The Blue Dog: Evaluation of an Interactive Software Program to Teach Young Children How to Interact Safely With Dogs

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Objective   Pre–post-randomized design evaluated *The Blue Dog*, a dog safety software program. **Methods**   76 children aged 3.5–6 years completed 3 tasks to evaluate dog safety pre- and postintervention: (a) pictures (recognition of safe/risky behavior), (b) dollhouse (recall of safe behavior via simulated dollhouse scenarios), and (c) live dog (actual behavior with unfamiliar live dog). Following preintervention evaluation, children were randomly assigned to dog or fire safety conditions, each involving 3 weeks of home computer software use.   **Results**   Children using *Blue Dog* had greater change in recognition of risky dog situations than children learning fire safety. No between-group differences emerged in recall (dollhouse) or engagement (live-dog) in risky behavior. Families enjoyed using the software.   **Conclusions**   *Blue Dog* taught children knowledge about safe engagement with dogs, but did not influence recall or implementation of safe behaviors. Dog bites represent a significant pediatric injury concern and continued development of effective interventions is needed.

Key words   computer software; dog bites; injury; intervention; prevention; safety.

Introduction

Dog bites represent a significant public health problem. Almost 5 million dog bites occur annually in the United States [Centers for Disease Control (CDC), 2008]. As a result of those bites, about 800,000 individuals require medical treatment, 6,000 are hospitalized, and about a dozen die (CDC, 2003, 2008). Similar data have been reported in Canada (Raghavan, 2008), South Africa (Dwyer, Douglas, van As, 2007), Spain (Rosado, García-Belenguer, León, & Palacio, 2009), Trinidad (Georges & Adesiyun, 2008), and many other nations.

By a large margin, children represent the demographic group with the highest risk of dog bites (CDC, 2003; Kaye, Belz, & Kirschner, 2009; Weiss, Friedman, & Coben, 1998). There are several hypotheses for why children might be at heightened risk over adults. First, children tend to act in unpredictable and active ways (Morrongiello, Marlenga, Berg, Linneman, & Pickett, 2007). Such actions may stress dogs and cause them to aggress. Second, children lack cognitive skills in perspective-taking that adults possess (Selman, 1980). The theory of mind literature implies that children's understanding of alternative perspectives of others—both people and animals—develops during the preschool years, and this presumably reaches adult levels somewhere around the age of 5 years (Surian, Caldi, & Sperber, 2007; Wellman, Cross, & Watson, 2001). Children's misperception, misunderstanding, or simple ignorance of the perspective of a dog due to an underdeveloped theory of mind may lead to stressed animals, frustrated and abusive children, and, ultimately, to aggression and biting by dogs. Third, children are shorter and weaker than adults. This leads to increased prevalence

of dog bites to the head and neck region, which often require more substantial medical treatment than bites to the limbs and are more likely to be reported and recorded in public health records.

Recognizing children's increased risk of dog bites, a few dog bite prevention programs have been developed to try to teach children to behave safely and appropriately with dogs (Jalongo, 2008). Empirical studies to evaluate those programs are few and tend to be small scale, but they nonetheless are valuable to inform the current research. Early work considered school-based programs using pre- or post- or case–control experimental research designs. In one study, for example, 7- and 8-year-old children were exposed to a 30 min classroom lesson by a dog handler (Chapman, Cornwall, Righetti, & Sung, 2000). Several days after that lesson, children were observed on the school grounds, where a docile dog had been tethered. Those children exposed to the lesson behaved more cautiously near the tethered dog than children not exposed to the lesson. A second study evaluated the BARK (Be Aware, Responsible, and Kind) program (Spiegel, 2000), which requires children to complete an educational workbook, an activity book, and a coloring book. These materials are supplemented with a brief video. A pre–post evaluation with almost 500 children in grades 2 through 4 demonstrated positive changes in knowledge about how to behave with dogs in the sample, and especially in the older children. However, no measures of actual behavior with dogs were collected. A third early study evaluated the Delta DogSafe program, which uses photographs and puppets to tell stories and model safe behaviors with dogs (Wilson, Dwyer, & Bennett, 2003) for children aged 3–5 years. In a pre/postexperimental design, children exposed to the DogSafe program were more likely to recognize photographs of dangerous behavior with dogs than children not exposed to the program. Again, however, no measures of children's behaviors with actual dogs were taken.

