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## Abstract

To include dogs in educational practice is becoming increasingly popular. Particularly children with special educational needs are believed to benefit from dog-assisted interventions. However, reliable evidence that supports the use of dogs in education is still scarce. Also, reports on the effectiveness of this approach are often anecdotal. This review aims to answer the question, whether dog-assisted interventions in an educational setting can help children with special educational needs to improve their social situation and to develop their emotional, social and cognitive skills. Following the PRISMA Guidelines, the literature was systematically searched for experimental studies until February 2021. Eighteen studies could be finally included in this narrative synthesis. They varied greatly in type of intervention, measured outcomes, sample size and quality. Overall, the studies reported mixed results in the different functional domains of stress reduction, motivation, social skills and cognitive abilities, reading abilities, conduct and mental wellbeing. No study reported any negative effects of the intervention. Most reliable evidence comes from studies on dogs' effects on physiological stress response in challenging situations and on motivation and adherence to instructions. They reported significantly lower levels of cortisol in both children and pedagogues in the presence of dogs, as well as increased motivation to learn and participate. Findings for other academic or social outcomes, however, are inconclusive, not the least due to weak study designs. Moreover, data on long-term effects are missing altogether. Still, this review indicates the potentials of dog-assisted interventions in special pedagogy, particularly towards supporting calm and trustful social contexts.

## **Zusammenfassung**

Der Einsatz von Hunden in der Pädagogik gewinnt zunehmend an Popularität. Besonders Kinder mit sonderpädagogischem Förderbedarf können von Hundegestützten Interventionen profitieren. Wissenschaftliche Arbeiten zur Wirksamkeit von Hunden in der Pädagogik sind jedoch rar und beschränken sich häufiger auf Erfahrungsberichte als auf aussagekräftige Studien. Diese Übersichtsarbeit geht der Frage nach, ob Hundegestützte Interventionen im Schulalltag die sozialen, emotionalen und kognitiven Fähigkeiten von Kindern mit sonderpädagogischem Förderbedarf verbessern und zu erfolgreichem, stressfreiem Lernen beitragen können. Gemäß den PRISMA Guidelines wurden sechs Datenbanken nach experimentellen Studien durchsucht, die bis zum Februar 2021 veröffentlicht wurden. Es konnten 18 Studien in die narrative Zusammenfassung eingeschlossen werden, wobei die Unterschiede zwischen Art der Intervention, untersuchten Endpunkten, ProbandInnenzahl sowie Qualität groß waren. Insgesamt kamen die Studien zu gemischten Resultaten hinsichtlich Stressreduktion, Motivation, sozialen und kognitiven Fähigkeiten, Leseleistung, Verhalten und psychischem Wohlbefinden. Keine der Studien berichtete von negativen Effekten von Hundegestützten Interventionen. Die aussagekräftigsten Daten liefern Studien zum Effekt von Hunden auf die physiologische Stressreaktion in belastenden Situationen sowie auf Motivation und Konzentration. Sie berichteten signifikant niedrigere Cortisolspiegel in Anwesenheit von Hunden, sowohl bei den Kindern, als auch bei deren Pädagogen; außerdem signifikant höhere Motivation und Teilnahme an den Interventionen. Keine klare Evidenz gibt es derzeit für andere akademische oder soziale Endpunkte, was jedoch auch durch ungeeignete Studiendesigns, methodische Mängel und geringe Probandenzahl bedingt sein könnte. Die zusammengefassten Ergebnisse dieses Reviews weisen auf eine Wirksamkeit Hundegestützter Interventionen in der Sonderpädagogik und deren großes Potenzial hin. Belastbare Daten aus gut durchgeführten Studien und Studien zu Langzeit-Effekten fehlen jedoch.

## 1. Introduction

Human nature seems to include a specific affinity for nature and other living beings, known as *biophilia*. This term was coined by Erich Fromm, popularized by E.O. Wilson (Fromm, 1964; Kotrschal, 2019; Wilson, 1984). The *biophilia* concept provides an important evolutionary-theoretical basis for research in the area of human-animal relations (Friedman & Krause-Parello, 2018; Julius et al., 2012). In fact, the idea that humans seem to be adapted to live with animals is supported by a number of positive health effects, including reduced cardio-vascular risks, as well as an increased resilience against mental problems such as anxiety and depression (for reviews see e.g. Fine, 2015; Friedman & Krause-Parello, 2018; Julius et al., 2012; Wells, 2009). In the elderly, animals can reduce loneliness, depression and the advance of dementia (Lai et al., 2019). Companion animals may satisfy the basic human need for loving and being loved in a more “essentialised” way as even human partners would, because such animals do not judge their human partners looks, wealth, health, intelligence or political orientation. They may even function as social lubricants/catalysts, promoting social contacts between humans (Eddy et al., 1988; Mader et al., 1989; McNicholas & Collis, 2000) and may socially support their human partners by comforting them in demanding situations (Crossman et al., 2018; Krause-Parello et al., 2018; McCullough et al., 2018; Vagnoli et al., 2015).

The younger the children, the greater their interest in animals, in how strongly they are naturally drawn to animals. Actually, babies/toddlers are more attentive to animals than to other categories of items (DeLoache et al., 2011; Wedl & Kotrschal, 2009) and their first vocalizations are usually animal-related. Consequently, hardly any children’s book or movie is free of animals, although mostly in a metaphorical role (i.e. animals in this literature are mostly not represented in a biological way, but are heavily anthropomorphised) (Melson, 2009).

Such overwhelming importance of animals in early human ontogeny may be considered as a window into the recent evolutionary history of *Homo sapiens* (assuming that ontogeny at least coarsely repeats phylogeny), pointing at the importance of animals in human evolution. Also, by their universal animal orientation children themselves define contact with animals and nature as a crucial factor for their optimal development (Kotrschal, 2019). Ignoring this may lead to a “*nature deficit syndrome*” (Kotrschal, 2016; Louv, 2008), which manifests as suboptimal executive functions (Diamond, 2013). Thus, growing up in the company of, and in good relationships with, dogs or other animals seems to support social competence, empathy, cognition and even good health in adults (Endenburg & van Lith, 2011; Melson, 2009). In other words, children thrive best in an environment that – in terms of evolutionary past - resembles humankind’s natural environment, with animals being an essential part of it. Among other benefits, growing up with animals is thought to foster social and emotional skills and executive functions, such as impulse control, planning and working memory (Kotrschal, 2014, 2016).

