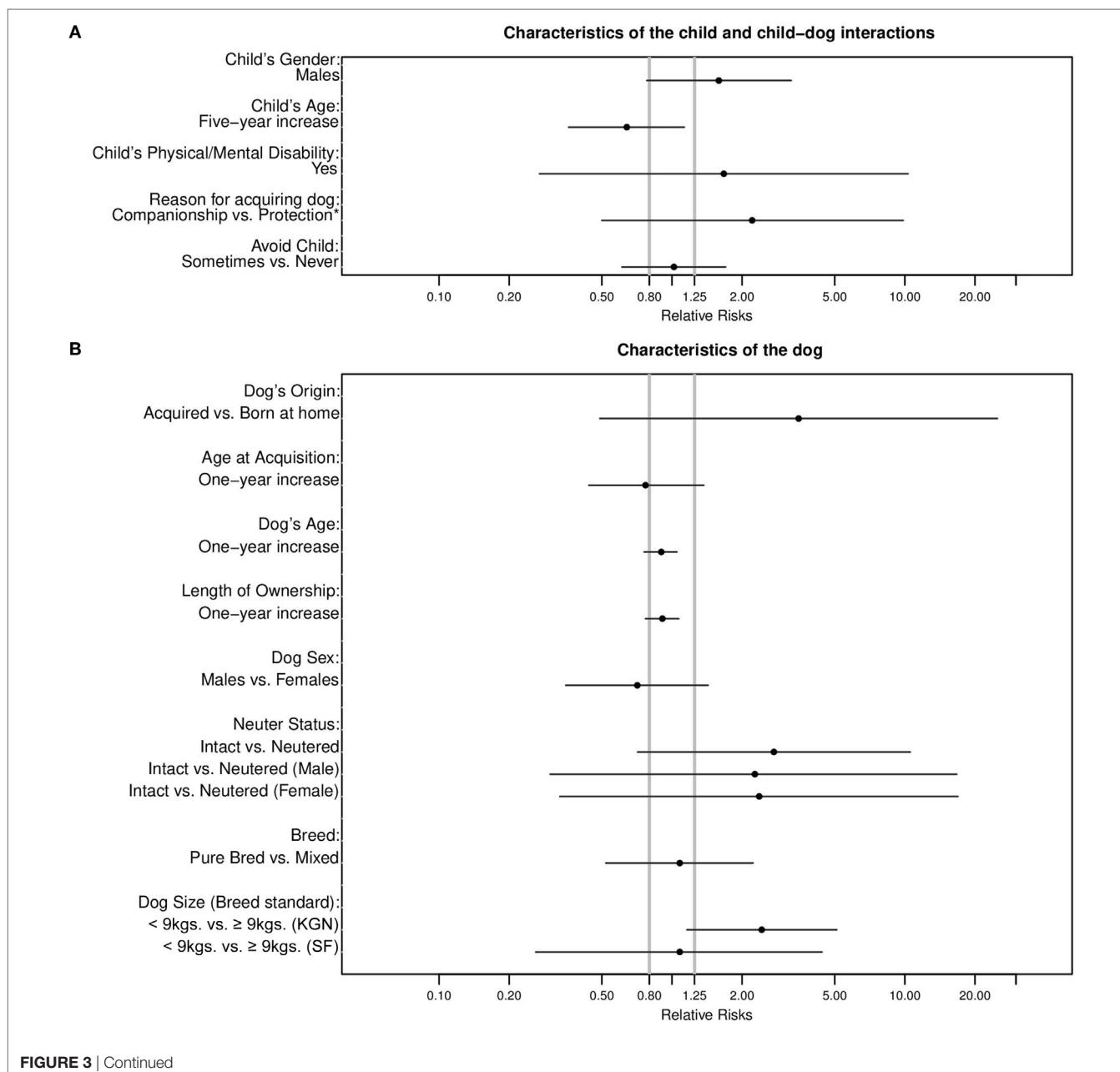
## Characteristics of the Child and Child–Dog Interactions

Males were 1.59 times more likely (95% CI: 0.78–3.25) to be bitten than females with  $\text{Prob}(\text{RR} \geq 1.25) = 75\%$  (**Figure 3A; Table 4**). The risk of being bitten was inversely related to the child's age (RR = 0.64; 95% CI: 0.36–1.13 for a 5-year increase

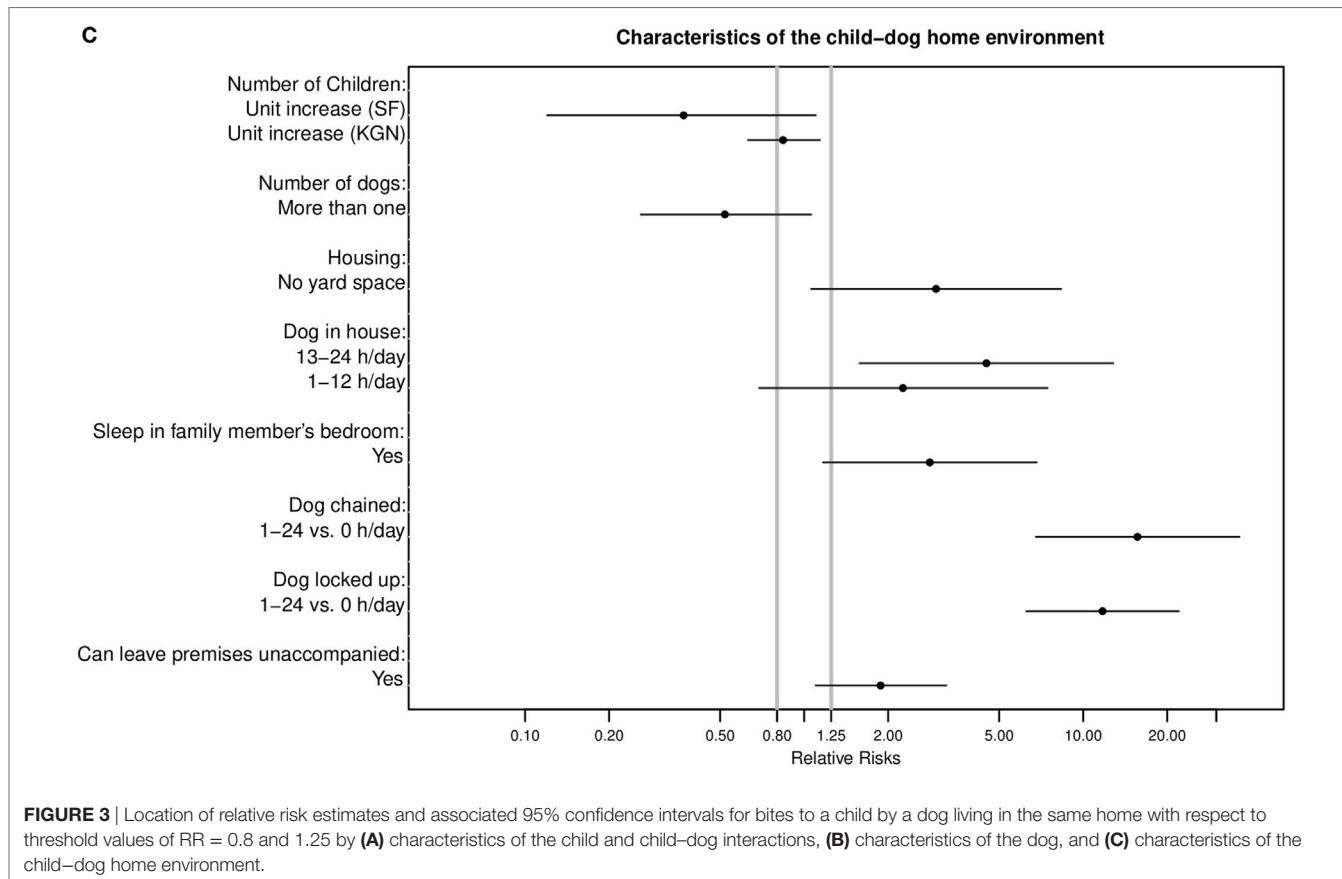
in age) with  $\text{Prob}(\text{RRs} \leq 0.8) = 78\%$ . Dogs that were obtained for companionship and other reasons excepting protection were 2.21 (95% CI: 0.50–9.84) times more likely to bite [ $\text{Prob}(\text{RR} \geq 1.25) = 77\%$ ] than dogs that were obtained for protection and other reasons excluding companionship. Dogs that sometimes avoided the child were no more likely to have bitten that child than those that never avoided the child (**Figure 3A; Table 4**).

## Characteristics of the Dog

The age of the dog at acquisition was inversely related to a child being bitten (RR = 0.77; 95% CI: 0.44–1.37—for a 1-year increase). Conversely, dogs that were acquired (as opposed to



**FIGURE 3 |** Continued



**FIGURE 3** | Location of relative risk estimates and associated 95% confidence intervals for bites to a child by a dog living in the same home with respect to threshold values of RR = 0.8 and 1.25 by (A) characteristics of the child and child–dog interactions, (B) characteristics of the dog, and (C) characteristics of the child–dog home environment.

**TABLE 2** | Qualitative interpretations of the probabilities that the population RR lies in the given ranges.

Probability (%)	Practically important $RR \geq 1.25$ or $\leq 0.8$	Not practically important $0.80 < RR < 1.25$
≤1	Almost certainly not	
>1–25	Very unlikely	
>25–50	Unlikely	
>50–75	Possibly	
>75–95	Likely	
>95	Very likely	

Adapted with modification from Hopkins, 2002 (36).

being born in their current owner's home) were at higher risk ( $RR = 3.5$ ; 95% CI: 0.49–24.98) for biting than dogs that were not (Figure 3B; Table 4). Both 1-year increases in dog age ( $RR = 0.90$ ; 95% CI: 0.76–1.05) and length of ownership ( $RR = 0.91$ ; 95% CI: 0.77–1.07) showed inverse associations with bites. Intact dogs were at overall higher risk for biting ( $RR = 2.74$ ; 95% CI: 0.71–10.55) than neutered [Figure 3B and Prob( $RR \geq 1.25$ ) = 87%]. This was also true when males ( $RR = 2.25$ ; 95% CI: 0.3–16.67) and females ( $RR = 2.37$ ; 95% CI: 0.30–16.89) were considered separately (Figure 3B; Table 4) with Prob( $RR \geq 1.25$ ) = 72 and 74%, respectively. In KGN, smaller breeds (<9 kg or 20 pounds) were at higher risk for biting ( $RR = 2.43$ ; 95% CI: 1.16–5.10) than larger breeds ( $\geq 9$  kg or 20 pounds), but not so in SF ( $RR = 1.08$ ;

95% CI: 0.26–4.41) (Figure 3B). The Prob( $RR \geq 1.25$ ) for the KGN and SF comparisons were 96 and 42%, respectively. No dog with a sight or hearing problem had bitten a child in the preceding 2 years (Table 1).

## Characteristics of the Child–Dog Home Environment

The risk of a child bite was inversely associated with the number of children in the home, though more so in SF ( $RR = 0.37$ ; 95% CI: 0.12–1.10) than in KGN ( $RR = 0.84$ ; 95% CI: 0.63–1.14) (Figure 3C). The Prob( $RR \leq 0.80$ ) and Prob( $0.80 < RR < 1.25$ ) for the SF and KGN comparisons were 91 and 62%, respectively. Similarly, bites were inversely associated with the number of dogs present in the home (Figure 3C; Table 4). Dogs that lived in a home with no yard space were at elevated risk of biting ( $RR = 2.97$ ; 95% CI: 1.06–8.33) compared to dogs that had yard space (Figure 3C). Dogs allowed inside for some portion of the day (1–24 h) were three times as likely to bite a child living in the home (95% CI: 0.94–9.62) than those that were not [Prob( $RR \geq 1.25$ ) = 93%]. Additionally, dogs that spent 13–24 h a day inside were approximately twice as likely to bite as those that spent 1–12 h per day (Table 4). Both these groups were at higher risk for biting than those that were not allowed inside (Table 4). Both chaining and confining to a kennel, pen, crate, or room for some portion of the day showed strong associations with child

bites [Prob(RR  $\geq 1.25$ )  $> 99.9\%$ ] though the 95% CIs were wide (**Table 4**; **Figure 3C**). Finally, a dog being able to leave the premises unaccompanied was positively associated with biting a child in the home (**Figure 3C; Table 4**).