Most recently, an evaluation was conducted of the *The Blue Dog*, an interactive computer-based program designed to teach children aged 3–6 years to recognize and safely react in situations where a dog may bite a child. Interactive computer-based software programs offer several advantages over classroom-based programs. They can be self-initiated and completed at home with a parent rather than during valuable classroom time. They also tend to be entertaining and engaging, and therefore maintain children's interest and encourage them to experience lessons repeatedly and fully. Moreover, such programs have proven successful in other areas of pediatric injury prevention, including pedestrian and bicycling safety (Glang, Noell, Ary, & Swartz, 2005; McLaughlin & Glang, 2010).

In *The Blue Dog* program, children are presented multiple animated scenes that include a child and a dog, and decide how the child character should interact with the dog in each scene. As an example, one scene shows a child approaching a dog sleeping in a dog basket. The child must decide whether to stroke the dog ''good night'' or leave the dog alone to rest. Incorrect choices (such as stroking a sleeping dog) result in a growling and angry Blue Dog character, while correct choices (leaving the sleeping dog alone) lead characters (both child and dog) to express positive emotions. Other scenes help children learn to deal with dogs that are sick or have fleas, to resolve conflicts over toys, and to understand and react appropriately to other situations when the dog may have one desire but the child a different one. The program was developed to be used jointly by young children with their parents and includes a lengthy parent guide that teaches parents about the program, dog–child interactions, and canine aggression.

Initial empirical testing of *The Blue Dog* program was conducted with a sample of 102 children aged 3–6 years in Lincoln, UK. A pre–post research design was used with a primary outcome measure of an 8-item yes–no survey about how to interact safely with dogs. Children demonstrated a significant increase in knowledge (from about 5.5 to 7.25 out of eight items correct) after 12–20 min of using the software. Knowledge was retained over a 2-week time period (especially among older children in the sample) during which parents were instructed to use the software two or three times per week (Meints & de Keuster, 2009).

The present study was designed to evaluate the efficacy of *The Blue Dog* further. We considered both transmission of relevant knowledge to children as well as changes in children's behaviors with dogs. We tested learning using multiple strategies in a randomized group pre–post design. We had three specific hypotheses: (a) children's recognition knowledge about safe and unsafe engagement with dogs would improve following exposure to *The Blue Dog* software, (b) children's recall of safe and dangerous behaviors while engaging with dogs in simulation using a dollhouse would improve following exposure to *The Blue Dog* software, and (c) children's actual risky behavior while engaging with a live dog in controlled unstructured and semistructured protocols would decrease following exposure to *The Blue Dog* software. Each of the three hypotheses was tested using a pre–post, randomized design, such that behavior and knowledge were evaluated both before and after the intervention (experience with *The Blue Dog* software at home with parents) and the experimental group of children was compared to a control group exposed to a

similarly designed software program on fire safety, *The Great Escape*.

Methods
Participants

Seventy-six children aged 3.5 through 6 years were recruited from community sources in Birmingham, Alabama ($n = 48$), and Guelph, Ontario ($n = 28$) and completed the study. Twenty-four other children were recruited but did not return for follow-up visits. The noncompleters were statistically similar to the completers in most respects, but were slightly older [$M = 5.25$ years, $SD = 0.85$ for noncompleters; $M = 4.78$, $SD = 0.92$ for completers, $t(97) = 2.05$, $p < .05$]. Since *The Blue Dog* is designed to teach children how to engage with their own pet dogs living at home, and a large portion of pediatric dog bites are incurred from familiar dogs in the home (Mathews & Lattal, 1994; Reisner et al., 2011), we recruited only children who had dogs at home. All children had between one and three pet dogs. The sample was 47% male and was 84% Caucasian, 8% African American, and 8% other races/ethnicities. Sixty-one percent of the sample had an annual household income at or >$80,000, 24% between $40,000 and $79,000, and 14% <$40,000. All families received modest compensation for participating in the study. All study protocols were approved by ethics review boards at both University of Alabama at Birmingham and University of Guelph.