In fact, dogs are man’s oldest and also socially most compatible and responsive companion animal (Kotrschal, 2014, 2016, 2018b). Although there is hardly any comparative data, it still seems that dogs are among the socially most potent companion animals in animal-assisted settings, pedagogy or therapy – and of course, as compared to horses, lamas or chickens, they are most practicable in such settings (Kotrschal, 2018a). Dogs have been playing a central role in animal-assisted therapy since the 1960s, when psychotherapist Boris Levinson discovered that withdrawn children opened up when his dog was present during sessions (Levinson, 1965; Podberscek et al., 2005). Even before this, psychotherapists such as S. Freud and C.G. Jung appreciated the benefits of a dog present in sessions with “difficult” clients (Fine, 2015). Ever since, animal-assisted activities and interventions in schools, youth welfare and health care facilities developed as a worldwide grassroot-movement. Hence, praxis rather than science was leading the bandwagon, which explains why scientific evidence towards the effectiveness of animal assisted activities and interventions for



supporting cognitive, social and emotional skills (etc.) was long lagging behind and is growing only recently (for review see Brelsford et al., 2017, Gee et al., 2017)

### 1.1. Animal-assisted intervention, activity, pedagogy and therapy

Animal-assisted interventions are goal-oriented, incorporating animals in health, education and human service for therapeutic purpose (Jegatheesan et al., 2014). Included are animal-assisted activities, animal-assisted education and animal-assisted therapy, just to name a few. These are to a certain degree overlapping categories. Animal-assisted activities are defined as relatively unstructured, non-goal-directed contacts with animals, mostly emphasizing fun and motivation. In contrast to therapy, animal-assisted activities are not necessarily administered by a professional trained in the field, nor in a health care context (e.g. visitation programs in nursing homes). Animal-assisted therapy, on the other hand, is per definition a highly structured and professionally administered intervention by trained therapists, for a defined population that is pursuing a certain clinical goal (Jegatheesan et al., 2014). Therefore, animal-assisted activities and animal-assisted therapy constitute the endpoints of the broad continuum of animal-assisted interventions (Friedman & Krause-Parello, 2018). While in animal-assisted therapy the dog is an essential, yet still assisting component of the work of a professional therapist, the dog itself qualifies as the main actor in animal-assisted activities and the role of the human partner there is mainly to ensure a pleasant and safe setting for client-dog interactions. The transition between the two domains is, however, often fluent and lines are not always easy to draw.

### 1.2. How animal-assisted-interventions work

Promising data suggest that integrating dogs in the curriculum can help children learn and make school more attractive to them (for review see Brelsford et al., 2017). Particularly children with special educational needs and/or emotional-behavioural disorders are at high risk of experiencing academic failure and

negative feedback, and therefore, develop fearful and aversive attitudes, which in turn block academic and societal success. Such a vicious circle is often started by suboptimal attachment patterns developed in early childhood (Julius et al., 2012) and by educational systems focussing on the weaknesses rather than strengths of individuals. Therefore, emotional dysregulation, impaired social skills and executive functions are common among children in need of special educational support. Those children might be particularly responsive to the positive effects of dog-assisted interventions.

What can animal-assisted interventions do for children with special educational needs? Before all, their presence can support a positive, concentrated atmosphere free of negative stress and fear, which is the precondition for optimal learning (Beetz, 2017). Dystress impairs cognition and mental mechanisms and negatively affects executive functions, including impulse control, self-motivation and working memory (Diamond, 2013). The possible calming and concentration-enhancing effects of animals are probably based on a combination of different interlinked neuronal and mental mechanisms (for review see Beetz, 2017); an overlapping set of such primarily social brain mechanisms are also used in “anthromorphising” (reviewed by Urquiza-Haas & Kotrschal, 2015).

The overarching evolutionary mental domain of all this is probably the aforementioned *biophilia*, the typically human, species-specific tendency to connect with nature and animals (Kotrschal, 2019; Wilson, 1984). It is found in humans regardless of cultural background, gender or age and reflects our evolutionary past, when modern *homo sapiens* mentally and cognitively developed over the past 300 000 years in close ecological and spiritual-cultural contact to nature and other animals. The mechanism of *acuity detection* is probably shared with other animals and has been crucial for surviving over human prehistory (Urquiza-Haas & Kotrschal, 2015). As a result, humans perceive aliveness generally more reliably and faster than inanimate objects (DeLoache et al., 2011). The presence of a calm and friendly animal generally has a relaxing and calming effect on humans, promoting the “*neuroception of safety*”, a

concept coined by Carter and Porges (2016). Because animals and their behaviour provided valuable information about changes and threats in the habitat, our ancestors probably developed a perception of them as sentinels and intuitively and unconsciously interpreted a calm animal as an indication of safety. The specifically human curiosity in the context of *biophilia* and an atmosphere of safety and trust created by a friendly animal is thought to be the general base for the efficiency of animal-assisted interventions and animals as a source of comfort and motivation for children.

An important mechanism involved is the activation of the oxytocin system. Oxytocin (OT) is a nonapeptide hormone released through childbirth and breast feeding, female orgasms, different kinds of pleasant intimate body contact and even by looking into the eyes of bonding partners, be it humans or dogs (Nagasawa et al., 2015; Uvnäs-Moberg et al., 2011). Oxytocin antagonises the synthesis of the main metabolic and stress-related steroid hormone cortisol. Through positive reinforcement via the limbic system, OT promotes bonding, supports empathy, socio-positive behaviour and bonding/attachment. It decreases anxiety and group-internal aggression and buffers stress via inhibition of the cortisol synthesis (Uvnäs-Moberg et al., 2011).

Physical contact with a companion animal - similarly to between-human body contact – may increase oxytocin levels. For example, stroking and petting their dog, leads to higher oxytocin levels in the owners – and in the dog (Beetz, Uvnäs-Moberg, et al., 2012; ). In our society and particularly in education, physical contact is rare and standardised distance prevails. Animals could compensate for this. For children, they can provide an opportunity for low-threshold, unconditional, stress-free body contact, and subsequent comfort, particularly in cognitively and socially challenging situations.

Companion animals may even become attachment figures, fulfilling the attachment criteria of Bowlby and Ainsworth (secure base, haven of safety, spatial proximity and separation distress; Ainsworth, 1991; Julius et al., 2012). This is particularly notable, given that in special education, a majority of the children show insecure or disorganised attachment styles (Julius et al., 2012),

impairing them to find security and social support in other people. However, the negative internal social working model of suboptimal attachments styles that can toxify human relationships might not be fully transferred to animals (Kurdek, 2008; Wedl et al., 2015). Thus, animals can provide valuable social support and thereby effectively reduce stress in emotionally and socially challenged children, breaking the vicious circle a lot of those children are trapped in.

### 1.3. What this review is about

Dog-assisted education has been studied and reviewed in the past (Brelsford et al., 2017). To my knowledge, there is, however, no concise review of the specific effects of animal-assisted interventions on children with special educational needs so far. This would be particularly useful, as institutions, governmental and other, need to justify the extra effort and odds potentially associated with animal-assisted approaches, as the case with animal-assisted interventions.

In this review, I aim to tackle the following questions: Is there robust evidence, that dogs can help children with special educational needs to improve their emotional, social and cognitive skills? Can dog-assisted interventions improve academic performance and learning? Can it reduce stress and enhance executive functions and therefore academic success? Can dogs facilitate concentration and motivation and make learning more rewarding for those children? Do the potential effects justify animal assistance in special pedagogy?

