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Animal-Assisted Therapy: A Meta-Analysis

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ABSTRACT Animal-assisted therapy (AAT) has been practiced for many years and there is now increasing interest in demonstrating its efficacy through research. To date, no known quantitative review of AAT studies has been published; our study sought to fill this gap. We conducted a comprehensive search of articles reporting on AAT in which we reviewed 250 studies, 49 of which met our inclusion criteria and were submitted to meta-analytic procedures. Overall, AAT was associated with moderate effect sizes in improving outcomes in four areas: Autism-spectrum symptoms, medical difficulties, behavioral problems, and emotional well-being. Contrary to expectations, characteristics of participants and studies did not produce differential outcomes. AAT shows promise as an additive to established interventions and future research should investigate the conditions under which AAT can be most helpful.

Keywords: AAT, animal-assisted therapy, meta-analysis

For centuries people have noted that animals can have a positive influence on human functioning. For example, in the 19th century, Florence Nightingale suggested a bird might be the primary source of pleasure for persons confined to the same room due to medical problems (McConnell 2002). Today, animals are often introduced to individuals struggling with a malady, such as taking a dog to a nursing home or hospital. This is known as Animal-Assisted Activities (AAA; Howie 2000). While conventional wisdom has long supported the use of animals in promoting human well-being, only recently has science investigated the therapeutic effect animals have in alleviating mental and medical difficulties. To date, the benefits of two forms of pet–human interaction enjoy scientific support. First, routine pet ownership is linked to beneficial results such as lower blood pressure, increased exercise, and stronger immunity (Anderson, Reid and Jennings 1992). Second, Animal-Assisted Therapy (AAT) has been shown to be effective. In this meta-analysis, we focused on the overall impact of AAT.

AAT is the deliberate inclusion of an animal in a treatment plan. Generally, AAT involves a credentialed treatment provider who guides interactions between a patient and an animal to realize specific goals (Chandler 2005). That is, the introduction of an animal is designed to accomplish predefined outcomes believed to be difficult to achieve otherwise or outcomes best addressed through exposure to an animal.

AAT has been employed in a variety of health care settings. For example, AAT has been used as an adjunct to physical therapy by having a patient walk a dog, pet or brush a cat, or play fetch with a dog. In this context, the activities are designed to increase muscle strength and improve control of fine motor skills. Here, interactions with the animal may serve to realize specific physical therapy goals and the animals' unique ability to be attentive to the client may serve to increase interest in the activities and mental health functioning (Chandler 2005). AAT has also been used in mental health settings. Here, a child might be encouraged to gently pet and talk to an animal to teach appropriate touch, reduce anxiety, increase a sense of connection to a living being, reduce loneliness, and develop a variety of skills (Chandler 2005; Delta Society 2006).

The use of an animal in therapy may be beneficial because animals seem to have a

natural tendency to create a bond with people. A good therapy animal will seek affection and interaction with the client. Thus, animals may promote a warm and safe atmosphere that can be independently therapeutic and help clients accept interventions offered by the treatment provider. AAT is not generally viewed as a stand-alone treatment. Rather, animals are used as a supplement or in conjunction with other interventions.

Despite being a supplement, AAT has been applied to a wide variety of clinical problems. These include autistic spectrum symptoms (Redefer and Goodman 1989), medical conditions (Havenar et al. 2001), compromised mental functioning (Kanamori et al. 2001), emotional difficulties (Barker and Dawson 1998), undesirable behaviors (Nagengast et al. 1997), and physical problems (Nathanson et al. 1997). Additionally, AAT has been used with individuals across the lifespan, including children, adolescents, adults, and the elderly.

The delivery of AAT varies with respect to the animal used (e.g., dog, horse, etc.), the setting in which it is delivered (e.g., inpatient or outpatient setting, camp, medical clinic, short- or long-term facility), the duration of the intervention (short- or long-term), and whether the intervention is delivered in a group or individual format. Just as there is variability in the way in which AAT is implemented, the design and rigor of studies differ. Some investigations have used rigorous methodology, utilizing randomized designs comparing AAT with control groups or established treatments, (e.g., recreational therapy) while others have used simple pre- and post-test designs. While most studies on AAT have been applied, some have investigated basic research questions. For example, one study investigated whether the presence of an actual animal versus a stuffed animal produced differential effects (Limond, Bradshaw and Cormack 1997).