Protocol

Families completed two laboratory visits. During the first, informed consent procedures were completed and then parents responded to several questionnaires (details below). Children engaged in the dollhouse and pictures task (in the randomized order) followed by the live dog procedure (details below). At the completion of the first visit, families were randomly assigned to one of two conditions. Those assigned to the dog safety condition were given *The Blue Dog*, a software program designed to teach children and their parents about how to engage safely with dogs. Those assigned to the fire safety condition were given *Great Escape*, a software program designed to teach children and their parents about fire safety in the home. In both cases, parents were taught how to use the software program, were instructed to use them frequently, and were scheduled to return for a second visit in about 3 weeks ($M = 20.29$ days, $SD = 9.81$). No specific information was provided parents to define "frequently," and neither program's materials offer direct guidance to parents on the recommended frequency of use. Both programs involve

several components and require approximately equal amounts of time to complete all lessons ($\sim$45–60 min).

Specifics of *The Blue Dog* program are offered above. *The Great Escape*, like *The Blue Dog*, offers children several scenarios, decision points, and interactive lessons. It is designed to teach basic fire safety principles such as "Stop, Drop, and Roll!" and developing a family escape plan from the home.

During the second laboratory visit, parents completed a few additional brief questionnaires (details below) and children again engaged in the dollhouse and pictures task (in the randomized order) followed by the live dog procedure.

Measures

Parents completed a brief demographic questionnaire and a few other instruments used for secondary analyses not relevant to the goals of this study (e.g., measures of fire safety knowledge). Since previous research has not been conducted using behavioral/psychological measures on risk taking with dogs, we developed three measures of children's knowledge about and behavior with dogs for the purposes of this study. These measures were developed to parallel similar assessments of children's risk-taking intentions and behaviors in potentially dangerous situations (e.g., Barton & Schwebel, 2007; Coppens, 1986; Morrongiello & Dawber, 2004; Morrongiello & Marks, 2008), and to elicit ecologically valid responses to real-world situations without putting children at risks of actual bites. The measures were also designed to assess risky behaviors commonly addressed in dog-bite prevention programs, including *The Blue Dog*, such as petting dogs only when they wish to be petted, allowing dogs to control their property and territory, and engaging with dogs in areas of their bodies where they prefer to be touched. Face validity was present in all three measures, and content validity considered carefully during development. Internal reliability was assessed with this sample. The three tasks are detailed below; they targeted three domains: recognition of safe behavior with dogs, recall of safe behavior with dogs, and actual safe behavior with dogs.

Recognition of Safe Behavior With Dogs: Pictures Task

In the pictures task, children were shown 16 photographs of dogs one at a time in random order, while experimenters briefly explained what was happening. For example, children were shown a photograph of a dog leaning down to eat from a bowl and were told, "This dog is eating his dinner." Following each description, the experimenter asked the child, "Would you go pet the dog now or not?" Dogs in the photographs varied widely in breed,

size, color, and age (including puppies). Half the photographs presented safe situations (e.g., dog is sitting and has just finished dinner) and served as control filler items. The other half of the photographs presented situations when children should not normally pet the dog (e.g., angry-looking dog in a wire cage). Children's responses to the eight situations that would be dangerous were scored dichotomously as safe/correct versus unsafe/incorrect and summed to yield a single score of recognition of safe behavior with dogs (Cronbach's α on pre-intervention data = .78). Higher scores indicate more knowledge.