## 2. Methods

### 2.1. Literature search

I conducted this systematic literature review according to the PRISMA guidelines for systematic reviews and meta-analyses, following a prior established protocol (Moher et al., 2009). I ran a systematic literature search in the scientific databases Pubmed, Scopus, Embase, PsycINFO and Taylor & Francis Online, from their start date to May 2020. In order not to miss any relevant, recently published studies, I repeated the search in February 2021, using the same search strategy. As search terms I used special education, special educational needs, behavioural problems combined with animal-assisted intervention, animal-assisted education, dogs and canine. I also searched the references of recent systematic reviews, as well as the Hochschulschriften Database of the University of Vienna and the database ProQuest for unpublished dissertations on the topic. For the comprehensive search strategy, see Appendix (7.1).

### 2.2. Eligibility of studies

I specified search strategy, eligibility and exclusion criteria following the PICO-scheme along a prior established protocol. A study qualified for inclusion, if

- a) it had been conducted in an educational setting involving children and adolescents up to 18 years of age with special educational needs. Special educational needs were defined as problems with behaviour, conduct and learning requiring extra support in form of special education groups or classrooms, or in youth welfare institutions.
- b) it focused on the effects of animal-assisted interventions incorporating dogs, irrespective of duration or type of these interventions. Studies on incorporating dogs in therapeutic programs and explicit animal assisted therapy settings (see definition above) were excluded.

- c) it was a controlled interventional study with no animal assisted intervention in the control group. Cross-over studies, where participants served as their own control are particularly adequate at low sample sizes and were included as well. Case series and case reports without controls, anecdotal reports and cross-sectional studies or surveys were excluded.
- d) the investigated outcome was the children's social or cognitive or academic performance, stress parameters (quantified by questionnaire, cortisol levels or physiological parameters), mental health or subjective well-being. Hence, studies concerned with animal-assisted interventions and physical health outcomes only (e.g. fitness or obesity) were excluded.
- e) the study design was experimental and the authors provided quantitative data, or data from which quantitative data could be calculated. Studies providing qualitative data only were excluded.

For the PICO scheme used and eligibility criteria in detail, see Appendix (7.1). No restrictions on language or study duration were being made.

### 2.3. Data extraction

For all studies included, I extracted the following information: Study design and setting, population characteristics (including number of participants, diagnosis, gender and age), type and duration of intervention, control condition, data on the dogs involved, measured outcomes, tools of measurement used and results.

### 2.4. Quality Assessment

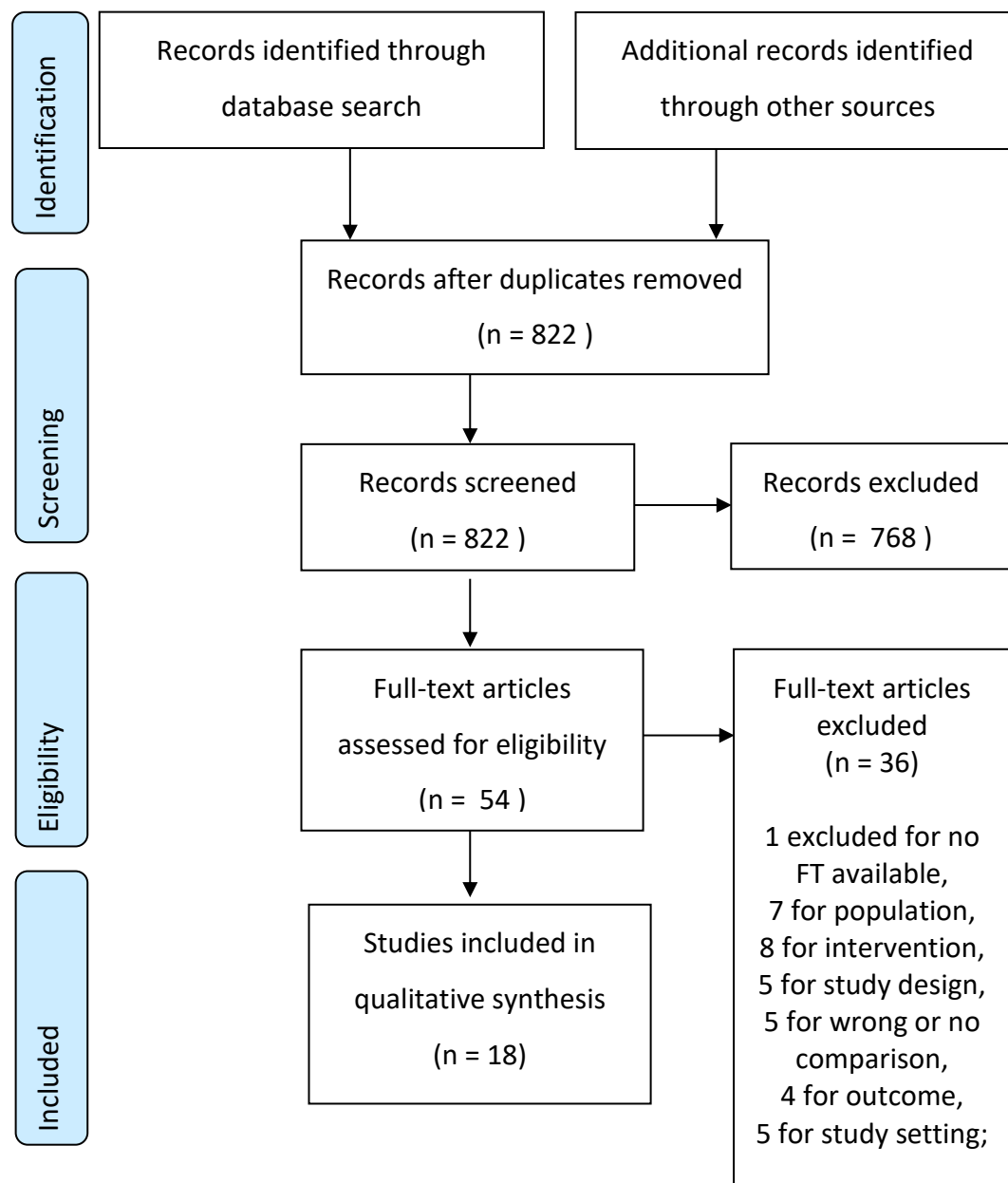
Risk of bias was assessed using a modified 4-domains-version of the The Risk Of Bias In Non-randomized Studies – of Interventions (ROBINS-I) assessment tool by the *Cochrane Collaboration* (Sterne et al., 2016). I assessed quality and risk of bias in four domains: Selection (including bias arising from recruitment, randomisation or differences in baseline characteristics of participants), comparability (including performance bias due to differences in conditions for intervention- and control-

group), data collection (bias due to lack of blinding or inappropriate tools of measurement) and attrition (bias due to high drop-out rates, missing data or selective reporting). If more than one outcome was investigated in a study, risk of bias was assessed for each outcome separately. For details see Appendix (7.2). Due to the nature of the interventions in question, blinding of participants and educators is hardly possible. With this in mind, risk of bias from lack of blinding was rated low, if either the assessor of the outcome was blinded, or if blinding was not possible, but an impact on the results was very unlikely. Risk of bias was rated moderate, if there was no blinding and a moderate risk for an impact on the results, or if blinding of the outcome assessor technically had been feasible but was not done. Risk of bias was rated high, if there was no blinding and an influence on the results could be assumed.