As the literature on AAT has matured, several qualitative reviews have been conducted. For example, Dashnaw-Stiles (2001) asserted that every study investigating AAT showed positive outcomes. Likewise, Brodie and Biley (1999) completed a qualitative review of AAT articles and found that AAT was associated with improvements in physiological health, social interactions, and happiness. While qualitative reviews are helpful in detecting patterns, such reviews are limited because of their subjective quality and inability to test hypotheses. Thus, the typical or average effect of AAT has not been established through a quantitative review or meta-analysis. A meta-analysis is a research strategy that can provide insight into the average or typical effect of a therapy. In this way, individual studies, rather than participants, are subjected to specialized quantitative analyses (Duriak and Lipsey 1991).

To date, no known meta-analysis on AAT has been published in a peer-reviewed source. However, Kathleen Ray LaJoie's (2003) dissertation attempted a meta-analysis. LaJoie concluded that a meta-analysis could not be conducted because she found only nine articles and felt that these studies were too disparate to be compared. Her work did, however, produce a literature review of AAT.

In an attempt to provide a quantitative review on AAT interventions, we conducted a thorough and comprehensive search of the literature for empirical investigations of AAT. Three objectives guided our study: (a) to assess the average effect of AAT, (b) to investigate the stability of this average effect, and (c) to evaluate whether variability in the implementation of AAT and/or participants influenced outcomes.

Methods

Study Selection

Three strategies were used to identify studies investigating the effectiveness of the outcomes after the animal was introduced into the study. First, computer searches of 11 databases were conducted in the Fall of 2004 (e.g., PsychInfo, Ebsco Animals, and MEDLINE) using 19 key words associated with AAT (e.g., animal, assisted, therapy, pet, facilitated, and equine). Second, hand searches were conducted on three journals that tend to publish studies on AAT from the years 1973–2004 (i.e., *Anthrozoös, Applied Animal Behaviour Science,* and *Society & Animals*). Third, there was a search through all the reference sections of all retrieved articles for additional studies. Using these three strategies, approximately 250 abstracts were identified. Next, four criteria were used to select studies for inclusion. Studies were included if they a) reported on AAT and not AAA or pet ownership, b) included at least five participants in a treatment group, c) were written in English, and d) provided sufficient data to compute an effect size.

We considered only using studies that included a control group as an inclusion criterion; however, we decided against this approach for two reasons. First, the literature on AAT is relatively new and underdeveloped which means that many studies would have been excluded. Second, by coding whether studies compared an AAT intervention with a comparison group we could test whether outcomes systematically differed based on study design. From the 250 abstracts, 119 studies seemed to meet the inclusion criteria. These studies were obtained and coded. Of these, 37 studies in peer-reviewed sources and 12 dissertations met eligibility criteria and were included.

Coding Studies

Studies were coded for effect sizes and moderator variables. As can be expected, studies looked at a variety of outcomes or dependent variables that were grouped into four outcome classes: autistic spectrum disorders, medical symptoms, well-being indicators, and behavioral actions. Additionally, study characteristics or independent variables were coded into seven groups: participant age, participants presenting problems, use of a control or comparison group, type of animal used, length of treatment, location of treatment, and how treatment was delivered. A codebook was developed and adequate inter-rater reliability was achieved (average kappa = 0.89) across all categories.

Dependent Variables

Four outcome groups were used to organize the various dependent variables investigated across studies. Several studies applied AAT to children diagnosed with an *Autistic Spectrum Disorder (ASD)* and targeted symptoms associated with this disorder. Examples of ASD behavioral outcomes included increases in positive social interactions skills, decreases in self-absorption, or increased communication (Redefer and Goodman 1989). Many studies used AAT to target *medical outcomes* such as improvements in heart rate, blood pressure, fine or gross motor skills, and coordination. For example, Havener et al. (2001) examined physiological arousal in children under stressful situations. Other studies focused on participants' *emotional well-being* and measured outcomes such as anxiety, depression, or fear. For example, Barker, Pandurangi and Best (2003a) examined how AAT influenced patients' fear levels prior to receiving a stressful medical intervention. Lastly, some studies examined how AAT influenced *observable behaviors.* Examples include verbal resistance, aggression, violence, or compliance with rules (Nagengast et al. 1997; Iannone 2003).

Independent Variables

Seven moderator or independent variables were coded. Three were derived from variations in participant characteristics and four came from variations in the delivery of AAT. To begin, we investigated if participant *age* would influence outcomes. Based on typical models of development (Broderick and Blewitt 2003) and, in part, the distribution of ages in the identified studies, we coded studies into four broad age groups: pre-adolescence (12 years and younger), adolescence (13 to 17 years), adulthood (18 to 64 years), and late life (65 years and older).