Recall of Safe Behavior With Dogs: Dollhouse Task

Children engaged in 10 brief simulated scenarios using a four-room dollhouse (Playmobil Take-Along Dollhouse, Zirndorf, Germany) including child and dog characters, furniture, and a yard. Each scenario presented real-life situations that children frequently encounter with dogs at home. As an example, an experimenter acted out the following scene with dolls: Child wakes up from bed and the dog gets up from a dog bed. The experimenter said, "*(Dog name) and (Child name) have both just woken up from a nap and would normally play a game of fetch at this time of day, but today (Dog name) is not feeling well and doesn't want to play with (Child name).*" The dolls were then given to the child participant, who was asked to "*show or say what would happen next*". Dog names were chosen randomly from 10 options (e.g., Champ and Shadow). Each scenario ended with a prompt for the child to demonstrate what would happen next, and the child's decision was subsequently coded (by videotape) dichotomously as either safe and correct or unsafe and incorrect. Scores across the 10 scenarios were summed to yield a single score of recall of safe behavior around dogs (Cronbach's α on preintervention data = .72), with higher scores indicating better recall. Inter-rater reliability between two independent coders was obtained from 25% of videotaped scenarios and was excellent (κ = 0.94, 95% CI 0.88–0.99).

Demonstration of Safe Behavior With Dogs: Live Dog Interaction

To assess actual behavior with dogs, children were exposed to a live unleashed dog in a closed room. All dogs were certified by either the Delta Society therapy dog program or the American Kennel Club's Canine Good Citizen program; they varied widely in terms of breed, size, and color. The live dog interaction occurred in a series of four segments.

First, children entered the room with the experimenter, where they found the dog (previously hidden from the child's view) and the dog's trainer who was seated in the corner of the room and appeared distracted. The room was sparsely furnished, with a table and chairs (for trainer and experimenter) in one corner, "dog" toys and a dog bed in a second corner, and a few mundane children's toys in a third corner. Children were permitted to play with any of the items in the room, including the dog, for 3 min.

Second, the researcher informed the child that the dog was "ready to play" and offered the child three options to play with the dog: (a) throw a ball for the dog to fetch, (b) brush the dog's hair with a dog brush, or (c) feed the dog a treat from an open palm. Children were permitted to choose just one of those activities. During the third segment of the live dog interaction, children were informed that it was "time for the dog to rest" and instructed to do whatever they preferred for a few minutes. The third segment lasted 3 min. Finally, the child's parent (who was not told to expect a dog in the room) was brought into the room and permitted to engage with their child, the dog, and the toys present. The final segment lasted 5 min.

All behaviors during the live dog interaction were videotaped to permit behavioral coding. A detailed coding scheme was developed to understand child, dog, and parent behaviors, and 20% of tapes were independently coded by two raters to establish inter-rater reliability for the behavioral constructs that were coded (parent behaviors are not considered in the present report). Inter-rater reliability was good (all κ's > .80 for categorical measures and all correlations > .95 for continuous measures).

To assess behavior with the dog, children's behaviors that were deemed potentially dangerous (that is, that might potentially lead to provoking the dog or a dog bite) were standardized and aggregated into a single measure of potentially dangerous behavior with the dog. These measures were chosen to parallel lessons included in *The Blue Dog* software and included risky behaviors such as handling a dog near its face or mouth, touching the dogs' toys, and playing aggressively with dogs. In total, nine objective measures were included in the aggregate: (a) touching the dog toys first upon entering the room (scored dichotomously); (b) brushing the dog's face rather than back, neck, or chest (scored dichotomously); (c) feeding the dog treats from the fingertips rather than with an open palm or by dropping treats onto the ground (scored dichotomously); (d) touching the dog during the dog's "nap" (scored dichotomously); (e) touching the dog in its mouth or mouth area (scored dichotomously); (f) number of times the child put his/her face to the dog's face (count variable); (g) number of times the child picks up the dog so that two or more of the dog's paws are lifted off the ground (count variable); (h) picking up a dog's toy (scored dichotomously); and (i) throwing a dog's toy to the dog (scored dichotomously).