### 3. Results

I identified 822 records through database searching up to February 2021, of which 54 were eligible for full text screening. After the exclusion of 36 papers according to the predefined criteria (above), I was able to include 18 studies in the final synthesis (see Figure 1, Table 1). For a list of all excluded studies and reasons for exclusion, see Appendix (7.3).

Figure 1 **PRISMA Flow Diagram**<sup>1</sup>



<sup>1</sup> Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *BMJ* 2009;339:b2535



Quality, study design and investigated outcome varied greatly between studies. Characteristics of the included studies are summarised in

Table 1; results in

Table 2. For quality assessment of each included study, see Appendix (7.2).

Twelve of the studies included were conducted in the United States, six in Europe and one in South Africa. Most of them used a cross-over experimental design in which every child served as his or her own control (11). Two were pre-post intervention studies, two controlled trials and two randomised controlled trials. In all the studies included, the intervention was either a short-term integration of one or more dogs in the curriculum (7 studies) or a test situation in which the children's performance in the presence of a dog was compared to performance without (11 studies). Fifteen studies were conducted at schools, preschools or kindergartens, two studies in a therapeutic housing program for children and adolescents with behavioural problems in Austria (*Lebensraum Heidlmaier®*) (Hutter, 2015; Martens, 2015). Two studies recruited children with special educational needs from a special education therapeutic day program and a residential treatment centre (Becker et al., 2017), or a local health care organisation (Uccheddu et al., 2019), respectively. Sample size was small in most of the studies and varied greatly, from 3 to 102 participants. Even though the majority of the studies employed a within-subject design (internal control) to compensate small sample size, this remains a methodological problem.

Due to the great heterogeneity of the included studies, a formal meta-analysis of the results was not feasible. Hence, I summarise the main results by outcome.

Table 1 Characteristics of included studies

Study	Study design	Country	Population	Intervention	Comparison	Duration	Outcomes (tool used)
<b>Becker et al., 2017</b>	controlled trial	USA	N = 31 (3 girls, 28 boys); Autism spectrum disorder; 8-14 years	Dog-assisted social skills training (N=17)	Social skills training without dog (N=14)	1 h/week, for 12 weeks	1) Social skills (SLDT <sup>2</sup> ; SRS-2 <sup>3</sup> ) 2) Theory of Mind (RMET <sup>4</sup> ) 3) Depression (CDI-2 <sup>5</sup> )
<b>Beetz et al., 2011</b>	Randomised controlled trial	Germany/ Austria	N = 31 (all boys); Insecure/ disorganised attachment style; 7-12 years	Trier Social Stress Test with social support from a friendly dog (N=11)	Trier Social Stress Test with social support from 1) a toy dog (N=9) 2) a friendly adult (N=11)	1-2 h	1) Stress response (salivary cortisol) 2) Self-reported stress level (SAM <sup>6</sup> ) 3) Interaction with social support (behavioural sampling)
<b>Beetz, Julius, et al., 2012</b>	Randomised controlled trial	Germany/ Austria	N = 47 (all boys); Insecure/ disorganised attachment style; 7-11 years	Trier Social Stress Test with social support from a friendly dog (N=24)	Trier Social Stress Test with social support from 1) a toy dog (N=13) 2) a friendly adult (N=10)	1-2 h	1) Stress response (salivary cortisol) 2) Self-reported stress level (SAM <sup>5</sup> ) 3) Interaction with social support (behavioural sampling)

<sup>2</sup> Social Language Development Test

<sup>3</sup> Social Responsiveness Scale, Second Edition

<sup>4</sup> Reading the Mind in the Eyes Task

<sup>5</sup> Children's Depression Inventory 2nd Edition

<sup>6</sup> Self-assessment manikin

<b>Clune, 2020</b>	Non-randomised controlled trial	USA	N = 7 (2 girls, 5 boys); Dyslexia; Grade-3 students	Reading to a dog in reading-aloud sessions (N=4)	Reading-aloud sessions without dog (N=3)	2 x 20 min for 7 weeks	1) Reading fluency (easyCBM <sup>7</sup> ) and accuracy 2) Reading anxiety and attitude towards reading (questionnaire)
<b>Esteves &amp; Stokes, 2008</b>	Pre-post study	USA	N = 3 (1 girl, 2 boys); Down's Syndrome, Mental retardation; 5-9 years	Play sessions with toys and a real dog	Play sessions with toys including a toy dog	8-minute sessions, 5x/week;	Communicative behaviour towards dog/caretaker (behavioural sampling)
<b>Gee et al., 2009</b>	Crossover design	USA	N = 11 (5 girls, 6 boys); Mixed sample of an inclusive preschool classroom (5 typically developed, 9 SEN <sup>8</sup> -students); 3-5 years	gross motor skills tasks performed together with a dog	gross motor skills tasks performed together with  1) a toy dog, 2) a friendly adult 3) alone	15-20 minutes	Adherence to instructions (7-points scale and video recording)
<b>Gee, Crist, et al., 2010</b>  <b>Experiment 1</b>	Crossover design	USA	N = 12 (6 girls, 6 boys); Mixed sample of an inclusive preschool classroom (5 typically	Object recognition/memory task performed in the presence of a dog	Object recognition/memory task performed in the presence of	NR <sup>9</sup>	Adherence to task (number of prompts needed to perform task)

<sup>7</sup> easyCBM Passage Reading Fluency Assessment

<sup>8</sup> special educational needs

<sup>9</sup> Not reported

			developed, 7 SEN-students); 3-5 years		1) a toy dog or 2) a friendly adult		
<b>Gee, Crist, et al., 2010</b>  <b>Experiment 2</b>	Crossover design	USA	N = 10 (5 girls, 5 boys); Mixed sample of an inclusive preschool classroom (5 typically developed, 5 SEN-students); 3-5 years	Object recognition/ memory task performed in the presence of a dog	Object recognition/ memory task performed in the presence of  1) a toy dog or 2) a friendly adult	NR	Adherence to task (number of prompts needed to perform task)
<b>Gee, Church, et al., 2010</b>	Crossover design	USA	N = 12 (5 girls, 7 boys); Mixed sample of an inclusive preschool classroom (7 typically developed, 5 SEN-students); 3-5 years	object categorization task performed in the presence of a dog	object categorization task performed in the presence of  1) a toy dog or 2) a friendly adult	3 x 10 minutes within 3 weeks	Accuracy of category choice (correctly identifying the object that “goes with” another object)
<b>Gee, Gould, et al., 2012</b>	Crossover design	USA	N = 17 (10 girls, 7 boys); Mixed sample of an inclusive preschool classroom (11 typically	Object categorization task performed in the presence of a dog	object categorization task performed in the presence of  1) a toy dog or 2) a friendly adult	NR	Accuracy of category choice for animate vs. inanimate objects (correctly identifying the object that “goes with” another object)