The *presenting problems* of AAT recipients were coded into three broad categories: medical problems, mental health difficulties, or behavioral problems. In each of these areas, AAT was viewed as an adjunct to a traditional model or as an experimental nontraditional intervention designed to help individuals cope. Examples of presenting problems coded in the medical category included children or adults seeking a medical procedure, such as a visit to a doctor or dentist where AAT was designed to reduce stress. Examples of mental heath difficulties included using AAT with individuals diagnosed with Alzheimer's or depression with the goal of increasing cognitive functioning or a sense of well-being. AAT was also directed at individuals identified as having problematic behaviors such as childhood aggression or severe conduct problems. Lastly, we coded whether participants were judged to have a life-long disability, such as Autism, developmental delays, mental retardation, or physical disabilities.

In addition to characteristics of participants, study characteristics were coded. First, studies were divided into those that used a *comparison group* and those that did not. Some comparison groups were wait-list or control groups, while others were alternative treatments. We note that studies comparing AAT with an alternative treatment are presented separately in the results section, as the interpretation is unique. Second, the *type of animal* used was coded; major categories included dog, horse, aquatic (e.g., dolphin), other, or a combination. Examples of animals in the other category included rabbits (Perelle and Granville1993) and birds (Holcomb et al.1997). While it is generally believed that cats are widely used in AAT (Chandler 2005), we found no qualified studies that used a cat.

Third, the *location of treatment* was coded into one of four settings: office, camp, hospital, or long-term residential facility. Cieslak (2001) used an office setting, while Bertoti (1988) delivered AAT in a camp setting on a horse ranch, and Nathanson et al. (1997) provided treatment at a dolphin center. In some cases, AAT was delivered in hospitals or clinics (Johnson et al. 2003), and AAT was often used in long-term residential facilities targeting older adults. The fourth study characteristic coded was the *delivery mode* that included individually administered AAT, group delivery, or a combination. Fifth, the *length of treatment* was coded based on the number of sessions reported.

To determine if study rigor influenced outcomes, we coded the methodological rigor of each study on a 9-point scale. Each study received one point for including each of the following: a control group, randomization, blind coders of observational data, a treatment manual, at least three descriptions of the sample (e.g., participant age, gender, socio-economic status), well-known measures of dependent variables, clear description of the intervention, delivery location, and provision of sufficient information to directly calculate an effect size from means and standard deviations rather than from other indicators (i.e., *t*-test, *p* value).

Results

Data Reduction

We used Cohen's *d* as the measure of effect size (Lipsey and Wilson 2001). Cohen's *d* reflects the difference between the post-treatment means of the treatment group and the control group divided by the pooled standard deviation, adjusted for sample size. In the case of a study that did not use a control group, *d* reflects the difference between the pre-treatment and post-treatment scores divided by a pooled standard deviation. Thus, *d* represents differences in means expressed in standard deviation units. The individual *d*s of each study and relevant details about the study can be found in Table 3. Effect sizes around 0.80 have been described as large in magnitude, while those around 0.50 are considered moderate, and those in the neighborhood of 0.20 are considered small though significant (Cohen 1988).

Within each of the four outcome groups, we tested for and corrected extreme values, as recommended by Lipsey and Wilson (2001). Correcting for extreme values in quantitative reviews is consistent with the purpose of meta-analyses, specifically to "arrive at a reasonable summary of

Table 1. Study characteristics and effect sizes.