## DISCUSSION

Studies of risk factors for dog bites are generally either dog- (16–18, 39–41) or victim-focused (42–44). This study differs from most others in placing equal emphasis on victim (child)- and

**TABLE 3** | Distribution of biting and non-biting dogs by exposure status and city of origin: Kingston (KGN), Jamaica, and San Francisco (SF), USA.

Exposure	Exposure categories	Bites		Non-bites	
		KGN n(%) <sup>a</sup>	SF n(%) <sup>a</sup>	KGN n(%) <sup>a</sup>	SF n(%) <sup>a</sup>
<i>By characteristics of the respondents</i>					
Respondent's age (years)	≤20	1 (4)	1 (14)	4 (2)	0 (0)
	21–30	5 (23)	0 (0)	30 (14)	5 (9)
	31–40	10 (45)	3 (43)	85 (40)	11 (21)
	41–50	4 (18)	2 (29)	61 (29)	28 (53)
	51–60	2 (9)	1 (14)	18 (8)	7 (13)
	61–70	0 (0)	0 (0)	12 (6)	1 (2)
	≥71	0 (0)	0 (0)	2 (1)	1 (2)
	<b>Total: 294</b>	<b>22</b>	<b>7</b>	<b>212</b>	<b>53</b>
Respondent's gender	Male	6 (27)	2 (29)	101 (47)	25 (46)
	Female	16 (73)	5 (71)	113 (53)	29 (54)
	<b>Total: 297</b>	<b>22</b>	<b>7</b>	<b>214</b>	<b>54</b>
Method of response	Alone	13 (59)	2 (29)	133 (62)	38 (70)
	Spouse/companion helped	2 (9)	0 (0)	18 (8)	4 (7)
	Child helped	7 (32)	5 (71)	55 (26)	9 (17)
	Other individual helped	0 (0)	0 (0)	8 (3)	3 (6)
	<b>Total: 297</b>	<b>22</b>	<b>7</b>	<b>214</b>	<b>54</b>
<i>By characteristics of the child and child–dog interactions</i>					
Child's gender	Male	14 (64)	3 (43)	103 (48)	25 (46)
	Female	8 (36)	4 (57)	110 (52)	29 (54)
	<b>Total: 296</b>	<b>22</b>	<b>7</b>	<b>213</b>	<b>54</b>
Physical or mental disability	Yes	1 (4)	0 (0)	1 (<1)	4 (8)
	No	21 (96)	7 (100)	206 (>99)	47 (92)
	<b>Total: 297</b>	<b>22</b>	<b>7</b>	<b>214</b>	<b>54</b>
<i>By characteristics of the dog</i>					
Dog's origin	Born at home	1 (4)	0 (0)	33 (15)	0 (0)
	Acquired	21 (96)	7 (100)	181 (85)	54 (100)
	<b>Total: 297</b>	<b>22</b>	<b>7</b>	<b>214</b>	<b>54</b>
Dog's sex and neuter status	Male (intact)	7 (32)	4 (57)	98 (46)	14 (26)
	Male (castrated)	1 (4)	0 (0)	5 (2)	19 (36)
	Female (intact)	14 (64)	2 (29)	105 (49)	7 (13)
	Female (spayed)	0 (0)	1 (14)	5 (2)	13 (24)
	<b>Total: 295</b>	<b>22</b>	<b>7</b>	<b>213</b>	<b>53</b>
Breed	Pure bred	5 (23)	5 (71)	61 (29)	36 (67)
	Mixed	17 (77)	2 (29)	152 (71)	18 (33)
	<b>Total: 296</b>	<b>22</b>	<b>7</b>	<b>213</b>	<b>54</b>
Dog breed size (based on breed standard) <sup>d</sup>	≥9.0 kg (20 lbs)	7 (32)	4 (57)	106 (49)	32 (59)
	<9.0 kg (20 lbs)	11 (50)	3 (43)	42 (20)	22 (41)
	Unknown	4 (18)	0 (0)	66 (31)	0 (0)
	<b>Total: 297</b>	<b>22</b>	<b>7</b>	<b>214</b>	<b>54</b>
Sight/hearing problems	Yes	0 (0)	0 (0)	6 (3)	6 (12)
	No	22 (100)	7 (100)	205 (97)	44 (88)
	<b>Total: 290</b>	<b>22</b>	<b>7</b>	<b>211</b>	<b>50</b>
Avoid child	≥50% of the time	1 (5)	0 (0)	5 (2)	3 (6)
	<50% of the time	2 (9)	2 (29)	22 (11)	9 (18)
	Never	19 (86)	5 (71)	182 (87)	38 (76)
	<b>Total: 288</b>	<b>22</b>	<b>7</b>	<b>209</b>	<b>50</b>

(Continued)

**TABLE 3 |** Continued

Exposure	Exposure categories	Bites		Non-bites	
		KGN n(%) <sup>a</sup>	SF n(%) <sup>a</sup>	KGN n(%) <sup>a</sup>	SF n(%) <sup>a</sup>
<i>By characteristics of the child–dog home environment</i>					
Number of dogs	1 dog	11 (50)	5 (71)	62 (30)	36 (68)
	>1 dog	11 (50)	2 (29)	148 (70)	17 (32)
	<b>Total: 292</b>	<b>22</b>	<b>7</b>	<b>210</b>	<b>53</b>
Housing	Yard space	21 (95)	5 (71)	211 (99)	47 (89)
	No yard space	1 (5)	2 (29)	2 (1)	6 (11)
	<b>Total: 295</b>	<b>22</b>	<b>7</b>	<b>213</b>	<b>53</b>
Dog in house (h/day)	19–24	10 (45)	7 (100)	42 (20)	29 (55)
	13–18	1 (5)	0 (0)	10 (5)	12 (23)
	7–12	0 (0)	0 (0)	12 (6)	6 (11)
	1–6	7 (32)	0 (0)	51 (24)	4 (7)
	0	4 (18)	0 (0)	99 (46)	2 (4)
	<b>Total: 296</b>	<b>22</b>	<b>7</b>	<b>214</b>	<b>53</b>
Dog sleeps in family member's bedroom?	Yes	8 (36)	6 (86)	26 (12)	27 (51)
	No	14 (64)	1 (14)	188 (88)	26 (49)
	<b>Total: 296</b>	<b>22</b>	<b>7</b>	<b>214</b>	<b>53</b>
Dog chained? (h/day)	19–24	0 (0)	0 (0)	6 (4)	0 (0)
	13–18	3 (14)	0 (0)	2 (1)	0 (0)
	7–12	0 (0)	0 (0)	12 (4)	0 (0)
	1–6	17 (77)	1 (14)	11 (3)	1 (2)
	0	2 (9)	6 (86)	183 (88)	52 (98)
	<b>Total: 296</b>	<b>22</b>	<b>7</b>	<b>214</b>	<b>53</b>
Dog locked up? (h/day)	19–24	1 (4)	1 (14)	24 (11)	0 (0)
	13–18	1 (4)	0 (0)	7 (3)	2 (4)
	7–12	3 (14)	2 (29)	30 (14)	11 (21)
	1–6	15 (68)	0 (0)	7 (3)	4 (7)
	0	2 (9)	4 (57)	146 (68)	36 (68)
	<b>Total: 296</b>	<b>22</b>	<b>7</b>	<b>214</b>	<b>53</b>
Dog can leave premises unaccompanied?	Yes	9 (41)	1 (14)	34 (16)	2 (4)
	No	13 (59)	6 (86)	178 (84)	50 (96)
	<b>Total: 293</b>	<b>22</b>	<b>7</b>	<b>212</b>	<b>52</b>

<sup>a</sup>Percentages don't add to 100 due to rounding error.<sup>b</sup>Included protection and other reasons (e.g. "love dogs," "to take care of dog," etc.) but not companionship.<sup>c</sup>Included companionship and other reasons (e.g. "love dogs," "to take care of dog," etc.) but not protection.<sup>d</sup>Based on breed standards (37, 38).**TABLE 4 |** Adjusted relative risks (RRs), 95% confidence intervals (CIs), confounders (C) causing  $\geq 10\%$  change in RRs, and probabilities that population RRs [Prob(RR)] lie in the given range, for associations between selected variables and family dog–family child bite incidents, Kingston (KGN), Jamaica, and San Francisco (SF), USA.

Exposure	Exposure categories	RR	95% CI	C	Prob(RR) (%)		
					$\leq 0.8$	$>0.8 - <1.25$	$\geq 1.25$
<i>By characteristics of the child and child–dog interactions</i>							
Child's gender	Males	1.59	0.78–3.25		3	22	75
	Females	1					
	<b>Total: 296<sup>a</sup></b>						
Physical or mental disability	Yes	1.67	0.27–10.32		22	16	62
	No	1					
	<b>Total: 296<sup>a</sup></b>						
Major reason for getting dog	Included protection (no comp.) <sup>b</sup>	0.55 <sup>d</sup>	0.12–2.57	d7	68	17	15
	Included comp.(no protection) <sup>c</sup>	1.22 <sup>d</sup>	0.54–2.78		15	37	48
	All other combinations	1					
	<b>Total: 296<sup>a</sup></b>						
Avoid child	Sometimes	1.02	0.61–1.70	d7, e7	17	61	22
	Never	1					
	<b>Total: 214<sup>a</sup></b>						

(Continued)

**TABLE 4 |** Continued

Exposure	Exposure categories	RR	95% CI	C	Prob(RR) (%)		
					≤0.8	>0.8 – <1.25	≥1.25
<i>By characteristics of the dog</i>							
Dog's origin	Acquired	3.5 <sup>d</sup>	0.49–24.98	7	8	85	
	Born at home	1					
	<b>Total: 296<sup>a</sup></b>						
Dog's sex and neuter status	Male (intact)	1.71	0.23–12.52	23	15	62	
	Male (castrated)	0.76	0.05–11.38	51	13	36	
	Female (intact)	2.37	0.33–16.89	14	12	74	
	Female (spayed)	1					
	<b>Total: 296<sup>a</sup></b>						
Breed	Pure bred	1.08	0.52–2.23	21	44	35	
	Mixed	1					
	<b>Total: 295<sup>a</sup></b>						
<i>By characteristics of the child-dog home environment</i>							
Number of dogs in home	More than one	0.52	0.26–1.06	88	11	1	
	One	1					
	<b>Total: 291<sup>a</sup></b>						
Housing	No yard space	2.97	1.06–8.33	1	4	95	
	Yard space	1					
	<b>Total: 294<sup>a</sup></b>						
Dog in house? (h/day)	13–24	4.5	1.58–12.81	d2, d7	<0.1	1	99
	1–12	2.26	0.69–7.45		4	12	84
	0	1					
	<b>Total: 272<sup>a</sup></b>						
Sleep in family member's bedroom?	Yes	2.82	1.17–6.81	d4, d7	<0.5	3	97
	No	1					
	<b>Total: 270<sup>a</sup></b>						
Dog chained? (h/day)	1–24	15.65 <sup>b</sup>	6.77–36.28	e3	0	0	>99.9
	0	1					
	<b>Total: 266<sup>a</sup></b>						
Dog locked in kennel, pen, crate, or room? (h/day)	1–24	11.73	6.26–21.99	e3	0	0	>99.9
	0	1					
	<b>Total: 266<sup>a</sup></b>						
Can leave premises Unaccompanied?	Yes	1.88	1.10–3.23	e7	0.1	6.8	93.1
	No						
	<b>Total: 264<sup>a</sup></b>		1				

<sup>a</sup>Total number of participants (297) less the number with missing data for at least one of the variables in the necessary set of confounders.

<sup>b</sup>Included protection and other reasons (e.g., "love dogs," "to take care of dog," etc.) but not companionship.

<sup>c</sup>Included companionship and other reasons (e.g., "love dogs," "to take care of dog," etc.) but not protection.

<sup>d</sup>RR heavily influenced by Kingston data.

d2, dog's sex/neuter status; d4, dog's current age; d7, dog size; e3, housing; e7, dog locked up?

dog-related factors contributing to a child bite. Additionally, as this study population is nested within the study population of a larger cohort study on dog bites, it facilitates comparisons of these results to previous findings on risk factors for general bites (16–18).