			developed, 6 SEN-students); 3-5 years				
<b>Gee, Belcher, et al., 2012</b>	Crossover design	USA	N = 20 (9 girls, 11 boys); Mixed sample of an inclusive preschool classroom (12 typically developed, 8 SEN-students); 2-5 years	Object recognition/ memory task performed with a dog as collaborator	Object recognition/ memory task performed with a friendly adult as collaborator	NR	Accuracy and speed of object recognition
<b>Hutter, 2015</b>	Crossover design	Austria	N = 9 (4 girls, 5 boys); Insecure/disorganised attachment, behavioural problems; 5-12 years	Two attachment-based dyadic play sessions with a pedagogue and dog	Two attachment-based dyadic play sessions with a pedagogue alone	4 sessions of 20 minutes each	1) Socio-positive and socio-negative interactions (behaviour sampling) 2) Stress response during sessions of children and pedagogues (salivary cortisol)
<b>Kirnan et al., 2020</b>	Retrospective pre-post study	USA	N = 4 (all boys); Learning and behavioural problems; Age not reported	Visiting and reading sessions with a dogs	retrospective data collected before intervention started	5 to 13 sessions from 2013 to 2015	Children's conduct in the classroom according to teacher-protocols
<b>Le Roux et al., 2014</b>	Randomised controlled trial	South Africa	N = 102 (gender not reported);	Sessions of reading to an adult and a dog (N=27)	1) Sessions of reading to an adult (N = 26)	10 weekly sessions of	Reading rate, accuracy and comprehension (Neale Analysis of Reading Ability)

			Students identified as very poor to poor readers; 7-13 years		2) reading to a teddy bear (N = 24) 3) no intervention (N = 25)	20 minutes each; Re-assessment after 18 weeks	
<b>Limond et al., 1997</b>	Crossover design	UK	N = 8 (6 girls, 2 boys); Down's Syndrome; 7-12 years	7 minutes interaction with a dog	7 minutes interaction with a toy dog of same size	14 minutes (2x7) once a week for 6 weeks	Communicative behaviour towards dog/caretaker (behavioural sampling)
<b>Martens, 2015</b>	Crossover design	Austria	N = 50 (22 girls, 28 boys); Socially challenged children/juveniles with adjustment disorders and/or problems with social conduct or learning in a therapeutic housing program; 5-17 years	Dinner situation in the presence of a friendly dog	Dinner situation without dog	5 visits during dinner (2 with dog, 2 without dog)	1) Stress level of participants during dinner (salivary cortisol) 2) Behaviour and social atmosphere during dinner (behaviour sampling)
<b>Somervill et al., 2009</b>	Crossover design	USA	N = 17 (4 girls, 13 boys);	15-minutes sessions with 5 minutes body contact with a dog	15-minutes sessions without a dog	1 intervention- and 1 control-	1) systolic and diastolic blood pressure and heart rate (upper arm blood pressure device)

			Attention-Deficit/Hyperactivity Disorder and/or Oppositional Defiant Disorder; 9 years			sessions on 2 test-days	2) Behaviour after sessions: mood, attention, anxiety, calmness and disruptive behaviour rated by teacher on a 5-point scale
<b>Uccheddu et al., 2019</b>	Randomised controlled trial	Italy	N = 9 (2 girls, 7 boys); Autism spectrum disorder; 6-9 years	Reading sessions in the presence of a dog (N = 5)	Reading sessions without a dog (N = 4)	10 session of 30 minutes over a period of 70 days	1) Reading ability (MT2 <sup>10</sup> , MCF <sup>11</sup> , TORC <sup>12</sup> ) 2) Cognitive abilities (WISC IV <sup>13</sup> , Vineland Test; IQ)

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<sup>10</sup> Cornoldi reading test

<sup>11</sup> Metaphonological competence

<sup>12</sup> Test of reading comprehension

<sup>13</sup> Wechsler Intelligence Scale for Children

Table 2 Results

Study	Population	Intervention	Results	Effect	Quality
<b>Stress reduction/cortisol</b>					
<b>Beetz et al., 2011</b>	Insecure/ disorganised attachment	Social support from a dog during a stressful task	<ul style="list-style-type: none"> <li>• Less increase in salivary cortisol and lower mean cortisol levels in the presence of a dog</li> <li>• Faster recovery after test in the presence of a dog</li> <li>• The more body contact with the dog, the lower cortisol levels after the test</li> </ul>	↑	high
<b>Beetz, Julius, et al., 2012</b>	Insecure/ disorganised attachment	Social support from a dog during a stressful task	<ul style="list-style-type: none"> <li>• lower mean cortisol levels in the presence of a dog</li> <li>• Same rise in cortisol levels during test in all groups, but significantly faster recovery in the presence of a dog</li> <li>• The more body contact with the dog, the lower cortisol levels after the test</li> </ul>	↑	high
<b>Hutter, 2015</b>	Insecure/disorganised attachment, behavioural problems	Two attachment-based dyadic play sessions with a pedagogue and dog	<ul style="list-style-type: none"> <li>• No differences in cortisol levels of children in intervention- and control-group.</li> <li>• Significantly lower cortisol levels in pedagogues when dog was present</li> </ul>	↔	high
<b>Martens, 2015</b>	Adjustment disorders, problems with social conduct or learning	Presence of a dog during dinner in a therapeutic housing program	<ul style="list-style-type: none"> <li>• No differences in cortisol levels of children in intervention- and control-group.</li> </ul>	↔	high
<b>Somervill et al., 2009</b>	Attention- Deficit/Hyperactivity Disorder, Oppositional Defiant Disorder	5 minutes body contact with a dog	<ul style="list-style-type: none"> <li>• Increased blood pressure after holding the dog</li> <li>• Decreased heart rate after holding the dog</li> <li>• No calming effect of contact with dog observable</li> </ul>	↔	low






Motivation / concentration / adherence to tasks					
Gee et al., 2009	Mixed sample of an inclusive preschool classroom	Adherence to instructions in a motor skills tasks performed together with a dog	<ul style="list-style-type: none"> <li>No overall significant difference between dog- and control-groups</li> </ul>	↔	high
Gee, Crist, et al., 2010	Mixed sample of an inclusive preschool classroom	Object recognition/ memory task with a dog as collaborator	<ul style="list-style-type: none"> <li>Children needed significantly fewer prompts in the presence of a dog than in the presence of a human; no significant differences in prompts needed in the presence of a real dog compared to a toy dog (Experiment 1)</li> <li>Children needed significantly fewer prompts in the presence of a dog than in the presence of a toy dog; no significant differences in prompts needed in the presence of a real dog compared to a human (Experiment 2)</li> </ul>	↑	moderate
Clune, 2020	Dyslexia	Reading to a dog in reading-aloud sessions	<ul style="list-style-type: none"> <li>Improved motivation to read and self-perception as a reader</li> </ul>	↑	low
Uccheddu et al., 2019	Autism spectrum disorder	Reading sessions in the presence of a dog	<ul style="list-style-type: none"> <li>Increased overall attendance in reading sessions in dog-group (100%) compared to no-dog-group (75%)</li> </ul>	↑	high
Social skills / communication					
Becker et al., 2017	Autism spectrum disorder	Dog-assisted social skills training	<ul style="list-style-type: none"> <li>No significant differences between dog- and control-group in emotion recognition and verbal and non-verbal social skills</li> </ul>	↔	moderate
Esteves & Stokes, 2008	Down's Syndrome, Mental retardation	Play sessions with a dog	<ul style="list-style-type: none"> <li>Increase in positive interactions with pedagogue and dog</li> <li>No difference in negative interactions between groups</li> </ul>	↔	low