Scores were reversed if necessary prior to aggregation so that higher scores indicate safer behavior. Several items occurred only rarely, and most were scored dichotomously; both these facts impact internal reliability computations, but average inter-item correlations for pre- and postintervention were $r = .06$ and $r = .27$, respectively (Cronbach's $\alpha = .43$ and .68).

Dog Behavior during Live Dog Interaction

Dog activity level and level of approach were coded and used as covariates. Each behavior was assessed on a 5-point scale ranging from low to high during the first three segments of the interaction (the interaction with parents was omitted, as dynamics of the interchange were altered greatly by the parents' presence). Each point of the scale was objectively described so coders could rate based on objectively observed behavior. Scores from the three segments were averaged to obtain one overall measure of dog activity level and one of dog approach for each participant's interaction with the dog pre-intervention and each participant's interaction postintervention. Inter-rater reliability was strong ($\kappa > .80$) on coding of both measures.

Software Use Diary and Survey

Participants randomly assigned to *The Blue Dog* intervention condition completed two forms to track their use and impression of the software. First, they completed a brief one-page sheet every time they used the software at home. This sheet included a listing of how many minutes were spent using the software. Second, they completed a brief survey during the postintervention laboratory visit. That survey assessed topics such as the parents' perception of the software quality, how much they believed their children learned from it, and the emotions they believed their children demonstrated while using the software. The control group completed parallel forms on the fire safety program they received; results from assessments from the control group are not reported in this manuscript.

Analysis Plan

Data were analyzed in four steps. First, we considered descriptive data, both for the full sample and within the two randomly assigned groups. Second, we conducted *t*-tests to inspect differences between the groups, including for the primary variables of interest (change in recognition of safe dog behaviors, recall of safe dog behaviors, and behavior with the live dog). Third, we computed repeated measures GLMs to examine change over time by condition. Finally, we considered descriptive data from the diary and postintervention surveys. We also examined whether

extent of software use was correlated to knowledge or behavior change.

Results

Table I shows descriptive data for the full sample, plus *t*-tests comparing the groups on continuous variables. As shown, the groups were similar on all child and dog characteristics, suggesting random assignment to condition was valid. Only one statistically significant change emerged among the outcome variables. Children in the dog condition ($M = 0.94$, $SD = 1.44$) had significantly greater change in recognition of risky dog situations than did children in the fire safety intervention group ($M = 0.18$, $SD = 1.78$), $t(74) = 2.04$, $p < .05$. Thus, children in the dog intervention group apparently learned to recognize risks with dogs more than did children in the control fire safety intervention group. Surprisingly, there was no indication of change in recall of risky behavior with dogs in the dollhouse task or in actual engagement in safer behaviors in the live dog interaction. In fact, all children in the study, no matter which condition they were assigned to, tended to display more dangerous behavior with the live dog postintervention than they did pre-intervention, probably as a result of familiarity with the situation and the fact that nothing negative occurred with the dog in Session 1.

Table II shows results of the three repeated measures GLMs for each of the three outcome variables (recognition of risky behavior with dogs, recall of risky behavior with dogs as shown in the dollhouse task, and potentially dangerous behavior with the live dog). Pre- and postintervention outcome scores served as dependent variables. All three models had a main effect of change over time, suggesting that across both conditions, children tended to demonstrate greater dog safety knowledge/behavior during the postintervention assessment than during the pre-intervention assessment. Further, there was a statistically significant interaction effect of condition by time for the recognition of dog safety outcome ($F[1, 74] = 4.17$, $p < .05$), suggesting there was greater change in scores among the dog intervention group (from 4.92 [$SD = 2.22$] to 5.86 [$SD = 2.02$]) than among the fire intervention group (from 5.64 [$SD = 2.28$] to 5.82 [$SD = 2.30$]). No other statistically significant results emerged.