		Study Characteristics					Effect Sizes			
		n	*n*			Moderator				
First Author	Yr	Tx	No	Control	Rigor	a/b/c/d/e/f/g	Autistic	Well-being	Behavior	Medical
						Children				
Havener	2001	20	20	Yes	8	1/1/1/1/3/2/1	–	–	0.42	1.2
Hansen	1999	15	19	Yes	7	1/1/1/1/1/2/1	–	0.77	–	0.00
Kaminski	2002	30	40	Yes	7	1/1/1/1/3/2/1	–	0.92	–	–
Redefer	1989	12		No	6	1/1/3/2/1/2/2	1.42	–	–	–
Terpin	2004	5		No	6	1/1/2/2/1/2/1	–	0.42	–	–
Nagengast	1997	10	13	Yes	6	1/1/1/1/3/1/1	–	–	0.85	–
Zemke	1984	16		No	6	1/4/2/2/2/3/2	–	0.54	–	–
Issacs	1998	5		No	5	1/1/1/2/1/2/2	1.42	–	–	–
Limond	1997	8		No	5	1/1/2/2/3/2/2	0.62	–	–	–
Bertoti	1988	11		No	5	1/4/1/2/2/2/2	–	–	–	1.19
Nathanson	1997	17	30	Yes	4	1/5/2/1/1/3/2	–	–	–	1.11
Martin	2002	10		No	2	1/1/2/2/6/2/2	0.10	–	–	–
						Adolescents				
Iannone	2003	19	7	Yes	7	2/4/3/1/4/1/1	–	0.60	-0.19	–
Cawley	1994	23		No	4	2/4/3/2/2/3/2	–	0.00	0.60	–
Kaiser	2004	16		No	4	2/4/2/2/2/1/1	–	-0.05	0.65	–
Biery	1989	8		No	2	2/4/1/2/4/2/2	–	–	–	0.53
						Adults				
Marr	2000	18	19	Yes	8	3/6/2/1/3/1/1	–	–	0.67	–
Pepper	2000	25	24	Yes	8	3/1/1/1/1/2/1	–	0.08	–	–
Beck	1986	8	9	Yes	7	3/6/2/1/4/1/1	–	-0.28	0.28	–
Cox	1999	22	39	Yes	7	3/1/2/1/3/1/1	–	0.50	–	–
DHooper	2003	6	5	Yes	7	3/1/2/1/1/1/1	–	-0.28	–	–
Kelly	2001	20	23	Yes	7	3/6/2/1/1/2/1	–	0.40	–	–
Turner	2002	8	9	Yes	7	3/1/2/1/4/1/2	–	–	0.05	–
Calvert	1988	32	31	Yes	7	3/1/2/1/4/1/1	–	0.56	–	–
Cieslak	2001	15	15	Yes	6	3/1/2/1/1/2/1	–	–	0.26	–
Barker	2003b	30		No	6	3/5/1/2/3/2/1	–	0.38	–	0.05
Barker	2003a	24	24	Yes	6	3/1/3/1/3/2/2	–	0.92	–	–
Barker	1998	230		No	6	3/1/2/2/3/1/1	–	0.48	–	–
Johnson	2003	10	10	Yes	6	3/1/1/1/3/2/1	–	0.68	–	–
Holcomb	1989	44		No	6	3/6/2/2/3/1/1	–	–	0.95	–
Farias-Tomaszewski	2001	18		No	6	3/4/1/2/3/2/1	–	0.49	–	–
Folse	1994	11	23	Yes	5	3/1/2/1/1/1/1	–	0.35	–	–

continued...

Table 1. Study characteristics and effect sizes*...continued*

		Study Characteristics					Effect Sizes			
		n	*n*			Moderator				
First Author	Yr	Tx	No	Control	Rigor	a/b/c/d/e/f/g	Autistic	Well-being	Behavior	Medical
						Elderly				
Barak	2001	10	10	Yes	8	4/6/2/1/4/1/1	–	–	0.91	–
Panzer-Koplow	2000	16	19	Yes	8	4/1/2/1/4/1/1	–	0.08	–	–
Zisselman	1996	25	21	Yes	8	4/1/2/1/4/1/1	–	0.27	0.32	–
Hagmann	1992	41	39	Yes	7	4/6/2/1/4/1/1	–	0.15	–	–
DeVault	1987	15		No	6	4/6/3/2/4/1/1	–	-0.02	0.53	0.22
Kanamori	2001	7	20	Yes	6	4/6/2/1/4/-/1	–	–	0.46	–
Richeson	2003	15		No	6	4/1/2/2/4/1/1	–	–	0.41	–
Banks	2002	15		No	5	4/1/3/2/4/2/1	–	0.77	–	–
Edwards	2002	45		No	5	4/5/2/2/4/1/1	–	–	0.92	–
Holcomb	1997	38		No	5	4/6/2/2/3/1/1	–	0.11	–	–
Perelle	1993	35		No	5	4/6/3/2/4/1/1	–	–	0.53	–
Bernstein	2000	12		No	4	4/6/3/2/4/1/1	–	–	0.00	–
Haughie	1992	37		No	4	4/1/3/2/3/-/1	–	–	0.41	–
Kaiser	2004	10		No	4	4/1/3/2/4/2/1	–	–	0.14	–
Walsh	1995	7		No	4	4/1/2/2/3/2/1	–	–	0.95	0.55
Fick	1993	36		No	4	4/1/3/2/3/1/1	–	–	0.36	–
Batson	1998	25		No	4	4/1/2/2/4/2/1	–	–	0.31	–

Notes for study characteristics: *n* is the number who received AAT treatment.