<b>Hutter, 2015</b>	Insecure/disorganised attachment, behavioural problems	Two attachment-based dyadic play sessions with a pedagogue and dog	<ul style="list-style-type: none"> <li>Significantly more engagement in play, socio-positive behaviour, laughing and greater attachment security with dog present</li> <li>Significantly fewer aggression and obsessive-compulsive behaviour with dog present</li> </ul>	↑	high
<b>Limond et al., 1997</b>	Down's Syndrome	7 minutes interaction with a dog	<ul style="list-style-type: none"> <li>No difference in frequency of communication with the pedagogue in dog- and control-condition</li> <li>Children were significantly more interested in the dog than the toy dog.</li> </ul>	↔	moderate
<b>Martens, 2015</b>	Adjustment disorders, problems with social conduct or learning	Presence of a dog during dinner in a therapeutic housing program	<ul style="list-style-type: none"> <li>Significantly more talking and involvement in conversation, more cheerful behaviour, sitting in a relaxed way when the dog was present</li> <li>Significantly fewer signs of nervousness and aggressive behaviour</li> <li>No difference in expressions of sadness or boredom and time spent interacting with another</li> </ul>	↑	moderate
<b>Cognitive abilities</b>					
<b>Gee, Church, et al., 2010</b>	Mixed sample of an inclusive preschool classroom	Object categorization task with a dog as collaborator	<ul style="list-style-type: none"> <li>Significantly fewer mistakes in the presence of a dog compared to a human or a toy dog</li> </ul>	↑	high
<b>Gee, Gould, et al., 2012</b>	Mixed sample of an inclusive preschool classroom	Object categorization task with a dog as collaborator	<ul style="list-style-type: none"> <li>No significant differences in correct categorisations between performance the presence of a dog, a human or a toy dog.</li> <li>More accurate categorisation of animate objects with the dog</li> </ul>	↔	moderate
<b>Gee, Belcher, et al., 2012</b>	Mixed sample of an inclusive preschool classroom	Object recognition/ memory task with a dog as collaborator	<ul style="list-style-type: none"> <li>Significantly faster and more accurate memory performance when collaborating with a dog compared to a human or a toy dog</li> </ul>	↑	high

<b>Uccheddu et al., 2019</b>	Autism spectrum disorder	Reading sessions in the presence of a dog	<ul style="list-style-type: none"> <li>No significant differences in intelligence quotient and social skills between dog- and control-group</li> </ul>	↔	high
<b>Reading abilities</b>					
<b>Clune, 2020</b>	Dyslexia	Reading to a dog in reading-aloud sessions	<ul style="list-style-type: none"> <li>Improved fluency and accuracy and less reading-anxiety in dog-group</li> </ul>	↑	low
<b>Le Roux et al., 2014</b>	Students identified as very poor or poor readers	Sessions of reading to an adult and a dog	<ul style="list-style-type: none"> <li>Significantly higher reading accuracy and reading comprehension during sessions with a dog</li> <li>Not all measured outcomes are reported</li> </ul>	↔	moderate
<b>Uccheddu et al., 2019</b>	Autism spectrum disorder	Reading sessions in the presence of a dog	<ul style="list-style-type: none"> <li>No significant differences in reading abilities between dog- and control-group</li> </ul>	↔	high
<b>Conduct/general behaviour</b>					
<b>Kirnan et al., 2020</b>	Learning and behavioural problems	Visiting- and reading-sessions with a dogs	<ul style="list-style-type: none"> <li>More negative behaviour on dog-days in two of four children</li> <li>No difference of behaviour between dog-days and non-dog-days in one child</li> <li>More positive behaviour on dog-days in one child</li> </ul>	↔	low
<b>Somervill et al., 2009</b>	Attention-Deficit/Hyperactivity Disorder,	5 minutes body contact with a dog	<ul style="list-style-type: none"> <li>No difference in teacher-rated level of happiness, arousal, attentiveness, anxiety or disruptive behaviour one hour after the dog-contact</li> </ul>	↔	low

	Oppositional Defiant Disorder				
<b>Mental wellbeing</b>					
<b>Becker et al., 2017</b>	Autism spectrum disorder	Dog-assisted social skills training	<ul style="list-style-type: none"> <li>Sign. decrease in depressive symptoms in both dog- and control group, but no difference between groups</li> </ul>	↔	moderate
<b>Beetz et al., 2011</b>	Insecure/disorganized attachment	Social support from a dog during a stressful task	<ul style="list-style-type: none"> <li>No difference in self-reported stress level or mood between dog- and control-group</li> </ul>	↔	high

-  Statistically significant positive effect of the intervention  
 No statistically significant effect or inconclusive results  
 Negative effect of the intervention

### 3.1. Physiological parameters of stress

Five studies reported a reduction of stress parameters via either salivary cortisol or heart rate and blood pressure.

In Beetz et al. (2011) and Beetz, Julius, et al. (2012) social support by a dog during a stressful test situation (Trier Social Stress Test) resulted in statistically significant lower overall cortisol levels in insecurely or disorganised attached boys (N= 31 and N=47, respectively), compared to social support by a human or a toy dog. Although the boys in the dog condition started out with higher cortisol levels, cortisol rose only slightly and dropped significantly more rapidly after the test, indicating a faster recovery from the stressful situation due to the presence of the dog. There was also an inverse correlation between intensity of body contact with the dog and salivary cortisol, with more stroking and petting resulting in lower cortisol levels.

Hutter (2015) investigated the effects of adding a dog to attachment-based dyadic play sessions for children with attachment and behavioural problems. Although their expectations of lower cortisol levels in children in the presence of a dog could not be confirmed, they found a rather unexpected effect in the involved pedagogues, who showed significantly lower cortisol levels when a dog was involved in the play sessions. Notably, a dose-response-relationship was described in all three studies: The more the children stroked and interacted with the dog, the lower their cortisol levels and the faster they dropped.

Martens (2015) investigated how the presence of a dog would affect stress levels during communal dinner in a therapeutic housing program for children with adjustment disorders or problems with social conduct or learning. Although remarkable positive effects on behaviour, communication and social atmosphere in the presence of the dog were observed (see below), cortisol levels were not different compared to the no-dog-condition. However, the authors state that cortisol levels in the dinner situation were generally low regardless of condition.

Lastly, Somervill et al. (2009) tested the calming effect of brief body contact with a lap dog on children with attention-deficit disorder and reported mixed results.

They observed increased blood pressure and decreased heart rate in the children after five minutes of holding the small dog on their laps. Thus, overall, the expected overall calming effect could not be confirmed in this study.

### 3.2. Social skills / styles of interacting and communicating

In five studies it was investigated, whether dog-assisted interventions would support social skills and the quality of communication between children and pedagogues.

In Hutter (2015), nine children with attachment and behavioural problems showed significantly more socio-positive behaviour and attentiveness to the pedagogue and enhanced play commitment when a dog was involved in their play sessions. Dog-accompanied children laughed more frequently and were more engaged in play and there was significantly less aggressive and obsessive-compulsive behaviour. The same positive effects could be observed in the involved pedagogues.