The associations with bites to children found for "lack of yard space," "increased hours spent by the dog inside," and "routinely sleeping in a family member's bedroom" are likely substantial and of practical importance [Prob(RR ≥ 1.25) ≥ 90%]. These associations are similar to those found for bites in general (Table 5). A history of sleeping in a family member's bed has also previously been found to be associated with bites to owners (41). It is probable that these effects are mediated through the frequency of child-dog interaction. If so, it seems paradoxical

that increased chaining or confinement are also positively associated with relative risks for biting the child that are very likely of practical importance [Prob(RR ≥ 1.25) > 99.9%] (Figure 3C; Table 4). One possible explanation is that while chaining and confinement might effectively restrict the interaction of dogs with non-household members, the same is not necessarily true for its interaction with a child that lives in the home. In fact, if not properly monitored, chaining and confinement may just limit the dog's ability to retreat from the child if it wishes to, and thus increase the risk of a bite incident. This could potentially explain the increased RRs compared to the general cohort (16) (Table 5). It is also possible that some dogs might be routinely chained or confined because they may have bitten the child previously. If so, this raises the possibility of temporal bias

**TABLE 5** | Adjusted relative risks (RR) and 95% confidence intervals for associations between selected variables and dog bites in general, Kingston (KGN), Jamaica, and San Francisco (SF) (Adapted from Messam et al., 2008) (16).

Exposure (sample size)	Exposure categories	RR	95% CI
<i>By characteristics of the child and child-dog interactions</i>			
Major reason for getting dog (1100)	Included protection (no comp.) <sup>a</sup>	0.82 <sup>c</sup>	0.49–1.38
	Included comp. (no protection) <sup>b</sup>	1.36 <sup>c</sup>	0.99–1.99
	All other combinations	1	
<i>By characteristics of the dog</i>			
Dog's origin (1100)	Acquired	1.41	0.8–2.44
	Born at home	1	
Dog's sex and neuter status (1026)	Male (intact)	2.56	1.51–4.34
	Male (castrated)	1.52	0.94–2.46
	Female (intact)	3.22	1.86–5.59
	Female (spayed)	1	
<i>By characteristics of the child-dog home environment</i>			
Housing (1101)	No yard space	1.16 <sup>d</sup>	0.77–1.75
	Yard space	1	
Dog in house (h/day) (1044)	19–24	1.97 <sup>c</sup>	1.17–3.32
	13–18	1.90 <sup>c</sup>	0.99–3.62
	7–12	2.18 <sup>c</sup>	1.18–4.02
	1–6	1.00 <sup>c</sup>	0.51–1.96
	0	1	
Sleep in family member's bedroom (1042)	Yes (KGN)	2.54	1.43–4.54
	Yes (SF)	1.11	0.67–1.85
	No	1	
Dog chained/leashed (h/day) (974)	1–24	1.15	0.66–1.99
	0	1	
Dog locked in kennel, pen, crate, or room (h/day) (973)	19–24	0.44	0.07–2.76
	13–18	0.93	0.35–2.46
	7–12	1.15	0.72–1.83
	1–6	1.71	1.02–2.86
	0	1	
Can leave premises unaccompanied (1042)	Yes (KGN)	1.04	0.63–1.72
	Yes (SF)	3.40	1.98–5.85
	No	1	

<sup>a</sup>Acquired for protection or for protection and other reasons excluding companionship.

<sup>b</sup>Acquired for companionship or for companionship and other reasons excluding protection.

<sup>c</sup>RR heavily influenced by KGN data.

<sup>d</sup>RR heavily influenced by SF data.

(45). Comprehensively, while we do not know whether these bites actually occurred within the context of such events (i.e., while being inside the house, sleeping in a family member's bedroom, while being chained or confined etc.), these results may indicate that these management factors are positively correlated with other factors that result in dog bites.

The finding that male children are more likely to be bitten than females is consistent with previous reports (4, 5, 44). It has been suggested that gender-based differences in the nature of human-dog interactions play an etiological role in differences in dog-bite frequency between males and females (15). If true, this is likely to be relevant in the home environment as well. These results suggest that this association is possibly

of practical importance. The observed inverse relationship between child-bite risk and child-age is likely due to a combination of increased size, increased knowledge of dogs, and less unpredictable behavior on the part of the child (4, 15). The true (population) effect of 5-year increases in child age is a likely substantial reduction in dog bite risk [Prob(RRs  $\leq$  0.8) = 78%]. Dogs obtained for reasons that included companionship but not protection are likely at substantially higher risk for biting a child [Prob(RR  $>$  1.25) = 77%] even after controlling for breed size. This is consistent with the results for general bites in the larger cohort as evident from the similarity of the corresponding RR estimates and overlap in the 95% CIs (Tables 4 and 5) (16). While these results might still be explained, in part, by residual confounding by breed, parents may also be more watchful and/or restrictive of children's interactions with a dog obtained for household protection. Data from Kingstonian participants disproportionately influenced these results as no SF dogs were obtained for reasons that included protection but not companionship (Table 3).

The inverse, though likely weak association [Prob(0.80  $<$  RR  $<$  1.25) = 93%] between dog age and bites to the family child is consistent with estimates from other studies (41, 43) but different to our findings in the larger cohort (17). It is reasonable to expect a substantial positive association between dog age and dog bites because of the relationship between age and the development of canine aggressive behavior. As we have mentioned elsewhere (17), a weak observed dog age–dog bite association could be attributable to age being used in the analysis in linear, as opposed to in polynomial form, as was used in the analysis of the larger cohort's data (17). Similar results for length of ownership (essentially the time the dog has lived in the home environment) can be explained by its high correlation (Pearson's correlation coefficient = 0.91; 95% CI: 0.84–0.98) with dog age. Higher risks for general bites observed for intact, compared to neutered dogs have been previously observed in the larger cohort (Table 5) (16) and by other authors (39, 41). This study's results suggest that the association between bites and neuter status is likely substantial and of practical importance [Prob(RR  $\geq$  1.25) = 87%]. The finding that acquired dogs were likely at substantially higher risks for bites [Prob(RR  $\geq$  1.25) = 90%] than dogs born into their current owner's home is also consistent with findings in the larger cohort (Table 5). Lower risks for dogs born into their current owner's home could plausibly result in part from the positive socializing effects of spending a longer time in the maternal environment and/or not experiencing the trauma of changing home (46). A recent review, highlighting increased risks for biting by intact compared to neutered dogs has suggested that, in addition to education, mandatory neutering of dogs might reduce dog bite frequency (47). This would preclude the realization of any beneficial effects on dog bite frequency by dogs being born into their owner's home in those jurisdictions in which it is currently practiced. Additionally, based on recent data from the United States, early neutering could have adverse effects on dog health especially for some large breeds (48, 49).

It is not clear why smaller breeds in KGN were likely at substantially higher risk for biting but not in SF or why the

association between the number of children in the home and bites was likely substantial in SF but not KGN. However, these results suggest that there may be local conditions acting to modify these relationships. Consistent with our findings in KGN, a study in Canada found that smaller dogs were more likely to bite family members than larger dogs (41). A contributing factor may be that smaller breeds in general tend to be more reactive with a higher activity level than larger breeds (37). The Canadian researchers also found that bites were positively associated with the number of teenagers in the home (41), contrary to our findings in both KGN and SF.

## Limitations

This study has a number of limitations. Small numbers of dog bite cases resulted in low precision of our estimates for most exposures. In addition, this low number of outcomes as well as the low prevalence of some exposures may have mitigated against us detecting other differences in city-specific RRs. Second, we did not have information on some potential important confounders (for example, extent of training of dogs), which might have affected some of our estimates (e.g., time spent in house, chaining, and confinement). Third, our inferences are based on an assumption that RRs  $\geq 1.25$  and RRs  $\leq 0.80$  are indicative of substantial population associations. Different thresholds for associations of practical importance could plausibly be used. Nevertheless, we believe that this approach is helpful to the investigation of dog bites. In focusing inferences on the magnitude of the parameter of interest (the RR), we encourage readers to ask and decide for themselves whether or not the observed effects are of practical importance. In addition to being data-based, the probabilistic statements made are based on assumptions of having little prior knowledge of the actual magnitude of the associations of these exposures with family dog bites to the family child. This is commensurate with information currently available on the topic.

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## CONCLUSION

Notwithstanding limitations, this study suggests that the risk of a bite to the family child by the family's dog is associated with home-environment characteristics. These include factors characteristic of the child, the dog, and the child–dog environment. The study also suggests that the relationships with dog bites, for most exposures examined, were of practical importance and are consistent with population RRs of at least 1.25 and no greater than 0.8, for positive and negative associations, respectively. Finally, these results suggest overlap between risk factors for dog bites to children at home and risk factors for dog bites to the general population.

## ETHICS STATEMENT

This study was authorized by the University of California Davis' Human Subjects Institutional Review Board and respondents provided verbal informed consent.

## AUTHOR CONTRIBUTIONS

LM conceived the study, collected and analyzed the data, and wrote the initial draft of manuscript. LM, PK, BC, and LH contributed to the design of the questionnaire, the design of the study, and reviewed successive drafts of the manuscript for intellectual content.

## ACKNOWLEDGMENTS

The authors are grateful for the assistance of staff of the following veterinary clinics in data collection: All Creatures, All Pets, Animal Care, Chang's Veterinary Clinic, the Jamaica Society for the Prevention of Cruelty to Animals, Noah's Ark, Phoenix Veterinary Clinic, Veterinary Medical (KGN), Pet's Unlimited, the San Francisco Society for the Prevention of Cruelty to Animals, the Avenues (SF). Partial support was provided by the University of California Davis Center for Companion Animal Health.

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**Conflict of Interest Statement:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# Assessing Preferences for Animals in Children with Autism: A New Use for Video-Based Preference Assessment

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## OPEN ACCESS

### Edited by:

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### Specialty section:

This article was submitted to  
Veterinary Humanities and  
Social Sciences,  
a section of the journal  
*Frontiers in Veterinary Science*

**Received:** 08 December 2016

**Accepted:** 17 February 2017

**Published:** 10 March 2017

### Citation:

Guérin NA, Rodriguez KE,  
Brodhead MT and O'Haire ME (2017)  
Assessing Preferences for Animals in  
Children with Autism: A New  
Use for Video-Based  
Preference Assessment.  
*Front. Vet. Sci.* 4:29.  
doi: 10.3389/fvets.2017.00029

The inclusion of animals into interventions for children with autism spectrum disorder (ASD) is a growing practice known as animal-assisted intervention (AAI). The choice of the animal to include in an intervention is often solely up to the interventionist and depends on their experience, subjective judgment, and ease of access to different animals. For individuals with ASD who are non-verbal and unable to indicate preferred stimuli or activities, incorporating preference into interventions has been linked to increases in positive behaviors and enhanced quality of life. We propose that animal choice based on a participant's preference may enhance the experience of AAI and maximize its outcomes. A common technique used to reliably determine preferred interactions and activities in interventions for children with ASD is a stimulus preference assessment. The video-based multiple-stimulus without replacement (MSWO) procedure, in particular, allows for discrimination of complex stimuli that could not feasibly be presented all at once, which is the case when choosing an animal. Based on the well-documented reliability of this technique in the field of applied behavior analysis, we propose that a future direction in AAI is utilizing video-based MSWO to guide animal selection.

**Keywords:** preference assessment, reinforcer assessment, animal-assisted intervention, autism spectrum disorder, applied behavior analysis

Animals are increasingly included in interventions targeting children with neurodevelopmental disorders, including autism spectrum disorder (ASD) (1). ASD is characterized by a deficit in social communication and restricted, repetitive patterns of behaviors and interests starting in the early developmental period (2). These symptoms result in social impairments, amplified emotional responses, and stress for the child and his/her family (3). The use of animals to target these difficulties, known as animal-assisted intervention (AAI), is a popular practice and is at the center of a growing body of research (4). This popularity is further evidenced by the finding that an estimated one in four children with ASD has participated in some form of AAI (5).