GLMs were also conducted with child age, child sex, dog behavior preintervention (aggregate of standardized dog activity and dog approach scores; these correlated strongly, $r = .78$), and dog behavior postintervention

Table I. *Descriptive Data and Comparison Between Randomly-Assigned Intervention groups*

Variable	Full sample, $N = 76$	Dog condition, $N = 37$	Fire condition, $N = 39$	t
Child characteristics				
Age	4.80 (0.92)	4.84 (0.90)	4.77 (0.96)	0.32
Sex	47% male	46% male	49% male	0.06[a]
Dog characteristics				
Dog activity-pre IV	2.48 (0.74)	2.51 (0.71)	2.45 (0.78)	0.38
Dog activity—post IV	2.29 (0.74)	2.31 (0.66)	2.27 (0.83)	0.21
Dog approach—pre IV	2.53 (0.73)	2.64 (0.67)	2.41 (0.78)	1.34
Dog approach—post IV	2.45 (1.00)	2.54 (0.95)	2.36 (1.05)	0.77
Outcome measures				
Recognition—pre IV	5.29 (2.26)	4.92 (2.22)	5.64 (2.28)	−1.40
Recognition—post IV	5.84 (2.15)	5.86 (2.02)	5.82 (2.30)	0.07
Change in recognition	*0.55 (1.65)*	*0.94 (1.44)*	*0.18 (1.78)*	*2.04**
Recall—pre IV	4.07 (2.33)	4.02 (2.43)	4.13 (2.27)	−0.20
Recall—post IV	4.83 (2.34)	4.91 (2.52)	4.76 (2.19)	0.28
Change in recall	*0.75 (2.15)*	*0.89 (2.51)*	*0.63 (1.77)*	*0.53*
Behavior—pre IV	0.47 (0.77)	0.51 (0.77)	0.44 (0.79)	0.44
Behavior—post IV	1.33 (1.50)	1.22 (1.44)	1.44 (1.57)	−0.64
Change in behavior	*0.75 (2.15)*	*0.70 (1.20)*	*1.00 (1.69)*	*−0.88*

Note. IV = intervention.
[a] x^2 performed instead of *t*-test for this categorical variable.
*p < .05.

Table II *Repeated Measures GLMs Testing Change in Dog Safety Knowledge and Behavior Across Groups and Time (N = 70)*

Variable	Recognition F (partial η^2)	Recall F (partial η^2)	Behavior F (partial η^2)
Between subjects effects			
Condition	0.53 (0.01)	0.00 (0.00)	0.11 (0.00)
Within subjects			
Main effect of time	9.05** (0.11)	9.31** (0.11)	25.50** (0.26)
Time by condition	4.17* (0.05)	0.28 (0.00)	0.77 (0.01)

*p < .05. **p < .01.

(aggregated postintervention, $r = .78$) included as covariates. Results were similar and are not presented.

Finally, we examined results from the diaries and postintervention survey among the families randomly assigned to *The Blue Dog* program. In general, parents believed their children already knew much or all of the material in the software (76%), but that children had learned most of what was new to them (66%) and that they believed children would apply all or most of what they had learned when interacting with their dog (65%). Parents tended to believe children had fun (54% a lot of fun; 43% some fun) and were happy (53% a lot of happiness; 41% some happiness) playing with *The Blue Dog* program, and just one parent (3% of sample) reported his/her child was scared or nervous playing the game. Interestingly, half of parents (50%) felt the *Blue Dog*

character probably or definitely did not behave in a way their dog might behave at home, and most parents admitted to not reading the 47-page Parent Guide thoroughly (7% read all of it, 50% most of it, 36% a little bit of it, and 7% none of it).

On average, families reported that children used the software alone for 16.03 min ($SD = 20.33$, median = 5.00, range = 0–60) and that children used the software with parents for 38.74 min ($SD = 32.56$, median = 32.50, range = 0–140). Altogether, therefore, children used the software for an average of almost an hour over the 3-week period between the two laboratory visits ($M = 54.76$ min, $SD = 32.95$, median = 50.00, range = 6–150). Only one parent (3%) who completed the questionnaire had any difficulty using the software on his/her computer system. Time of use was not correlated to change in recognition or recall of safe dog behavior or behavior with the live dogs (r [32] between change [postintervention − preintervention] scores, and total software usage were −.22, −.06, and −.22, respectively, within the dog intervention group).