Control: Control group or not.

Rigor: The studies received rigor points if they included: what the specific treatment was, where the treatment took place, was there a manual, was it randomized, was there a control, was the effect size calculated from the mean, was there a know dependent variable, was there a reliable measure used, were there blind coders, and were at least three characteristics of the sample listed.

Information for the seven moderators are listed as the following:

a) Mean age group: 1 = child (0–12), 2 = adolescent (13–17), 3 = adult (18–64), 4 = elderly (65–above);

b) Animal type: 1 = dog, 2 = cat, 3 = rabbit, 4 = horse, 5 = aquatic, 6 = other;

c) Type of originating problem: 1 = medical, 2 = mental, 3 = behavioral;

d) Control group: 1 = yes, 2 = no;

e) Location of Treatment: 1 = office, 2 = camp, 3 = hospital, 4 = long-term residential facility, 5 = in client home, 6 = combination;

f) Mode: 1 = group (2 or more clients at once), 2 = individual, 3 = combination;

g) Participants functioning level: 1 = normal, 2 = delayed.

Table 2. Control and no-control group characteristics.

Moderators	Control	No Control
Mean Age		
Child (0–12 years old)	5	7
Adolescent (13–17 years old)	1	3
Adult (18–64 years old)	12	3
Elderly (65 years old +)	5	12
Presenting Problem		
Medical	6	4
Mental	15	13
Behavioral	2	9
Animal Type		
Dog	15	13
Cat	0	0
Rabbit	0	0
Horse	1	6
Aquatic	1	2
Other	6	5
Location of Treatment		
Office	7	4
Camp	0	3
Hospital	7	7
Long-Term Residential	9	9
In Client Home	0	0
Combination	0	0
Mode		
Group	13	10
Individual	8	13
Mix	1	2
Participants Functioning:		
Normal	21	18
Delayed	2	8

the quantitative findings of a body of research studies" (Lipsey and Wilson 2001, p. 107). This was done by identifying d values that were greater than two standard deviations (*SD*) from the mean of the sample of *d* values obtained within a particular construct and time frame. Values above two *SD* units were assigned a value equivalent to two *SD* units from the mean (i.e., *Windorizing*). Four studies examining the immediate impact of AAT were Windorized.

In addition to looking at overall effects, moderator analyses were conducted to provide a more specific assessment of the strength of effect based on predefined parameters (i.e., independent variables). Homogeneity was analyzed using the within-class, goodness-of-fit statistic or Q_w (Johnson 1993). A significant Q_w statistic suggests heterogeneity within a set of studies and the need for moderator analyses. The presence of statistical differences between categories of AAT program characteristics was examined using the between-class goodness-of-fit statistic, or Q_b. A significant Q_{b^*} statistic indicates the magnitude of the effect differs between categories of the moderator variable. As a guide, *k* refers to the number of studies contributing to a particular *d* value and CI refers to confidence interval.

Table 1 shows effects sizes and study characteristics for each study. Table 2 provides an overview of how many studies contributed to particular moderator variables based on whether a control group was utilized.

Table 3. Effect sizes and confidence intervals.