In Martens (2015) the mere presence of a dog during dinner in a therapeutic housing program for children and adolescents with behavioural problems resulted in a significantly improved communication, featuring overall more talking and involvement in conversation, more cheerful and relaxed behaviour and less nervousness and aggressive behaviour in the 50 participants. In addition, the authors rated the atmosphere during dinner as less tense and noise levels as lower when the dog was present.

Both Limond et al. (1997) and Esteves and Stokes (2008) looked into the effects of playful interactions with a therapy dog in children with Down's Syndrome, with the second study (2008) intending to replicate the design of the preceding one (1997). Both studies yielded mixed results: Limond et al. (1997) found that children did not initiate communication with the involved pedagogue more frequently when the dog was present, although the children were significantly more interested in the dog than the toy dog that was provided in the control condition. In contrast, Esteves and Stokes (2008) found that children initiated

positive interactions with their pedagogues significantly more often when the dog was present. However, there was no difference between socio-negative interactions between dog and no-dog conditions. As the authors provided observational data on single-participants only, with no information on statistical significance, an objective interpretation of these results is not possible. Lastly, Becker et al. (2017) found no statistically significant improvement of emotion recognition and verbal and non-verbal social skills after social skills training with a dog compared to training without dog in 31 children with autism spectrum disorders.

### 3.3. Motivation, concentration and adherence to tasks

Gee and colleagues conducted five studies on children performing memory- and gross motor skills-tasks in a mixed classroom with both children developed within the normal range and children with special educational needs. In three of their studies, the authors reported on the children's concentration and adherence to the given tasks, quantified by the number of additional instructions and prompts that were required.

In Gee et al. (2009) eleven children performed a motor skills task either alone or together with a trained therapy dog, a friendly college student or a stuffed toy dog. There was no difference in adherence to instructions between the four conditions. In Gee, Crist, et al. (2010) and Gee, Church, et al. (2010) children needed significantly fewer instructional prompts in a memory task with a real dog as their "collaborator" compared to tasks performed with a toy dog or a friendly college student. According to the authors, this might reflect a motivation-increasing effect of the dog.

Clune (2020) found improved motivation to read and self-perception as a reader in four students with dyslexia after reading sessions in the presence of a dog, compared to three students who completed the same reading sessions without a dog. However, the author provided no information on statistical significance.

The study by Uccheddu et al. (2019) was the only one providing quantitative data on attendance and motivation to go to school. They found that attendance of reading session was significantly higher on “dog-days” – namely 100 percent – than on no-dog-days, on which on average only 75 percent of the children were present. Although their sample was small (N=9), results indicate an increased motivation to attend reading sessions because a dog was present.

### 3.4. Cognitive abilities

Four studies reported on the effects of animal-assisted interventions on cognitive abilities such as memory, object categorisation and intelligence quotient (IQ).

The sample in the three studies by Gee and colleagues (Gee, Church, et al., 2010; Gee, Belcher, et al., 2012; Gee, Gould, et al., 2012) featured both, typically developed children and children with special educational needs. In an object recognition task (Gee, Belcher, et al., 2012) memory performance was more accurate when the children were collaborating with a dog as compared to a toy dog or a friendly college student. In Gee, Church, et al. (2010), 12 children made significantly fewer mistakes in a task where they had to assign objects to certain categories with a trained dog as collaborator, compared to “collaborating” with a toy dog of similar size and colour or a friendly college student. Gee, Gould, et al. (2012) reported mixed results when they replicated the same test in a slightly altered way with 17 children: In the dog-group, they reported an increase in correct categorisations of animate but not inanimate objects, proposing that the animal’s presence increases the children’s awareness for the animate world. Overall, no differences in test performance were found between the dog and non-dog groups.

Uccheddu et al. (2019) compared IQ and social skills after reading sessions of nine children with autism spectrum disorder, five children reading in the presence of a dog, four children reading alone. No significant differences in IQ or



cognitive skills between the two groups were found, but due to the small sample size, a comparison at a group level is inadequate anyway.

### 3.5. Reading abilities

Clune (2020) conducted a controlled trial with four children with dyslexia reading to a trained therapy dog in reading-aloud sessions, and three children completing the same sessions reading to an adult. The author reported on slightly improved fluency and accuracy and less reading-anxiety after seven weeks in the dog-group, however, without providing statistical information. Interventions lasted for 20 minutes, twice a week, but no long-term effects were measured. So magnitude and persistence of the observed effect remain unclear.

Le Roux et al. (2014) conducted a randomised controlled trial involving 102 children in total, all identified as poor readers and falling behind their academic benchmark. Four groups attended weekly reading sessions for ten weeks, one group reading to a dog, one to an adult, one to a teddy bear and one reading alone. The authors report on slightly, but significantly higher overall reading accuracy and comprehension in the dog group compared to the other groups eight weeks after completion of the intervention. However, the authors provided no quantitative results for overall reading scores and also, other substantial information is missing. For example, all results were reported for girls and boys separately, but the authors give no information on how many girls and boys participated.

Uccheddu et al. (2019) found no significant increase in reading abilities in their randomised controlled trial with nine children with autism spectrum disorder, who completed ten sessions of reading either in the presence of a dog (N=5) or without a dog (N=4). Long-term effects of the intervention had not been considered.

### 3.6. Behaviour and conduct

In a retrospective study, Kirnan et al. (2020) looked into the effects of a dog visitation and reading program in four boys with problems in conduct and learning. Contrary to their expectations, the boys showed overall even more negative and disruptive behaviour on the days the dog was present in the classroom compared to no-dog days. Only one of four boys showed better conduct on dog-days. Hence, due to small sample size and high risk of bias, these results are of limited value.

In Somervill et al. (2009), teachers rated behaviour and mood of 17 participating children with attention deficit disorder after five minutes of body contact with a lap dog. No differences were observed before and after the intervention.

### 3.7. Mental well-being

In Becker et al. (2017), 31 children with disorders of the autism spectrum (ASD) received social skills training. Half of them had training that involved a dog. Social skills and depressive symptoms were measured before and after the interventions. Although depressive symptoms decreased in both groups, there was no significant overall difference in social skills or depressive symptoms between groups.

Beetz et al. (2011) reported on perceived levels of stress or mood in 31 boys with attachment problems during and after a socially stressful task (Trier social stress test). Although children who were socially supported by a dog had lower cortisol levels compared to control conditions, self-reported stress did not differ between groups.

## 4. Discussion

To my knowledge, this is the first systematic review of controlled experimental studies on dog-assisted interventions in a special education context. Similar to previous work on animal-assisted interventions in regular school settings, methodology in most of the studies was weak, with rather inconclusive results. The fact that only 18 of 54 possibly relevant studies identified through abstract screening (= 33 percent) could be included based on criteria of good scientific practice (and that in some of these 18 studies these criteria had to be stretched to their limits to allow inclusion) hints at a severe problem with scientific quality of the target area.