Discussions

Results suggest that children exposed to *The Blue Dog* software program showed modest improvement in basic knowledge of how to behave more safely with dogs, but

they did not spontaneously recall those lessons in dollhouse simulations, nor did they actually implement those safer behaviors when exposed to an unfamiliar live dog. Results also demonstrated that The Blue Dog program was enjoyable and engaging for children and their families and that families spent time regularly using the computer program.

Dog bites represent a major cause of unintentional pediatric injury worldwide. They cause significant pain, distress, and cost to families. They also are quite common, with available population-based prevalence studies citing rates such as 28% lifetime bite prevalence in a sample of 8- to 12-year-old children in Trinidad (Georges & Adesiyun, 2008), 3.4% prevalence in the past year among a sample of children and adults in Lyon, France (Chomel & Trotignon, 1992), and 2.2% prevalence in the past year among a sample of children in French-speaking Belgium (Kahn et al., 2004). We are unaware of similar prevalence data from any North American regions, but the US Centers for Disease Control WISQARS database offers an injury rate of 217.42 per 100,000 3- to 5-year olds receiving treatment by a doctor or hospital for dog-bite injuries in 2009 (Centers for Disease Control, 2011). In addition, all available prevalence studies include families without dogs at home, and both European studies reported a dog-ownership rate <34% in the samples studied. Given the scope of the public health problem, it is rather surprising that few dog-bite prevention programs have been developed, empirically tested and demonstrated efficacious. Indeed, we are unaware of any intervention programs that have demonstrated efficacy in multiple peer-reviewed published randomized trials, nor of any that have been disseminated broadly and widely to at-risk children and families.

From an intervention perspective, results of the present study are mixed. It is encouraging that children learned some relevant lessons from The Blue Dog. Combined with previous empirical results (Meints & de Keuster, 2009), it appears that The Blue Dog may be an effective strategy to transfer critical knowledge about dog safety to young children. It is disappointing, however, that the increase in knowledge did not translate to behavior change in the dollhouse simulation or the interaction with the live dog. The present results indicate that some knowledge may be transferred to children, but that knowledge is not necessarily utilized effectively by children when they encounter dogs.

Surprisingly, the time children spent using The Blue Dog was not associated with the extent of their learning. Within the experimental group exposed to The Blue Dog, correlations between outcome measures and time using the software were nonsignificant. Previous work evaluating The Blue Dog recommended parents use the CD two to three times per week for 2 weeks but did not assess actually usage (beyond verification that the CD was used; Meints & de Keuster, 2009). Future work might consider dosage effects, and whether longer or repeated usage might improve learning outcomes or transfer of knowledge to impact behavior.

Our assessment of children's behavior with the live dog actually yielded unexpected trends for children exposed to The Blue Dog to take greater risks with the dog following the intervention. Although this trend raises possible concern with iatrogenic effect (i.e., that children exposed to training may actually feel overconfident in their ability and take greater risks with dogs), the fact that the increase in risk-taking was comparable across both experimental groups suggests other explanations. It may be that the change in risk-taking with the live dog reflected familiarity with the situation rather than training or exposure to the intervention. Another possibility is that because exposure to the unfamiliar dog initially produced no negative effect, children gained an increased sense of confidence that dogs are "safe", resulting in greater interactions the next time they encountered an unfamiliar dog. Past research has shown that children often develop an "optimism bias" (i.e., belief that they are less likely to be injured than someone else doing the same behavior) when risk behaviors do not lead to negative consequences (Morrongiello & Rennie, 1998). Future research examining how repeated positive contacts with dogs impact children's beliefs about injury vulnerability is a necessary next step, particularly for intervention planning.