	Well-being			Behavior			Medical		
	d	**CI**	***k***	***d***	**CI**	***k***	***d***	**CI**	***k***
Overall	0.39	0.29–0.50	27	0.51	0.38–0.65	23	0.52	0.26–0.77	8
Moderators									
Design									
Control group	0.42	0.27–0.58	16	0.43	0.17–0.69	9	0.77	0.39–1.15	3
No control	0.37	0.23–0.51	11	0.54	0.39–0.70	14	0.32	-0.02–0.65	5
Age									
11 years and younger	0.58	0.28–0.89	5	0.57	0.16–0.99	3	0.82	0.47–1.17	4
12 to 17 years.	0.17	-0.30–0.66	2	0.34	-0.15–0.82	2	0.47	-0.52–1.46	1
18 to 64 years	0.44	0.30–0.58	10	0.53	0.13–0.93	4	0.05	-0.46–0.55	1
65 years and older	0.24	0.02–0.46	6	0.56	0.34–0.78	7	0.29	-0.30–0.89	2
Disability									
Disability	0.28	-0.05–0.61	4	0.29	-0.01–0.59	5	0.96a	0.50–1.42	3
No Disability	0.40	0.30–0.51	23	0.57	0.42–0.72	18	0.33a	0.03–1.15	5
Animal Type									
Dog	0.49a	0.36–0.61	15	0.39	0.19–0.58	11	0.57	0.14–1.01	3
Horse	0.26	-0.05–0.56	5	0.42	0.03–0.83	3	0.82	0.15–1.48	2
Aquatic	0.37	-0.14–0.88	1	0.90	0.47–1.34	1	0.45	0.06–0.85	2
Other	0.04a	-0.37–0.45	2	0.46	0.04–0.89	2	–	–	–
Combination	0.18	-0.14–0.50	3	0.69	0.40–0.97	5	0.21	-0.51–0.93	1
Participant Characteristic									
Medical Diagnosis	0.53	0.28–0.77	6	0.55	0.05–1.06	2	0.44	0.13–0.75	5
Mental Diagnosis	0.35	0.23–0.48	16	0.63	0.45–0.82	13	0.93	0.39–1.48	2
Behavioral Problems	0.42	0.12–0.73	5	0.35	0.14–0.56	8	0.21	-0.15–0.93	1
Location									
Office	0.31	0.02–0.62	6	0.83	0.08–1.57	1	0.58	0.12–1.04	2
Camp	0.21	-0.11–0.54	4	0.59	0.14–1.05	2	1.10	0.20–1.99	1
Hospital	0.49	0.35–0.63	8	0.57	0.35–0.78	7	0.46	0.08–0.84	3
Long-Term Residence	0.28	0.07–0.50	9	0.44	0.25–0.66	13	0.30	-0.28–0.88	2
Mode									
Group	0.34	0.22–0.47	13	0.54	0.38–0.70	15	0.20	-0.51–0.93	1
Individual	0.55	0.35–0.74	11	0.45	0.13–0.77	5	0.44	0.15–0.74	6
Combination	0.21	-0.24–0.65	2	0.58	-0.01–1.17	1	1.09	0.46–1.73	1

Note: *d* = effect size. *k* = Number of studies. Subscripts within a column for a given moderator reveal a significant contrast; subscripts "a" is used for $p < 0.05$. Qw not significant throughout.

Findings

The overall effectiveness of AAT as an intervention was assessed first by looking at ds for each outcome class (see Table 3). Effect sizes for changes in autistic spectrum behaviors were in the high-range ($d = 0.72$, $k = 4$, 95% CI = 0.23–1.22), while they were in the low to moderate range for well-being indicators ($d = 0.39$, $k = 27$, 95% CI = 0.29–0.50), and solidly in the moderate range for behavioral and medical indicators ($d = 0.51$, $k = 23$, 95% CI = 0.38–0.65 and $d = 0.59$, $k = 8$, 95%, CI = 0.26–0.77), respectively. Each of the overall effect sizes significantly differed from zero as evidenced by confidence intervals that did not cross into the negative range. These values represent some studies that employed control groups and some that did not, limiting confidence in the generalizability of the findings. However, we were able to empirically test whether studies that employed a control group differed from those which did not.

When compared, studies that used control groups did not significantly differ from those that did not across medical, well-being, or behavioral outcomes (see Table 3), suggesting the above-mentioned values are probably a good reflection of the general effectiveness of AAT. We also ran

bivariate correlations between rigor ratings and effect sizes to further assess the relationship between study rigor and strength of outcomes. The correlation between rigor and effect sizes for medical outcomes was r = -0.09 (k = 8), for behavioral outcomes r = -0.01 (k = 23), and for well-being outcomes r = 0.03 (k = 25). These values suggest a nonexistent or weak relationship between study rigor and effect size.

Consistent with the second objective of the study, we examined the stability of the average effect or the degree of heterogeneity across studies. Across the four outcome classes, tests of heterogeneity were not significant (i.e., all Q_w *ps* > 0.05). This means that the overall effect for each outcome class likely represents the effectiveness of AAT for those outcome classes. As significant heterogeneity was not found, the third objective of the study, to investigate whether certain variables moderate outcomes, was not technically needed. However, we decided to conduct exploratory moderator analyses as a means of producing questions about factors that may moderate AAT outcomes.