The umbrella term AAI comprises any intervention using animals in support of human health or well-being, including animal-assisted therapy (AAT), animal-assisted activity (AAA), and animal-assisted education [AAE (6)]. During AAT, an animal is specifically incorporated into therapy with a trained interventionist such as a social worker, counselor, or medical professional (7). In contrast, AAAs do not feature a structured intervention or a predetermined therapeutic outcome but instead occur in situations in which an animal is partnered with motivational or recreational activities (7). Finally, AAE refers to the inclusion of an animal in an educational setting. This broad definition

of AAI encompasses a number of practices with varied research methodologies, target populations, and outcomes reported in the scientific literature (4). Common types of AAI for children with ASD include animal visitations to treatment centers (8), literacy programs (9), therapeutic horseback riding (10), and the inclusion of pets in the classroom (11).

The rationale supporting the inclusion of animals in services for children with ASD is that an animal may provide a non-judgmental, soothing presence (12) that could calm or bring emotional stability to a child (13). Animals have also been reported to increase social interactions and act as a transitional object, and thus may facilitate communication between a child with ASD and his or her therapist, peers, or family (14–16). Studies have also found that the presence of an animal during therapy can decrease problem behaviors such as physical and verbal aggression (17), while increasing positive emotional expression (15, 17, 18). These findings extend to the school setting, where interacting with guinea pigs has been reported to increase social interactions (19) and reduce physiological arousal (20) in children with ASD.

A variety of animal species can be included in AAI, though domestic species are often recommended to both ensure the safety of the participants and maximize welfare for the animal. The most common species included are dogs, horses, small mammals (e.g., guinea pigs, rabbits), and domestic farm animals [e.g., dairy cows, sheep (4)]. Because of the availability of multiple species of animals, the selection of the animal to include in AAI is generally an open choice for the interventionist. Sometimes, specific therapeutic goals such as physical/motor skill development can inform the choice of the animal. For example, equine-assisted therapy is indicated to improve motor functioning, as the rocking movement of the horse's gait helps relax the lower body (21). Other times, the animal is included in an intervention for the larger aim of providing social support or facilitation, roles that can be held by a number of different animal species (22, 23). In these cases, the choice of the animal may rely on availability or simple convenience rather than based on individual need. For example, an interventionist may choose to include the animal that is the most accessible to them—typically their own pet—rather than an animal of a specific species.

The attitude of children toward animals varies from liking certain species to having a phobia of others and is significantly associated with their age, sex, ethnicity, background, and most importantly their personal experience (24). Even though children with ASD have been reported to have a lower rate of animal phobias than chronologically age-matched controls, those who do have animal phobias are more likely to show problem behaviors (25, 26). For these children, selecting the right animal can make the difference between presenting a source of enrichment or a trigger for panic.

Research on the incorporation of individual preference in populations with neurodevelopmental disorders such as ASD has grown substantially in past decades and has been shown to be an important consideration for intervention success (27). While typically functioning individuals are easily able to verbally indicate their preferences, low-functioning individuals with ASD are often unable to effectively communicate what they like and dislike due to core deficits of ASD (2). A solution to help mitigate this

deficit in communication and increase the quality of life of these individuals is the use of a preference assessment, a technique that has been shown to reliably assess preferences without the need for verbal communication [see Ref. (27) for review].

Behavioral studies have found that incorporating choice into the daily lives of individuals with severe developmental disabilities can result in an increase in appropriate positive behaviors, decreases in problem or challenging behaviors, and enhanced task engagement and participation (28–30). Further, incorporating choice into areas such as vocational and job selection have now allowed those who cannot express their preferences verbally to experience improved job performance, increased job satisfaction, and enhanced quality of life (31–33). Behavioral researchers have also demonstrated that opportunities to make choices can function as a reinforcer (34). Therefore, along with the benefit of identifying preferred stimuli, choice-making has the ancillary benefits of enriching lives of individuals with ASD.

Based on the encouraging findings of behavioral research on choice and preference, we propose that incorporating choice into AAI has the potential to improve positive outcomes and engagement while reducing problem behavior by incorporating the participant's desires and/or aversions into animal selection. By incorporating the widely used stimulus preference assessment (SPA) tool into the practice of AAI, low-functioning individuals can voice their own opinion prior to an animal interaction. Evaluating preference for an animal can increase the probability that a preferred animal is selected and individual autonomy respected. Furthermore, preference assessments may also help to rule out possible animal phobias that could increase the efficacy of AAI by avoiding discomfort and maximizing any positive outcomes to be gained. In this paper, we discuss the potential of SPAs for use in AAI, particularly to inform animal selection while offering suggestions and guidelines to both researchers and clinicians.

## OVERVIEW OF STIMULUS PREFERENCE ASSESSMENTS

Preference assessments first emerged in applied behavior analysis (ABA) research as a way to identify effective reinforcers in participants with low verbal communication. In one of the first attempts to assess preferences in non-verbal individuals, Pace et al. (35) designed a study in which items were successively presented in front of an individual. Those that were chosen or approached more often were assumed to have a higher reinforcing value for the individual than those that were either not chosen or chosen less often (35). The reinforcing value of these items could then be verified through an experimental evaluation (36). In recent literature, preference assessments are most often used to identify individualized reinforcing stimuli to offer as a reinforcer during a behavioral intervention. These assessments are methodologically rigorous and have been shown to be more reliable and effective at assessing preference and identifying reinforcers (37) than the sole reliance on parent and caregiver suggestions (38, 39), making them a potentially valuable asset to the field of AAI.

The structure and format of preference assessments have considerably varied over time (37). Early approaches used touching an item as an indicator of preference, with only one stimulus presented at a time (35). Later, a forced choice format between stimuli was found to be a more accurate predictor of subsequent reinforcing value, first with two stimuli (40), then with multiple stimuli (41, 42). The multiple stimuli method, in particular, has shown strong predictive validity for identifying verified reinforcers and is markedly more efficient than other methods (37, 43).

Whether in a single, paired, or multiple stimuli format, preference assessments have previously been limited by size and modality; that is, in order to be presented on a surface the choice items must be both small and physically available. While this is practical with toys and other tangible items such as food, this method is logically challenging when desired stimuli are either not present at the time of assessment, too large to be presented in this format (e.g., a playground), or represent a leisurely activity which cannot be represented by a single item (e.g., taking a walk outside). With the development of evaluation methods that are increasingly efficient and sensitive to practitioner needs, researchers have addressed this limitation by presenting non-tangible and non-accessible stimuli with alternative formats such as printed words, static pictures, and most recently with dynamic video formats (27).

Video technology has emerged as a particularly useful tool for interacting with individuals with severe disabilities (44, 45). As a method of stimulus presentation, videos provide more contextual information than pictures or words, and can increase the salience of the stimuli. Video-based preference assessments have been validated as a comparable measure to tangible preference assessments, with studies showing reliability of choice across those two methods (46, 47). Thus, a video-based SPA is appropriate for choices between complex stimuli such as interactions with different animals, which could specifically benefit from the inclusion of movement and sound in their presentation (47).

## POTENTIAL BENEFITS OF IMPLEMENTING VIDEO-BASED STIMULUS PREFERENCE ASSESSMENTS FOR AAI

Preliminary research suggests that animals may be incorporated into SPA. A recent study by Protopopova et al. recently used SPA with children with intellectual and developmental disabilities, rewarding the achievement of academic tasks with the access to leisure items or a dog (48). The dog was identified as a strong reinforcer, more so than the leisure items. In this study, the animal was present in the room in front of the child during the preference assessment. This finding is encouraging and suggests that SPA is a feasible technique to identify preferred animals. When the choice is between one animal and inanimate items, the animal can easily be in the intervention room. But when trying to determine preference between multiple animals, the presentation of videos may be a useful alternative to preserve animal welfare and ensure feasibility.

A key characteristic of video-based preference assessments is their ability to feature more salient characteristics of the stimuli than pictorial, static formats. The incorporation of video assessments into the field of behavior analysis interventions has allowed researchers to broaden the utility of preference assessments into areas previously unavailable to incorporate choice in daily life, such as work preference and job selection (45, 49). This advancement has allowed individualized preference to be established with stimuli that are abstract, complex, and activity-based (47). This is especially relevant to AAI because the movement, sound, and interaction elements of AAI are important to display in stimuli that cannot be displayed through pictures. For example, while a static picture of a rabbit might depict physical characteristics of the animal, a video of a human interacting with the rabbit (e.g., brushing, stroking, or holding it) can include sounds that the animal might make as well as laughs, smiles, and giggles of the participant. Thus, the *interaction* can be captured rather than the animal alone. When using pictures, an individual's repeated choice of a picture of a rabbit over a picture of a cat might be attributable to unknown characteristics of the picture's contents. However, repeated choice of a video of stroking a rabbit over stroking a cat might parse out the particular interest of the participant's desire to touch the animal rather than to simply view the animal.

Another primary advantage of using video-based preference assessments in AAI is that an individual can complete a session without needing to be directly exposed to animals. Preliminary research suggests that during preference assessments, obtaining contingent access to an activity after the choice is not necessary. For example, Clark et al. presented items via video to children with ASD in a paired-stimulus video format without providing access contingent on selection and found that even if the individual did not physically have access to the item, highly preferred stimuli did function as reinforcers (50). Brodhead et al. (38) extended the work of Clark et al. and found similar results when assessing preference for activities. Finally, Brodhead and Rispoli demonstrated that video assessments may also be used to accurately assess preference for novel stimuli (51). That is, this method may be used to assess preference for stimuli with which the individual has not yet interacted.

The above findings have important implications for feasibility because it seems unlikely that a clinician wishing to incorporate animal interactions into a therapy or intervention program would have access to a wide variety of animals at one time. Even in the case of larger therapy centers specialized in AAI, where the access to many sizes and species of animals is not a problem, presenting multiple animals at the same time may be logically difficult and detrimental to animal welfare. Thus, it is more appropriate and plausible that an animal is introduced after the individual has completed a brief assessment and a preferred animal was identified. At that point, the activity or therapeutic intervention has been appropriately designed and maximizes the efficient use of both the animals' and humans' time.

Another potential benefit for implementing a preference assessment prior to designing an AAI involves avoiding unknown or unpredictable phobias. Animals can be a common fear among children, especially among low-functioning

or non-verbal individuals. Though teachers and parents can report a known phobia, studies have shown that caregiver reports can often be unreliable (38, 39). As discomfort can be triggered by showing a participant a video of a known feared animal (52), a preference assessment is likely to identify a phobia. Doing so before a participant is presented with a live feared animal will help to avoid undue stress and anxiety in AAI participants.

## CONSIDERATIONS AND LIMITATIONS IN THE APPLICATION OF VIDEO-BASED STIMULUS PREFERENCE ASSESSMENTS FOR AAI

Although video preference assessments might have advantages for use in AAI, their implementation raises several considerations. First, picture or video-based assessments are limited by the prerequisite of the individual's ability to associate the animal seen on video with a live, tangible animal. This ability to associate an object seen on video and a tangible object is referred to as video-to-object and object-to-video correspondence. In previous research comparing two matched tangible and pictorial preference assessments, Clevenger and Graff found that only individuals who were capable of picture-to-object and object-to-picture matching skills had similar preference hierarchies (53). It is recommended that assessments using video or pictures be used only with participants who display 80% accuracy of video-to-object and object-to-video matching skills in a matching assessment test. This prescreening would limit the pool of participants for whom these assessments are applicable, and therefore may not be possible for all individuals with ASD.

Second, a limitation of the implementation of SPAs into the field of AAI and a critical area for research is the untested assumption that a highly preferred animal interaction presented in a video will translate to an effective in-person activity for the individual receiving the intervention. Although a plethora of research has investigated the predictive validity and reliability of reinforcers identified from SPAs of all modalities (37, 54), further research is needed to extrapolate conclusions drawn from previous literature to the novel use of SPAs for animal interactions.

## IMPLEMENTING AN SPA INTO THE DESIGN OF AAI

The specifics of the protocol to incorporate SPA into AAI remain to be developed and assessed for feasibility and relevance. Practical elements to determine are the design of the SPA, the medium used to present the SPA, and the content and format of the videos. A brief multiple-stimulus paradigm with several video stimuli is the gold standard in the field of ABA and would be adapted to showing videos of human-animal interactions.

The content of the video should reflect the animal with which the participant may interact, in a context representative of the actual interaction that is offered. Depending on the goal of the SPA and the choice presented, the videos could represent animals from different species (e.g., a guinea pig or a cat), or different

individual animals of the same species (e.g., two different dogs). The behaviors and the types of interactions with humans that are presented in the videos should be directed by the goals or nature of the intervention. For example, the videos could show the animals eating, being groomed, or playing with people. In addition, capturing the animals' natural noises may increase the fidelity of the video to the animals and help participants make an informed choice.