Health behavior change research frequently discovers discrepancies between presence of health-relevant knowledge but failed transmission to behavioral change (Rollnick, Mason, & Butler, 1999; Shumaker, Ockene, & Riekert, 2009). Although our results introduce an added layer of complexity with the young developmental stage of children, researchers have struggled to identify effective strategies to overcome the barrier of translation of knowledge into health behavior change for years (Rollnick et al., 1999; Shumaker et al., 2009). How does one inspire individuals who have gained prerequisite knowledge (in this case, knowledge about how to interact safely with dogs, which apparently can be obtained by using The Blue Dog software) to actually engage in safe behaviors based on knowledge that has accumulated. To move toward development of new dog-bite prevention strategies, and cope with both the knowledge-to-behavior change conundrum and the complexities of child development involved,

different strategies should be invoked for young children and their parents versus for older children.

For young children, child development theory must be considered foremost. Preschoolers apparently are able to learn rote lessons about dog safety (e.g., never touch a dog while it's sleeping, never play with the dog's toys) from programs like *Blue Dog*, but prior to ages 5 or 6, most children do not have the cognitive capacity to read, interpret, and understand a dog's emotions and desires, even if it is a highly familiar pet dog. Dating to Piaget's classic work on perspective taking (Piaget, 1959) and continuing with more contemporary work on children's theory of mind (Flavell, 2004), we know that most preschoolers have a poor ability to understand others' desires and wishes. Thus, parents must be highly engaged in dog-bite prevention programs and should be urged to supervise closely young children with all dogs, even those that are familiar dogs.

Given the need to involve parents in protecting young children's safety with dogs, health behavior change theory should be invoked to consider how to influence parent's behavior in supervising and training their children in safety with dogs. It is difficult to change people's health behaviors, particularly if they have experiences suggesting they are safe (e.g., positive experiences with their own family pet). Prior research has shown that parents often have unrealistic expectations about their ability to keep their child safe (Morrongiello & Dayler, 1996), which makes them likely to believe that their dog is safer than other dogs and very unlikely to bite their child (Weinstein, 1983, 1984). Convincing parents of vulnerability and susceptibility to dog bites is essential. Also important is persuading parents of the importance of modeling safe practices. Children learn via direct lessons from parents, but they learn much more simply by watching their parents in action (Bandura, 1971; Morrongiello, Corbett & Bellissimo, 2008). If parents behave in risky or inappropriate ways with dogs, their children are likely to do so as well. It is interesting to note too that parents spent relatively little time reading the written materials provided with *The Blue Dog*. This is a finding that has been noted before in child safety intervention programming (Morrongiello & Kiriakou, 2005), and it highlights another challenge to research in this area. Finding ways to promote parent engagement with all the resources provided could enhance the impact of this and other dog safety programs.

For older children, one can presume some cognitive capacity to learn how to engage safely with dogs. Our study found that both parents and children enjoyed using *The Blue Dog* (see also Meints & de Keuster, 2009), and a computer-based platform seems a logical vehicle to deliver dog safety lessons to children and their families. Thus, extension of *The Blue Dog* to an older target age group and development of engaging, entertaining, interactive, and efficacious training computer-based programs may be a worthwhile enterprise to teach older children about dog safety. Given that younger children often model the safety and risk practices of their older siblings (Morrongiello & Bradley, 1997), this is another way that the dog-directed behavior of young children could be improved.

Despite the insights gained from this study, there are two methodological limitations. First, the sample size was modest and there was a higher than desirable loss to follow-up. Future work should include larger samples and may require substantial resources to retain participants in a longitudinal design. Second, the measures of behavior with dogs were strong but not perfect. The dollhouse simulation re-enacted actual situations children might find themselves in, but was a simulation rather than a real-life situation. The live dog interaction permitted interactions with an actual dog, but it was an unfamiliar dog rather than a familiar personal pet. *The Blue Dog* is designed to alter behavior with children's own pets. The live dog measure also suffered from poor internal consistency and may not have been a valid measure of children's behavior with a dog. In future research, examining child–dog interactions with the child's own pet dog would be an important extension.

To conclude, this randomized pre–post design incorporated multiple ecologically valid outcome measures. The results suggest that *The Blue Dog* can teach children valuable lessons about safety near dogs, but may not be sufficient to elicit risk-reducing behavior changes.

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