Several cautions are warranted when making inferences from the exploratory moderator analyses we conducted. First, many of the comparisons and effect size groupings lack stability because they are based on very few studies (i.e., less than four studies). For example, for the 13- to 17-year-old group only two studies contributed effect sizes to the well-being outcome, which limits our ability to understand how effective AAT is for this age group. When only a few studies contribute to a specific outcome for a particular moderator variable, confidence intervals are likely to have a higher range and often cross zero, which suggests high heterogeneity, and, therefore, lower confidence in the value. When a study contributes to one outcome for a particular moderator variable, such as is the case for aquatic animals for the well-being outcome, meta-analytic procedures and interpretations are not appropriate. A second caution is over-interpreting the presence or absence of significant differences between groups given that a priori predictions were not made. Third, given the large number of comparisons made in the exploratory analyses, there is a high likelihood that statistically significant differences were due to chance and do not reflect meaningful differences. Given these caveats, we hope that our presentation of moderator analyses serves to generate questions rather than to answer questions. We highlight some interesting patterns that might guide future investigations (see Tables 1, 2, and 3).

From the AAT studies included in this meta-analysis, dogs were used most often, and AAT most often targeted mental health concerns. In addition, AAT was used more with adults compared to minors. The data do not support the use of AAT with adolescents–though this inference is based on only two studies. The data suggest that use of dogs in AAT is consistently associated with moderately high effect sizes, which is not the case with all other animal groups. Specifically, the confidence intervals for studies using horses and aquatic and other animals often cross zero or are near to zero, which suggests that animal type does matter. While animal type seemed to matter, the presenting problem (e.g., medical, mental health, or behavioral) did not influence outcomes. Although not statistically significant different, a meaningful difference in effect sizes favors the use of individual delivery of AAT compared with group delivery for emotional well-being outcomes. The only statistically significant difference that was found showed that individuals with disabilities (d = 0.96, k = 3) benefited more than their counterparts (d = 0.33, k = 5) on medical outcomes.

We also explored the relationship between the number of AAT sessions and effect-size strength. The correlation between number of sessions and medical outcomes was negative (r = -0.57, k = 6), for well-being outcomes it was negative (r = -0.13, k = 14) and for behavioral outcomes it was positive (r = 0.22, k = 19). Though none of the correlations reached statistical significance, the correlation for medical outcomes suggests that more AAT is associated with fewer desirable outcomes.

The most rigorous tests of AAT that we found came from four studies that compared AAT with another treatment. Here, positive effect size values indicate AAT was superior to another treatment, while negative values indicate the opposite, and an effect size near zero suggests equal effectiveness. Marr et al. (2000) compared AAT with an exercise intervention and found that those involved in AAT interacted more with behavioral problem patients (d = 0.65) and smiled or showed more

pleasure (d = 0.68). In a study examining interaction patterns among older individuals in a psychiatric inpatient setting (Haughie, Milne and Elliott 1992), AAT had a more desirable social interaction pattern compared with a photography group (d = 0.41).

Another study conducted in long-term residential facility with older adults showed that AAT was just as effective as recreational therapy (d = 0.00) in promoting positive social interaction behaviors (Bernstein, Friedmann and Malaspina 2000). Lastly, Holcomb and Meacham (1989) reported that an AAT therapy group (Hug-a-Pet) delivered in an inpatient psychiatric setting boasted higher attendance than other therapy groups (d > 1.0).

Discussion

The results from this meta-analysis support the long-held impression that animals can help in the healing process. Positive, moderately strong findings were observed across medical well-being, and behavioral outcomes as well as for reducing Autism spectrum symptoms. Moreover, effect sizes across the four outcome areas were consistent or homogenous. Further support for the use of AAT came from four studies that compared AAT with established interventions and found that AAT was as effective as or more effective than other interventions. Taken together, these findings suggest AAT is a robust intervention worthy of further use and investigation. While the results of this research synthesis support the statement that "AAT is an effective intervention," the complexity of interventions in general and the variability of AAT use specifically demands that "subplots" are investigated.

Approximately half of the studies included in this meta-analysis employed a control or comparison group. Findings from these studies carry greater confidence compared with studies that do not employ a comparison group. However, many quantitative studies investigating AAT have not used comparison groups. To present a more representative sample of AAT studies, we included studies that did not include a control group. When we compared the outcomes of these two design types, no significant differences were found. Thus, we believe that results from uncontrolled studies can be legitimately presented alongside those using comparison groups. The increased number of studies allowed for greater power in assessing heterogeneity of variance and potential group differences.

While speculative, given that the summary values were homogenous and only one exploratory group difference reached the level of statistical significance, several questions and patterns emerged from the exploratory moderator analyses which might spawn discussion or research on the conditions under which AAT is most effective. For example, young children consistently benefited across all outcome variables including symptoms associated with Autism. Other age groups, however, were less consistent in the degree to which they benefited from AAT. While the reasons for these patterns are not known, it may be that young children are more accepting of an animal's influence.