The videos should be presented in a format such that participants can easily select or point to a preferred stimulus. In the field of ABA, computers and more recently handheld tablets have been used to identify preferred stimuli. An example of an effective design could incorporate an adaptive program that simultaneously presents multiple previews of videos of animal interactions and allows the participant to select a video to play in full screen for a few seconds. When back to the main screen, the participant can choose any other video to watch next. Each time a video has been played, it disappears from the main screen. When all animals have been selected, all of the videos are available from the main screen again for a second round of viewing and eventual preference selection.

Before any large-scale implementation, researchers should test any animal preference assessment method for predictive validity. A first step would be to compare the choice identified during the SPA before and after the participant has met the animals. If the same animal is preferred both before and after the participant has had a chance to interact with all the animals presented in the SPA, it is likely that the stimuli presented were representative. This would confirm the feasibility of identifying a preferred animal from a video.

If the predictive validity of an SPA for AAI is established, the next step will be to examine the clinical relevance of identifying a preferred animal during a therapeutic intervention or AAA. We hypothesize that preferred animals will yield more positive outcomes from AAI, as participants may feel a stronger sense of bonding or affinity with animals with which they chose. This assumption could be tested by comparing the outcomes of interventions preceded by an SPA or not, and within interventions preceded by an SPA, led with an animal either identified as preferred or non-preferred. Better outcomes from the intervention with the animal identified as preferred would then be a sign that the use of SPA offers a significant enhancement to AAI.

## CONCLUSION

Stimulus preference assessments have been widely implemented in the field of ABA in order to incorporate the desires of those with communicative difficulties to interventions. With heavily validated, tested, and refined methodology, SPAs may be a useful tool for the field of AAI. However, although SPAs have been widely used and empirically researched in the field of ABA, it is important to note that this is a currently unexplored and untested strategy for AAI. While some clinician guidelines for implementing AAI do suggest to control for the potentially confounding variables of pet ownership, animal aversion, and any allergies (55), there is not a best-practice guideline in place for determining a suitable AAI for those who are non-verbal or particularly

low-functioning, such as those with severe ASD. Therefore, preference assessments may serve as a starting point for the field to become more systematic in incorporating different types of animals into research and practice.

In summary, we have proposed that integrating preference assessment methodology into AAI practices is a promising way to maximize positive outcomes for individuals who are severely disabled or experience communicative difficulty. Moreover, beyond simply assessing preference, it also may act as a way to rule out AAI as a possible treatment for an individual with ASD who is averse to animals or might not explicitly benefit from or exhibit positive emotions from an animal interaction. Further, behaviors that indicate aversion such as avoidance (56) or a lack of response (57) should be monitored during any sort of animal-focused SPA. This would serve to both avoid possible distress for the individual with ASD while both saving time and investment that would be involved during the AAI, and protecting animal welfare.

By incorporating individual preferences into AAI, clinicians will be able to better identify and avoid animals that a participant might be averse to and/or incorporate animals for which the individual might have a particular affinity. Ultimately, an ideal use

of SPAs in the field of AAI could aid in increasing the efficiency and efficacy of the interventions that include animals, possibly by even determining its feasibility before starting. Additionally, we hope that the exploration of this practice will eventually allow for a broader application of incorporating animals into improving the mental health and well-being of those with ASD, who might have been restricted from AAI in the past because of their communicative limitations. Applications include the choice of a preferred animal prior to AAI, and the choice of activities during AAI. While the use of SPAs in identifying animals for therapeutic interventions is still exploratory, we believe that there are benefits to be gained from implementing this practice and encourage AAI researchers to consider the effects of incorporating preference and aversions into their research.

## AUTHOR CONTRIBUTIONS

NG and KR are co-first authors; both wrote the body of the text and articulated the main ideas presented in this paper. MB provided extensive guidance and expertise in the area of applied behavior analysis. MO provided expertise in the area of animal-assisted intervention.

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**Conflict of Interest Statement:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# Affectionate Interactions of Cats with Children Having Autism Spectrum Disorder

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## OPEN ACCESS

**Edited by:**

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**Specialty section:**

This article was submitted  
to Veterinary Humanities  
and Social Sciences,  
a section of the journal  
*Frontiers in Veterinary Science*

**Received:** 31 May 2017

**Accepted:** 19 February 2018

**Published:** 12 March 2018

**Citation:**

Hart LA, Thigpen AP, Willits NH,  
Lyons LA, Hertz-Pannier I and  
Hart BL (2018) Affectionate  
Interactions of Cats with Children  
Having Autism Spectrum Disorder.  
*Front. Vet. Sci.* 5:39.  
doi: 10.3389/fvets.2018.00039

Mental and physical benefits of dogs have been reported for adults and children with special needs, but less is known about benefits of cats for children. A cat that can be held by a child could provide important therapeutic companionship for children with severe or less severe autism spectrum disorder (ASD) who otherwise may lack prosocial behaviors. Because relatively little is known about the behavior of cats around children, we conducted this study. Phase 1 gathered web-survey data from families having an adult cat and a child with ASD ( $n = 64$ ). In Phase 2, there were direct telephone interviews of parents having a child with severe ASD ( $n = 16$ ) or less severe ASD ( $n = 11$ ), or typical development ( $n = 17$ ). From the Phase 1 web survey of families with ASD children (full range of severities), affectionate interactions of the cats with children were common. Most parents with ASD children volunteered positive comments regarding the cat, such as calming the child, being a soothing protector or a guardian. In the interviews in Phase 2, for all three groups, most parents characterized cats as at least moderately affectionate toward the child. However, cats living with severe ASD children were reported to exhibit less affection than those living with typically developing children or children with less severe ASD. A minority of cats in each group showed some aggression to the specified child; this was not elevated with ASD children. Responses suggested that the cats adopted as kittens were more affectionate and less aggressive to all categories of children than those adopted as adults. Overall, participants reported that ASD children's behaviors indicated that they valued the relationship with the cat, similar to typically developing children, pointing to the importance and potential usefulness of selecting affectionate and compatible cats for ASD children.

**Keywords:** aggressive behavior of cats, affectionate behavior of cats, autism, autism spectrum disorder, cats and children, anthrozoology, human-animal interaction

## INTRODUCTION

Many families with children have dogs and/or cats as pets, and much has been studied in recent decades about the value of pets for the emotional and physical development of children in the typical family (1). Introducing a pet—dog, cat, or hamster—to children with autism spectrum disorder (ASD) was associated with an increase in the children's prosocial behaviors, as compared with children lacking

a pet (2). Canine companions have been particularly studied for the mental and physical benefits of dogs for children with ASD (3). The term, ASD, is inclusive and now encompasses the range of mild-to-severe autistic impairments (4).

Service dogs have particular utility in assuring the safety of the child, giving the family respite, taking the social focus off the child, adding stature to the family and assuring safety by keeping the child from bolting and running away (5). Service dogs were shown to decrease cortisol secretion upon awakening in children with ASD, and parents reported improvements in behavior of the child when having a service dog (6). Not surprisingly, the use of dogs with autistic children is an expanding role for service dogs, with the numbers of dogs placed in families with an autistic child increasing among facilities accredited with Assistance Dogs International (ADI) and also among non-accredited facilities in the U.S. (7).

Although dogs have the capacity to perform useful tasks and are more interactive with people than cats, they require more attention and care, and some parents reportedly find their ASD child is more compatible with a cat, or that a dog simply would not be a feasible companion for their child (2). In some other contexts, cats have been found to be a better lifestyle fit. For example, people with AIDS (acquired immune deficiency syndrome), who have cats are reported to enjoy their cats, find them comforting, and are spared concerns of many dog owners who are expected to fulfill their dogs' needs for exercise and being taken outdoors for elimination (8). Middle-aged women who were caregivers at home for an elderly family member with Alzheimer's disease reported that, for them, a cat was a more compatible and satisfying pet than a dog (9). Having had cats was even found in one study to be associated with fewer deaths from heart disease than having had a dog or no pets (10).

We hypothesized that a relaxed cat that can be held and/or carried about could be a therapeutic companion for a child with ASD, perhaps offering ongoing calming comfort supplementing that from a parent or other human family member, and also facilitating social behavior by the child.

The goal of this study was to obtain background information about the interactions of cats with children in small samples of families who have a cat and a child with ASD. These children presumably could benefit emotionally, and perhaps cognitively, from contact warmth and affection that might be supplied by an appropriate pet cat. A cat that "belonged" to the affected child, and was affectionate and liked to be held, could offer a positive relationship for the child and supplement the parents' affection and be emotionally beneficial, or perhaps even bridge to other social interactions for the child. Given the nature of ASD, dogs may be less appropriate for providing ongoing contact affection to some children. It could even be possible that an autistic child might be educated not only to interact appropriately but also to partially care for the cat and even verbally communicate with the cat (if demonstrated by the parents).

It is relevant to point out that cats vary a great deal in affection and aggressive behavioral predispositions toward family members. This variability is also evident when comparing purebred cats (11). Selecting a purebred that is genetically predisposed to be affectionate and comforting could play a role in the assessment

of which cats would be most likely to be best for a child with ASD. An extensive study on cat breeds revealed that the most affectionate, socially outgoing, and least aggressive, breed is the Ragdoll. While not approaching the Ragdoll in the absence of aggression, the popular domestic shorthair also was rated as very affectionate. In terms of sex, neutered males were rated as being more affectionate than females. Although genetics and gender are important, so also are the manner in which the cat is reared and managed and the ways in which humans behave toward the cat.

Expecting that a cat would be affectionate with a child may pose particular challenges, since cats were found by Mertens (12) to prefer adults to young children, in terms of approaches and duration of proximity. Cats in families preferred adult women, with whom they reportedly had their most reciprocal relationships. These findings raise a possibility that predicting the interactions of cats with children may be more challenging.

In this study, Phase 1 gathered data in a web-based survey on the nature of cat-child interactions in families with an ASD child. Most behavioral questions pertained to the extent to which the cats' characteristics were: very affectionate, or at least moderately affectionate, low in fearfulness, and relatively non-aggressive with the children. Two questions concerned the responses of the children to the cats. We then explored similar questions in Phase 2, by virtue of direct structured telephone interviews of adults in families with children who have ASD, comparing cats' interactions with children with confirmed diagnoses of severe ASD or less severe ASD as well as a sample of families with typically developing children.

## MATERIALS AND METHODS

### General Methods for the Two Studies

In addition to demographic information on family members and pets in the household, parents provided behavioral ratings for the specified cat and specified child, as well as other members of the household, on a five-point scale. The cat's affectionate interactions were categorized as: very affectionate (loved being held or carried around); affectionate (mostly liked being held or carried); moderately affectionate (liked some degree of being held or carried); relatively non-affectionate (preferred not being held or carried); and non-affectionate (did not like being held or carried). The aggressive interactions were categorized as: very aggressive (family members limited exposure to cat); quite aggressive (family members had to be on alert around cat); moderately aggressive (sometimes acted up when held too much); relatively non-aggressive (occasionally would get irritated); and non-aggressive (regardless of how interacted with).

Fearfulness, toward visitors, was categorized as: very fearful (runs away and stays hidden); fearful (runs away, eventually comes out); moderately fearful (may or may not hide depending on who is present); relatively non-fearful (greets most, but not all, visitors); and non-fearful.

Responses of the specified child toward the specified cat were categorized as: indifferent to cat; fearful of cat; sometimes likes to hold or sit with cat; moderately responsive (holds or sits with cat half of the time when the cat is around); usually likes to hold and

pet cat when around; always seems to want to hold, pet, snuggle, and sleep with cat; and other (explanation could be provided).

### Institutional Review Approval Board

Approval was obtained from the University of California, Davis, Institutional Review Board as Protocols #201018447-1 and #284059-2.

### Phase 1. Web Survey of Parents Having both a Child Who Had Been Diagnosed with ASD and a Cat

To clarify the characteristics of a cat that make it a desirable companion for a young child, we designed a 39-item web-based survey in SurveyMonkey directed toward families having an adult cat and a child diagnosed with ASD. The survey included the stated requirement that participants had to have a child within the age range of 3–12 years and a cat at least 1 year of age. We distributed the web-link and solicited participation *via* listservs and groups serving families that have children with ASD. The survey did not require details on the child's diagnosis. This survey was available for responding May 2013 through June 2014.

The UC Davis Institutional Review Board (IRB) approved a written informed consent waiver because of the anonymity of participating parents since no identifying information was requested in the survey. Participants were informed that they were participating in a research survey, and by completing the survey, they were consenting to the use of their responses in a study analysis. Participants were required to be 18 years of age or older to submit the survey.

Among the 88 respondents to this web survey, 64 met the following inclusion criteria: responding adults having at least one child aged 3–12 years diagnosed with ASD (the specified child); having in the household at least one cat 1 year of age or older (the specified cat); completing the 39 questions of the survey; and residing in North America. The sociodemographic information gathered included: gender and age of the specified child; gender, breed, age and source of the specified cat; household information on adults and other children in the household; and information on numbers of dogs and other cats in the household. Behavioral questions regarding the specified cat addressed: sleeping location, usual daily time spent with the child, and ratings of the cat on affection, aggression, and fearfulness, playfulness, and friendliness with visitors. Behavioral questions regarding the specified child addressed information on the specified cat's interactions with the child, and the child's level of interest and responses to the cat: the child being fearful of the cat; indifferent to the cat's affection; liking to sit with or hold the cat; being moderately responsive to the cat; usually loving to hold and pet the cat; or always wanting to hold, pet, snuggle, and sleep with the cat; or other (to be specified). Types of interactions for the child interacting with the cat that could be selected by respondents included multiple options: frequently talking to the cat; frequently attempting to read to the cat; frequently attempting to play with the cat; liking to feed or give treats to the cat; or none of the above. A final question invited respondents to briefly comment on their experiences with young children interacting with cats.

### Phase 2. Direct Interviews of Parents of a Child Diagnosed with Severe ASD, Less Severe ASD, or Typical Development

Drawing from a database of parents' names provided by the University of California, Davis, School of Medicine, M.I.N.D. Institute CHARGE (Childhood Autism Risks from Genetics and Environment) study (PI: IHP), we acquired 557 potential participants' names and mailing addresses. The database included families with a child diagnosed with: severe ASD; less severe ASD, often referred to as Asperger's syndrome; delayed development; typical development; and a non-specified diagnosis. These families had cats and had previously indicated a willingness to be contacted. Inclusion criteria included that the child be 5–12 years of age.

All 557 potential participants were sent a packet including a letter with instructions on how to participate in the study, consent forms, the participant's bill of rights, and an IRB-approved brief description of the study. Participants were invited to reply through the mail with the signed consent form.

We presumably reached 515 parents with a mailed invitation to participate (mailed packets not returned). Sixty-four of these potential participants replied through the mail, volunteering to participate in a telephone interview. Among those who still had a cat and could be reached by telephone, 48 phone interviews with the responsible adult were completed and met the inclusion criteria. The 48 interviews were conducted in January 2012–June 2014. The single interviewer who conducted all interviews did not know the category of diagnosis of the child when interviewing the parent.

The primary emphasis was to characterize cats' behaviors with the children and compare cats' interactions with children having ASD, less severe ASD, or typical development. The interview questions were drawn directly from the web survey, but the interviews permitted more extensive responses than the multiple choices possible in the web survey. A parent provided ratings by telephone of the cat–children interactions according to degrees of affectionate, aggressive, and fearful interactions, playfulness with the children, and the extent to which children liked holding and interacting with the cats. After the 48 phone interviews were completed and the responses were scored and the participants given unique identifiers, the diagnoses of children, among the five types listed above, were provided. The data that had been collected pertained to 16 children diagnosed with severe ASD, 11 with less severe ASD, 17 designated as being typical, and 3 with delayed development, as well as 1 child with incomplete diagnoses. Included here are data on 44 children–cat pairs, for children with severe ASD, mild ASD, or diagnosed as typically developing.

### Statistical Analyses

Data of the two studies are reported using descriptive statistics, using medians, and the results of chi-square or Fisher exact tests for significance. For the survey data from Phase 1, 12 responses were identified as reflecting the quality of interactions between the autistic child and the cat. These included: cat sleeping in the child's room; cat sleeping on the child's bed; cat being within the child's arm's reach on the bed; time cat spent with the specified

child; cat's affection toward the child; and nature of the child's reactions to the cat, including talking to the cat, reading to the cat, playing with the cat, giving food to the cat; and the cat's aggression toward the child; and cat's playfulness with the child. A principal component analysis (PCA) was run on these variables, and the first principal component explained 31% of the variability in the responses. In this analysis, three of the 64 subjects were excluded, due to incomplete values for one or more of the responses. The factor loadings for the first factor were all positive except for "aggression toward child," which was negative. The first factor was used as a dependent variable in running several one-way ANOVA models, looking for systematic differences with respect to the child's gender, the source where the cat was acquired, the cat's gender, the cat's breed (unknown, DSH, DLH, and "purebred"), and whether the cat was gonadally intact or not. The residual errors from these analyses were checked for normality using Wilk Shapiro tests, all of which indicated a close agreement with a normal distribution ( $W > 0.95$ ). The first factor was also used as the dependent variable in a regression tree analysis (CART) that used a broader array of explanatory variables. All analyses were run using SAS, version 9.4, except for the regression trees, which were run using R statistical software and the rpart command.

## RESULTS

### Phase 1. Web Survey of Parents with a Child at Least 3–12 years of Age Diagnosed with ASD

**Family Demographics and Ages of Children and Cats**  
The survey was of 64 families with an ASD child and a specified cat, so as to characterize the relationships of the child and the family with the specified cat as described by an adult family member. When families had multiple cats, the parent responded concerning a specified cat that was most interactive with the child. Most children resided in households that included several family members and animals.

Only slightly over half of the families had other children in the home. Concerning the age ranges of all children in the household (including the specified child), only 17% of households had teenagers 13–19 years of age, with higher proportions of households with children of other ages: 44% with children 10–12 years, 61% with children 6–9 years, and 38% with children 3–5 years (Table 1). The specified child with ASD was a boy 72% of the time with the median age range of 6–9 years. Most families had multi-pet households, with 38% having one or more dogs. A majority of households, 52%, had multiple cats over the age of 1 year, so, most homes offered the child a choice between at least two cats.

Of the specified cats that interacted with the specified child the most, the median age range was 4–6 years. Male neutered (42%) and female spayed (42%) accounted for most specified cats. A majority of the cats (52%) were domestic shorthair.

### The Cat's General Behavior with the ASD Child and Typical Children

Of the specified cats interacting with the ASD child, 78% were at least somewhat affectionate, with 30% rated as very affectionate (Table 2). The latter rating was described as the cat loving being

**TABLE 1 |** General descriptive information of households having a severe or less severe autism spectrum disorder (ASD) child and a specified cat, Phase 1.

		Number of respondents (%)
Living in the house	Other children present	37/64 (58%)
	Dog(s) present	24/64 (38%)
	1 cat	30/64 (47%)
	2 cats	16/64 (25%)
	3 cats	14/64 (22%)
	4 cats	3/64 (5%)
Specified cat	More than 4 cats	1/64 (2%)
	1–3 years old	31/64 (48%)
	4–6 years old	14/64 (22%)
	7–10 years old	13/64 (20%)
	Over 10 years old	6/64 (9%)
	Generic shorthair	33/64 (52%)
	Generic longhair	8/64 (13%)
	Purebred	13/64 (20%)
	Sleeps outdoors	1/64 (2%)
	Sleeps indoors	63/64 (98%)

**TABLE 2 |** Behaviors of cats with severe or less severe autism spectrum disorder (ASD) children in Phase 1, and ASD children's behaviors with cats.

		Number of respondents (%)
Affection of cat (decreasing degrees are inclusive)	Very affectionate	19/64 (30%)
	At least mostly affectionate	31/64 (48%)
	At least moderately affectionate	50/64 (78%)
Child's interaction with cat	Child at least usually wants to hold, pet, snuggle, and sleep with cat	35/64 (55%)
	Child always wants to hold, pet, snuggle, and sleep with cat	22/64 (34%)
	Child frequently talks or reads with cat	41/64 (64%)

held and carried around by the child. In contrast, among all cats, 22% were very affectionate to adults, 5% toward children ages 10–12 years, 9% toward children ages 6–9 years, and 9% toward children ages 3–5 years.

Of the 19 specified cats that were very affectionate toward the specified child, not all were affectionate toward adults, as indicated by only eight of these cats (42%) being very affectionate toward adults ( $p < 0.05$ ). The same was true for other children in the family ( $p < 0.05$ ). Thus, these very affectionate cats were more affectionate to the specified child than to adults or other children in the family. Among the 19 cats that were very affectionate to the specified child, five (26%) were over 6 years of age; 31% of the remaining less affectionate cats were over 6 years of age (ns).

In addition, all specified cats were relatively low in aggression, with 47% never being aggressive to the specified child. And 47% of cats also were never aggressive to adults, but only 25% of specified cats were never aggressive to another child in the household. Mirroring the affection results, this leads to the assumption that these cats were more likely to be attached, affectionate, and non-aggressive to the ASD child and often preferred the specified child rather than adults or other children in the household.

### Cat's Behavior Affecting the Child–Cat Relationship

Most of the ASD children (55%) always or usually wanted to hold, pet, snuggle, or sleep with the cat (Table 2). However, the median

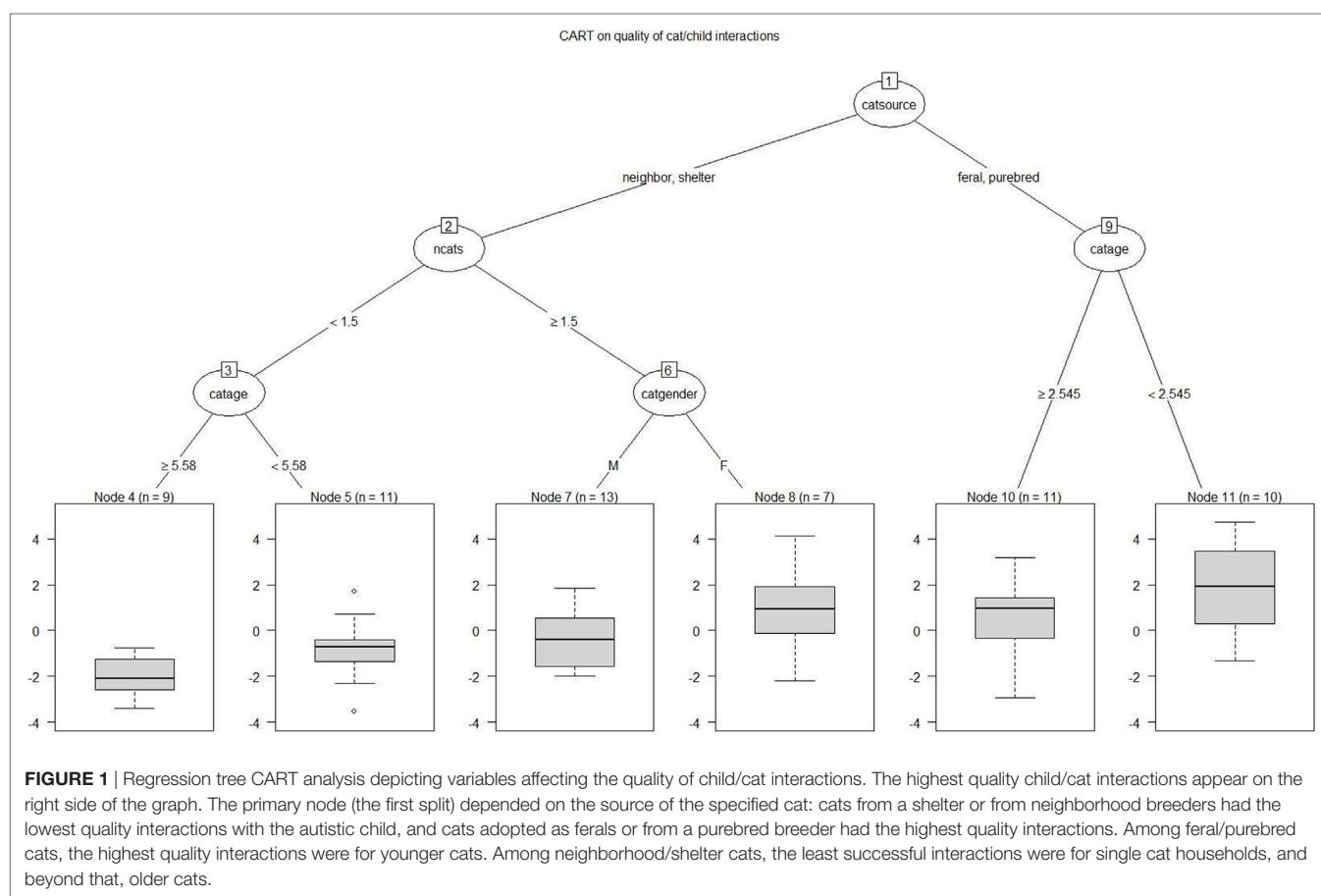
range of time these children were reported to actually spend per day with the cat was just 1–2 h. Only 25% of these cats slept in the child's bedroom. Despite the child's strong interest in the cat, most of the hours of the day most cats spent much of their time apart from the specified child.