Another interesting pattern was that non-disabled individuals showed stronger and more reliable benefits compared with individuals with disabilities, in the well-being and behavioral categories. Interestingly, considerable variance existed in the studies focusing on individuals with disabilities in well-being and behavioral dependent variables, as evidenced by confidence intervals that included negative values. This pattern conflicts with clinical lore coming from qualitative studies on AAT suggesting that disabled individuals benefit more through the use of AAT. The idea that AAT is particularly effective with disabled populations may be a function of hope that AAT will reach this difficult-to-help population rather than a reality. Yet, individuals with disabilities did show much stronger and reliable improvement compared with their non-disabled counterparts for the medical outcome dependent variables. While clear patterns about the potential influence of participants presenting problems or treatment location did not emerge, there may be an advantage to delivering AAT in an individual, compared with a group format, if the goal is to promote recipients' well-being or enhance medical outcomes.

Dogs were the most commonly used animals in the studies included in this research synthesis. This pattern may arise from dogs being domesticated and easily accessed and trained. The higher

use of dogs may also have arisen from service providers observing that dogs have a more salient impact than other animals. Regardless of why dogs were used more often, the pattern of effect sizes and confidence intervals strongly suggest that dogs have a greater chance of being effective compared with other animals. While our data cannot answer why this is the case, the adage that a dog is man's best friend may be extended to a "dog is an AAT service provider's best choice."

Our study investigated if AAT is effective at accomplishing its objectives and whether participant or treatment characteristics influenced outcomes and not how AAT is effective or why certain conditions moderate outcomes. As was mentioned, the answer to the question about "if" AAT is effective is "yes," and the answer to questions about "whether" participant or treatment characteristics influence outcomes seems to be "not in a significant manner." Our study was not designed to address questions of "how" or "why" AAT is effective under various conditions. In this vein, our assessment of the AAT literature is a dearth of theories aimed at explaining the mechanisms through which animals influence medical interventions. A stronger theoretical base would likely guide specific research questions that could address how AAT influences the healing process and the conditions under which AAT could be expected to be most beneficial.

Conducting this study presented the authors with an opportunity to read many articles on AAT. From our reading, we offer several comments, which may support future research on AAT. First, further research needs to be conducted, especially research that examines the conditions under which AAT might be most helpful. For example, we did not find studies that compared the use of different animals or how the same animal might influence individuals of varying backgrounds.

Second, we believe there is now a sufficient body of quantitative and qualitative studies detailing the effectiveness of AAT that anecdotal reports or case studies are not needed as much as rigorous studies. Studies that investigated AAT but were ineligible for inclusion seemed enthusiastic about AAT and tended to advocate its use. Our impression is that practitioners who are interested in AAT will use such reports to reinforce their beliefs about the value of AAT. However, more skeptical audiences, such as administrators of budgets who might fund AAT interventions or research, require a higher standard to begin to endorse the use of nontraditional therapies. The results from this meta-analysis and from other high-quality investigations of AAT begin to build a case for the efficacy of AAT. However, more research and theory development is needed.

Conclusion

Our findings support the continued use and investigation of AAT. While we had hoped to provide suggestions on how AAT might be used in specific practice settings or for particular groups, our findings and the nature of the current literature do not indicate conditions under which AAT may be most beneficial. There are several limitations to the findings of this meta-analysis. First, the oft-cited criticism of meta-analysis "mixing apples with oranges" applies to some degree in this study, as the outcome classes (i.e., dependent variables) were broad, such as medical functioning, emotional well-being, and behavioral actions. These broad outcome classes seem to be a function of the wide range of problems targeted by AAT coupled with the fact that quantitative investigations of AAT are relatively new. While some see the lack of similarity in outcome measures across studies as a limitation in meta-analyses, others argue that variability in measuring dependent variables provides a robust picture of complex fields of study because many constructs are assessed through various strategies (Cooper and Hedges 1994; Lipsey and Wilson 2001). Similarly, there was considerable variation in the AAT interventions studied. As AAT is routinely used as an adjunct to other interventions, its deployment varies greatly. Such variance means that a universal understanding of what AAT is and how it is used does not exist. While some of this variance was accounted for through the moderator analyses we conducted, considerable variance still existed. AAT is generally delivered as an adjunct to other interventions; to gain further insight into the precise impact of AAT interventions, studies will need to be designed to account or control for the "confound" of using AAT with other interventions.

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