As described in the Statistical Methods, a PCA was run on all responses that pertained to the quality or depth of the relationship between the autistic child and the specified cat. The child's gender and the cat's gender, intact status, and breed first were found to be insignificant factors. The first principal component summarized this information, with positive factor loadings for all positive cat/child interactions, except for "aggression toward child," which had a negative factor loading. Thus, high values of the first principal component indicated a positive/deep relationship, and low values indicated a poor/shallow relationship.

A regression tree was run on the value of the first principal component, using a series of demographic variables as potential predictors. The goal of this analysis is to define predictors and threshold values that distinguish between low and high values of the response. The results of this analysis are presented in **Figure 1**, where the nodes with the highest quality child/cat interactions appear on the right of the graph, while the nodes with lowest quality interactions appear on the left. The primary node (the first split) depended on the source of the specified cat, with cats from a shelter or from neighborhood breeders having the lowest quality interactions with the autistic child, and cats adopted as ferals ( $n = 19$ ) or from a purebred breeder

( $n = 2$ ) having the highest quality interactions. Among the feral/purebred cats, the highest quality interactions were for younger cats (less than 2.5 years of age). While data were not gathered on the cat's age at adoption, among the 64 respondents, 9 of the feral cat adopters and only one of the neighborhood adopters volunteered that they had adopted the cat as a kitten; none of the shelter adopters mentioned acquiring a kitten, nor did the two purebred adopters where adopting a kitten would be likely. Beyond that, within the neighborhood/shelter group, the least successful interactions were for single cat households, and beyond that, older cats (age 5.58 or greater). Among multiple cat households in the neighborhood/shelter group, female cats had somewhat better quality relationships (not significant) with the specified child than male cats.

Of the 64 respondents, 52 parents volunteered comments regarding interaction of the cat and the child: 40 comments were positive, three neutral, and nine negative. Comments volunteered from 19 parents characterized behavior of the cat in being a calming, loving, soothing protector, bonded friend, or guardian for the child. The child's feelings for the cat often were described as: loving, enamored, or bonded. Mood regulation of the child was mentioned as an effect of the cat. Less-positive descriptions pertaining to behavior of the child or cat included: "My son does not interact at all with cats or dogs; he just ignores them"; "In the past, when the child was young, the cat did not like the hyper behavior of the child and would avoid most interaction, but as the child has gotten older, the cat will seek out the child."



Parents described the special role of the cat for the child with the following sample of quotations: "When the specified child is upset, the cat will sit by or in the lap of the specified child." "The only time we get to hear our autistic child spontaneously speak is when he is interacting with this cat." "He is non-verbal and doesn't sign for much, but he does sign for his kitty numerous times each day!" "My son just likes to look at the cats and talk to them." "He will sit and read to the cats although you can't understand what he is saying." "The specified cat helped my child say new words."

One quotation regarding an autistic child attached to two cats was quite noteworthy: "Our Tonkinese are amazing with my autistic daughter. They understand her moods and needs. They respond to her so incredibly. When she does not bond with humans' touch, she does with her cats. They bring her back to me."

**TABLE 3** | General descriptive information of households with a child and a specified cat, based on child's diagnosis, Phase 2.

		Number of respondents (%)		
		Autism spectrum disorder (ASD)	Less severe ASD	Typical
Living in the house	Other children present <sup>a</sup>	5/16 (38%)	7/11 (64%)	16/17 (94%)
	Dog(s) present	14/16 (88%)	10/11 (91%)	17/17 (100%)
	1 cat	9/16 (56%)	6/11 (55%)	9/17 (53%)
	2 cats	5/16 (31%)	4/11 (36%)	7/17 (41%)
	3 cats	2/16 (13%)	0	0
	4 cats	0	1/11 (9%)	0
	More than 4 cats	0	0	1/17 (6%)
Specified cat	1–3 years old	1/16 (6%)	4/11 (36%)	5/17 (29%)
	4–6 years old	5/16 (31%)	1/11 (9%)	1/17 (6%)
	7–10 years old	5/16 (31%)	2/11 (18%)	3/17 (18%)
	Over 10 years old	4/16 (25%)	4/11 (36%)	6/17 (35%)
	Generic shorthair	9/16 (56%)	6/11 (55%)	11/17 (65%)
	Generic longhair	2/16 (13%)	1/11 (9%)	1/17 (6%)
	Purebred	2/16 (13%)	4/11 (36%)	3/17 (18%)
	Sleeps outdoors	2/16 (13%)	1/11 (9%)	3/17 (18%)
	Sleeps indoors	11/16 (69%)	10/11 (91%)	11/17 (65%)

<sup>a</sup>Fisher test: \* $p < 0.0004$ .

They are the bridge I need so that I can enjoy my daughter more. When she has them on her lap, I can hold her hand. They serve as a buffer, a calming energy. They know their role. They cry to be let in her room. They choose her lap over mine when hers becomes available. They are truly amazing!"

## Phase 2. Interview Results

### Family Demographics, Children's Diagnoses, and Cats' Descriptions

These parents were contacted after some time had passed since they had initially enrolled with the University of California, Davis, Mind Institute. Interviews meeting the inclusion criteria included: 44 respondents with cats, whose children had diagnoses of severe ASD ( $n = 16$ ), less severe ASD ( $n = 11$ ), or typical development ( $n = 17$ ). The specific cats in each group were: for ASD children, 5 neutered males and 11 spayed females, including 11 domestic shorthair or longhair cats and 5 other breeds; for less severe ASD children, 7 neutered males and 4 spayed females, including 7 domestic shorthair or longhair cats and 4 other breeds; and for typical children, 9 neutered males and 8 spayed females, including 12 shorthair or longhair cats and 5 other breeds.

All of these households had at least two adults except two typically developing child's and one less severe ASD child's households. Most families had multiple children, excepting one family in the typical group, four families in the less severe ASD groups, and five families in the ASD group. Families in the typical group were significantly more likely to have additional children in the home, as compared with ASD or less severe ASD groups (Table 3). All families of typical children and 91% of families of less severe ASD children had dogs. Most families (87.5%) of ASD children also had dogs and half of these had more than one dog. About half of the families had more than one cat; typical, 48%; mild ASD, 45%; and ASD, 44%.

### The Cat's General Behavior with the Child

Results of interviews are shown in Table 4, rating the cat-child interactions on the scales for the cat's aggression, affection, and playfulness, as well as the child liking to hold the cat. A minority of cats showed some aggression with the specified child: 19, 27,

**TABLE 4** | Behaviors of cats with children in Phase 2 diagnosed as autism spectrum disorder (ASD), less severe ASD, or developing typically, and children's behaviors with cats.

		Number of respondents (%)		
		ASD	Less severe ASD	Typical
Affection of cat (decreasing degrees are inclusive)	Very affectionate*	3/16 (19%)	7/11 (64%)	9/17 (53%)
	At least quite affectionate	6/16 (38%)	8/11 (73%)	12/17 (71%)
	At least moderately affectionate	11/16 (69%)	9/11 (82%)	16/17 (94%)
Playfulness of cat	At least moderately playful**	6/16 (38%)	8/11 (73%)	12/17 (71%)
Aggressiveness of cat	Any aggression toward specified child	3/16 (19%)	3/11 (27%)	6/17 (35%)
	Any aggression toward specified child, adults, other children, and/or other cats	10/16 (63%)	4/11 (36%)	11/17 (65%)
Fearfulness of cat	Very fearful toward visiting children and/or adults	7/16 (44%)	3/11 (27%)	3/17 (18%)
Child's interaction with cat	Child at least usually wants to hold, pet, snuggle, and sleep with cat	11/16 (69%)	6/11 (55%)	10/17 (59%)
	Child always wants to hold, pet, snuggle, and sleep with cat	4/16 (25%)	4/11 (36%)	6/17 (35%)
	Child frequently talks or reads with cat***	8/16 (50%)	10/11 (91%)	15/17 (88%)

Fisher tests: \* $p < 0.040$ ; \*\*trend  $p < 0.093$ ; \*\*\* $p < 0.019$ .

and 35% for cats of ASD, less severe ASD, and typical children, respectively. Among all cats, 71% of males and 74% of females were scored as never aggressive with the specified child. Overall, the highest aggression scores of cats with the specified child were for two female cats of typical children (“aggressive enough that we have to be alert”), and one female cat of an ASD child and another female cat of a typical child scoring as “moderately non-aggressive.” **Figures 2A,B** for male and female cats shows the level of aggression of each cat plotted by the cat’s age and group, showing that aggression to ASD children was no worse than with less severe ASD or typical children. Nonetheless, as shown in **Table 4**, when also comparing the aggressive behaviors for cats of severe ASD children with adults and all children or cats in the same household (63%), the specified cats’ levels of aggression were significantly heightened above that shown only to the specified child (19%):  $p < 0.012$ .

A majority of cats in all groups were at least moderately affectionate with the children. Specified cats were significantly

less likely to be very affectionate with severe ASD children when compared with the specified cats for the less severe ASD or typically developing children ( $p < 0.040$ ). However, the likelihood of the cat being quite affectionate or moderately affectionate with the child did not differ among groups.

Ratings of each cat’s level of affection to the specific child, adults, and other children in the family were compared. With the 17 typically developing children, one cat was more affectionate to adults, and two more affectionate to the specified child; among the 16 of these children who had siblings, two cats were more affectionate to the specified child than other children in the family. Among the 11 less severe ASD children, three cats were more affectionate with adults and two with the specified child. Among 16 ASD children, five cats were more affectionate with adults than the specified child and one cat was more affectionate with the child than adults.

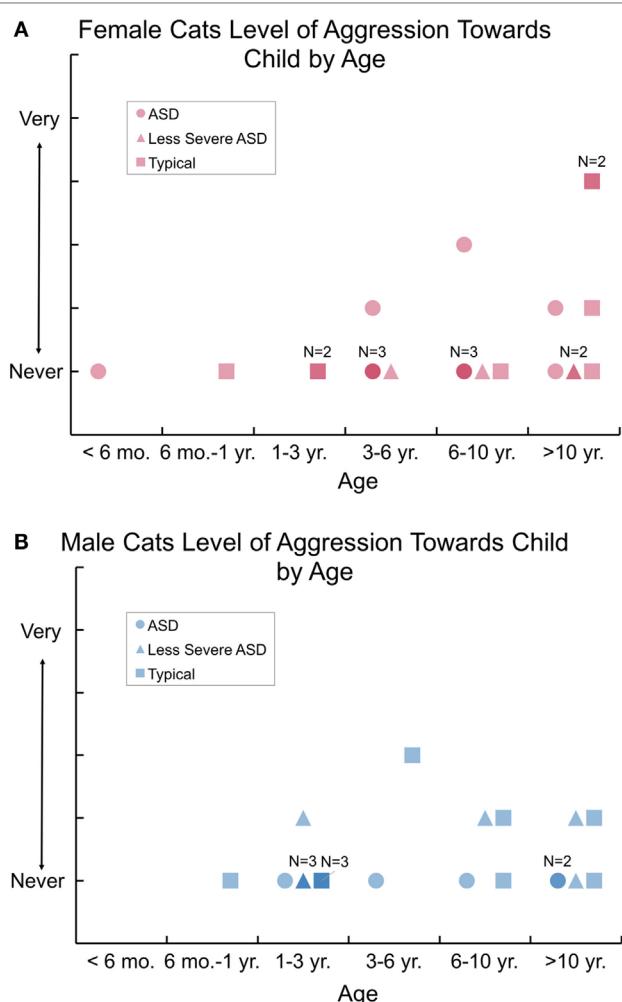
### Specified Child’s Reaction to the Specified Cat

Autism spectrum disorder children generally liked holding the family cat (some always wanted to hold, pet, snuggle, and sleep with cat). ASD, less severe ASD, and typical children all liked to hold the cat in about the same proportions (55–69%). The median time range per day the child spent with the cat each day was 30–59 min for typical and ASD children, and 1–2 h for the less severe ASD children.

While there was a range in reports of relationships with the specified cat and autistic children, for a majority of respondents, there was a very favorable relationship between the cat and ASD child, as well as with cats and less severe ASD and typically developing children. Among parents of typically developing children, 9 offered very positive comments. “Cat and child love each other.” “Child likes to talk to our baby about the cat and bring the cat over to the infant to say hi.” “Child loves to carry the cat around.” “Child loves the cat.” “Cat tries to guard the family.” “Fun to watch the children loving to interact with the cat.” Two parents had no comment. Another described the cat and child ignoring each other, and two said the child was slightly fearful of the cat. Two said the children hated and were afraid of unfriendly cats; one usually unfriendly “cat comes into the bedroom at night purring to get petted, child will scream for parents to come get the cat.”

Positive comments from parents of six less severe ASD children included: “Son says the cat definitely improves his quality of life.” “Cat calms down child.” “Child is always looking for the cat.” “Cat follows child throughout the day.” Parents provided two negative comments concerning children who ignored the cat: “Cat and child are fine ignoring each other”; “cat occasionally seems more interested in child than child is in cat.”

Among parents of children diagnosed with ASD, nine offered positive comments. “Cat is a lover, not a fighter, very tolerant.” “Very nurturing cat.” “Child would much rather have a service cat (than a dog).” “She’s the child’s therapy cat.” “Child prides himself in the special bond.” “It was better to get a quiet cat (than a barking dog).” Other comments mentioned the child’s disinterest in the cat ( $n = 3$ ), dislike or fear of the cat ( $n = 2$ ), or the child being a bit rough on the cat ( $n = 1$ ), or had no comment but offered to send a picture. One parent wondered if the lack of bonding at the



**FIGURE 2 |** The level of aggression of each female **(A)** and male neutered cat **(B)** plotted by the cat’s age and group. Aggression to severe autism spectrum disorder (ASD) children was no worse than with less severe ASD or typical children.

**TABLE 5** | Comparing percentages of cats rated as moderately affectionate to children and adults: Phase 1 web survey of families with a severe or less severe autism spectrum disorder (ASD) child; Phase 2 interviews of parents with child of specified diagnosis.

#### Cats at least moderately affectionate

	Number of respondents (%)	
	Adults	Specified child
<b>Web survey: Phase 1</b>		
Severe or less severe ASD child	58/64 (91%)	50/64 (78%)
<b>Interviews: Phase 2</b>		
Severe ASD child	14/16 (88%)	11/16 (69%)
Less severe ASD child	10/11 (91%)	9/11 (82%)
Typical child	16/17 (94%)	16/17 (94%)

beginning, when the child was less than 2 years old, accounted for the lack of interaction 8 years later.

### Comparisons from the Two Phases of the Study

Considering results across the two phases and as summarized (**Table 5**), 88% or more of the cats for all groups in both phases of this study were at least moderately affectionate to adults. A somewhat lesser percentage, 69% or more, were similarly affectionate to children.

We found no effect of neuter status or gender related to the aggression or affection shown by the cats. Being the only cat in the house seemed to be a risk factor for heightened aggression and reduced affection by the specified cat; however, in such cases, the child had only one cat available.

Cats in households with an ASD child appeared to be affectionate and minimally aggressive with the ASD child. However, the cat's level of affection seems higher among cats living with children developing typically as compared with those with severe or less severe ASD.

### Limitations of the Research

Participants all knew that having a cat was an inclusion criterion of the study. We can assume that this increased participation by people whose families had more positive relationships with their cats. Some families with ASD children may have sought to facilitate positive relationships with pets, perhaps even to selectively acquire a cat for the child, and our survey was designed to explore how well that was working in those families. Families with children may choose to relinquish aggressive cats, especially if they are dealing with an ASD child. No information was gathered on whether a cat had previously been relinquished. The study did not randomly survey about cats in the families. In fact, in multi-cat households, respondents were asked to answer the survey with regard to the cat most interactive with the children. Most families had multiple pets, so, they were optimizing opportunities for the child to connect with an animal. The survey did not ask respondents for the age of adoption of the cats in the families, including the specified cat. While we address the issue in the discussion, in retrospect, this was an important omission.

Recruiting participants from the CHARGE study yielded fewer participants than we had expected. These families already

deal with many diagnostics and assessments of their children and face many challenges in providing resources, care, and education for their children. They may have felt that they lacked the time to add on something more. It is possible that those parents who responded were having more positive experiences with their cats than did parents who were non-respondents.

The study did not include an opportunity to conduct direct observations of the interactions of the child and cat; rather, parents provided their perspectives on the behavior of the cat and the relationship of the child and the cat based on their ongoing lives with child and cat. Further, the role of the cat's breed could not be assessed because of the small numbers of cats.

### DISCUSSION

This study focused primarily on the particular features of cats' interactions with children having ASD or less severe ASD, and these children's responses to the cats. Research involving interactions of animals with children having ASD has addressed the animals' contributions to the social behavior and development of the child, most often in numerous studies with dogs [reviewed in Ref. (13)]. Even guinea pigs (14) and robotic animals have been explored as aids in the social development of children with ASD (15). Other highlighted outcomes studied have included the animal's contribution to the safety of the child (4), the emotional connection with the child (16), reduction of the child's problem behaviors, and the child's cortisol levels upon awakening (6).

Other research has addressed the isolating and stigmatizing experiences for parents who have a child with ASD. Parents often feel disconnected from their autistic child and other family members and are required to engage in extremely vigilant parenting of the child (17). Acquiring a pet dog was found to be associated with improved family functioning and reductions in parenting stress with these children (18). This study on the behaviors of cats with young children focuses on the affectionate behavior that cats demonstrate toward children and that is appreciated by most children, and is calming and comforting to the children.

Most parents of ASD children reported affectionate behavior to the children by the cat. The positive interactions of cats with ASD children revealed that cats can provide an avenue of positive relationships. When there were limitations in the relationships, these usually appeared to be from the cats' unwillingness to be affectionate rather than the child being disinterested.

It was clear that the specified cats varied considerably in behavior. The study has revealed the importance of having a cat that is inherently low in aggression, socially outgoing, and affectionate as a family companion for a child with ASD or that is typically developing. One such resource that explores purebreds and domestic shorthair and longhair cats in this regard has rated the breeds on scales for these traits (11). A study where adult cat owners rated personality attributes of their cats also suggests the importance of careful pet selection. Six personality dimensions were identified, and one of these, amiability, was strongly correlated with the respondent's satisfaction with the cat and the bond quality, and the extent to which the cat was not perceived as troublesome (19). Active selection for an affectionate cat could

improve the chances of a calming rewarding relationship of cat and child.

In both phases of this study, a minority of cats was reported as sometimes being aggressive with the specified child, adults, other children, or other cats. Importantly, aggression was not heightened with ASD children. Consistent with other studies, a somewhat higher proportion of cats were affectionate with adults than the specified child (**Table 5**). Yet, most cats were affectionate with the ASD child, a somewhat surprising result given earlier reports of cats more often approaching and spending longer times with adult females rather than other family members (12). Over decades, Turner (20) conducted extensive studies of human–cat interactions, clearly revealing that either the cat or the person can initiate the human–cat interaction, that this affects the subsequent duration of the interaction, and that both parties play very active roles in the interactions and relationship. Further studies using methods similar to those of Turner could clarify the exact nature of the interaction between cats and ASD children.

Many children seek an affectionate relationship with their cats and may benefit from the affection, but their desires are often not fulfilled. Cats that are affectionate to adults, but that are not affectionate to young children, may not tolerate attempts to be held by a child. Some well-known rearing practices of kittens, that would logically predispose cats to being affectionate to young children, are socially habituating (socializing) kittens to several young children and even dogs and other cats. The early weeks of cats' lives are known to be a sensitive period for inducing friendly, affectionate behavior in cats (21, 22).

When considering placing a cat with a child with ASD, the cat's welfare is sometimes a concern. We found that in most cases, the cat was spending only an hour a day or less with the child. Appropriately, this means that the cats were able to spend most of the day in various other activities, and, if the child's behavior with the cat could be problematic, supervising the child's behavior with the cat would not require extensive time commitments from a parent.

For children known to be consistently kind with the cat, the relationship could offer an at-home brief break for the parents. In the Netherlands, animals are used to provide a short break for children with ASD at care farms (23), but having a calming animal at home offers a more consistent and convenient source of affection. Simply seeing the child being calmer with the cat can be comforting to the parents, as indicated in some of the volunteered comments by parents.

Cats likely to be affectionate may provide rewarding relationships for children with ASD. Most children with diagnosed ASD liked to hold the specified cat (or even always wanted to hold, pet, snuggle, and sleep with cat)—at similar levels as in typically developing children. Concerning the cats, most were at least moderately affectionate toward the ASD child, with almost 20% very affectionate. While the cats generally were affectionate with the ASD children, it was noticeably less than with typically developing children. Importantly, the results revealed that cats showed little aggression with ASD children, and certainly no more than with typical children. It seems that cats in families with an ASD child often provided valuable bonding, attention, and calming affection to the child.

Although the surveys did not ask about the age of the cat at adoption, half of the feral cat adopters voluntarily mentioned acquiring their cats as kittens (whereas adopters from other sources did not); thus, we attribute the positive results for feral and purebred cats to their younger status at adoption, which is consistent with other aspects of the results. Persons seeking to acquire a suitable cat for a child in the family could do well to adopt a calm kitten at weaning, assuring that it has frequent gentle interactions with people of all ages, especially ASD children.

Families are highly motivated to seek out optimal experiences for their ASD children. Most families had a variety of companion animals; thus, the families were increasing their chances of creating a good match for their ASD child. Most cats were supportive of the ASD children, offering them a relationship that often met the lifestyles and needs of the children. The children welcomed affection from the cats that provided love and support in some distinctive ways; not surprisingly, the cats' affectionate behaviors differ in some ways from those of dogs (24). These findings provide the essential information needed to pursue a controlled prospective clinical study where parents with autistic children could be offered an appropriately reared and socialized pet cat (kitten) of a breed known to be very affectionate, less aggressive, low in fearfulness, playful, and socially outgoing.

## ETHICS STATEMENT

Approval for conducting interviews was obtained from the University of California, Davis, Institutional Review Board as Protocols #201018447-1 and #284059-2. The web survey responses were entirely anonymous with an introductory description of informed consent provided to respondents.

## AUTHOR CONTRIBUTIONS

Conceived and designed all phases of study; collected and analyzed data, and drafted and compiled manuscript: LAH, BLH, APT. Also conceived and designed Phase 1, edited ms: LAL. Provided access to the CHARGE study families with ASD and typically developing children who met eligibility criteria and volunteered for this study; provided confirmed diagnostic and covariate data for the analysis: IHP. Conceived and conducted extended statistical analyses for Phase 1, and drafted text for methods and results pertaining to results and figures that resulted, with specific edits: NHW. Reviewed and edited interim and final draft manuscripts: LAH, APT, NHW, LAL, IH-P, BLH.

## ACKNOWLEDGMENTS

We appreciate the generous grant support: NICHD #1R03HD066594-01 and Mars/WALTHAM. The UC Davis Center for Companion Animal Health #2016-56-F/M also provided partial support. Grants to the UC Davis Mind Institute for the CHARGE Study include: from NIH (NIEHS), #P01-ES011269, and #R01-ES015359; and from U.S. Environmental Protection Agency, #R-829388, R833292, and RD-83543201.

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**Conflict of Interest Statement:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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