Although overall, there are clear indications pointing towards an overall positive effect, there is insufficient data on the benefits of dog-assisted interventions on behavioural aspects or academic performance of children requiring special education. This is even more true, as a fair proportion of the 18 studies included suffers from a high risk of bias. Still, I found promising evidence that dog-assisted interventions may reduce physiological stress parameters, support concentration and motivation and thereby, also, to some extent, academic performance. I am going to discuss these results, starting with these most substantial findings.

### 4.1. Cortisol levels and stress

Contact to a friendly dog – physical contact in particular – is thought to buffer against stress via increasing levels of oxytocin. However, measuring oxytocin is not easily accomplished, so cortisol – to which oxytocin is a known antagonist – is an appropriate, feasible and less invasive way (e.g. from saliva) to indirectly conclude towards oxytocin and to quantify physiological stress levels (Uvnäs-Moberg et al., 2011). This had been done in all the included studies focusing on stress, except for one, which used heart rate and blood pressure (Somervill et al., 2009). Overall, the studies point towards a stress dampening effect of the presence of a dog during stressful tasks. And in two studies the authors even

reported a clear dose response-relationship between social support by a friendly dog and decreased salivary cortisol (Beetz, Julius, et al., 2012; Beetz et al., 2011). These findings are supported by some studies on typically developing children in stressful situations, such as when undergoing forensic interviews or medical procedures (for review see Friedmann et al., 2011). However, these results contrast a number of studies that showed no effect of dog involvement on cortisol levels in children performing stress-inducing tasks (Crossman et al., 2018; Kerns et al., 2018; Kertes et al., 2017; Krause-Parello & Gulick, 2015; Krause-Parello et al., 2018; Martens, 2015; Somervill et al., 2009). While there are some reports on reduced heart rate and blood pressure in both children and adults when supported by a dog, data on potential cortisol reduction are scarce and often contradictory (for review see Ein et al., 2018).

In a number of studies on dog-assisted interventions children were subjectively less stressed in the presence of dogs, while this was not reflected in physiological parameters, such as heart rate and blood pressure (Krause-Parello & Gulick, 2015; Krause-Parello et al., 2018; Schretzmayer et al., 2017; Somervill et al., 2009). A possible explanation for this divergence could be that the excitement about interacting with a dog increases blood pressure, heart rate and even cortisol levels in the sense of eustress. Moreover, some of the study designs chosen do not take into account the considerable inter-individual variability in both stress response and attitude towards dogs. This is particularly relevant for causing Type II-error when sample size is low and a group-based, between-subject design instead of a within-subject design is employed.

Importantly, most of these rather inconclusive findings on stress come from studies in children developing within a normal range. However, cortisol-lowering effects could be more pronounced in socially challenged, special education population. Previous research found reduced levels of oxytocin in children who had adverse social experiences and had grown up deprived of usual care-giving (Fries et al., 2005). This suggests that if dog-assisted interventions reduce stress via increasing oxytocin, disturbed children in particular are more likely to show low baseline-levels of oxytocin and therefore could be more responsive to the

anti-stress effects of the interventions compared to typically developing children. This hypothesis is further supported by significantly lower cortisol-levels found in insecurely attached boys who were socially supported by a dog (Beetz, Julius, et al., 2012; Beetz et al., 2011).

Concerning the potentially stress-reduction-effects of dogs, important questions remain unanswered. For example, while there is evidence that the presence of companion dogs reduces stress in their owners, it is not clear whether unfamiliar therapy dogs are comparably effective. The relationships between time of exposure and interaction quality during this time and stress reduction remains unclear too. Also, whether there is a cumulative effect of repeated animal-contact (Friedmann et al., 2011), i.e. whether a potential beneficial effect would increase with the number total time of exposure or would decrease due to habituation.

Moreover, the “active ingredient” of dog-assisted interventions still needs to be better characterised. Many study designs do not allow to distinguish whether it is the animal *per se* that is effectively lowering stress, or the distraction the animal provides, for example during medical examinations or other unpleasant procedures, or the potential distraction-effect of the dog on the communication style of the pedagogue, etc. In their study, Barker et al. (2015) tried to control for this distraction-effect of a dog-assisted intervention and found no effect on stress response that exceeded mere distraction. For clarification, studies with appropriate control conditions are much needed.

The findings of Beetz et al. (2011), where physical contact with the dogs resulted in greater reduction in salivary cortisol support the idea that tactile stimulation might be an important “active ingredient” of dog-assisted interventions. If active interaction and body contact is indeed responsible for the observed stress-reduction, dogs can provide an opportunity for unconditional contact, freed from the complexity and ambiguity inherent in human interactions and without the risk of being rejected - particularly for children with adverse social experiences (Fung, 2017). In contrast to such results, even the mere presence of a dog (without any physical contact) may affect the quality of communication

(Martens, 2015). This is explained by the so-called *biophilia* effect (Kotrschal, 2014). Again, well-designed studies are needed to further explore the role of tactile stimulation.

In fact, the implications of potential calming of the involved pedagogues in dog-assisted interventions is worth a closer look. Pedagogues in special education are regularly confronted with emotionally challenging situations (e.g. Male & May, 1997). As the significantly lower cortisol levels in dog-assisted pedagogues found by Hutter (2015) suggest, pedagogues too, may benefit from the presence of a dog in terms of stress, resulting in a significantly improved pedagogue-client communication supporting their major goal of building trust with their clients. This points towards an indirect, but potentially important mechanism of dog-assisted interventions: Less stressed pedagogues could provide a more positive learning environment and therefore less stressed children. In essence, the pedagogue-client-dog relationship is a socially dynamic triangle with interactions and causalities being far from understood.

#### 4.2. Motivation

Although there is considerable individual variability, and fear of dogs is quite common among children, it seems that most children enjoy animal-assisted activities. I am not aware of any experimental studies explicitly looking into the motivational effects of dog-assisted interventions. However, indirect hints are common: Many of the included studies reported higher attendance and more engagement in tasks on the part of the children – not always as a main outcome, but mainly “on the side”. In virtually all of the included studies concerned with motivation and adherence to tasks as the main outcome children seemed more enthusiastic and concentrated (Clune, 2020; Gee, Church, et al., 2010; Gee, Crist, et al., 2010; Gee et al., 2009) and attendance was higher on intervention-days (Uccheddu et al., 2019). Authors reported on children painting pictures or writing poems for the dogs and expressing disappointment when the intervention was over. Moreover, teachers observed “increased interest and enthusiasm for school in general, and reading specifically” after the implementation of a

reading-to-a-dog program (Kirnan et al., 2020). These distinct qualitative observations are in line with findings of many more studies on a range of human populations, not included in this review (e.g. Bassette & Taber-Doughty, 2013; Heyer & Beetz, 2014; Linder et al., 2018; Noble & Holt, 2018; Rousseau & Tardif-Williams, 2019; Schretzmayer et al., 2017; Schuck et al., 2018; Sorin et al., 2015; Stevenson et al., 2015)

As the findings by Gee and colleagues (Gee, Church, et al., 2010; Gee, Crist, et al., 2010; Gee et al., 2009) indicate, dogs at school seem to boost intrinsic motivation, i.e. to do something out of enjoyment and not because of external factors, like reward or punishment (Beetz, 2017). With negative academic experiences and frustration being rather common among children in special education, dogs could be a valuable source of intrinsic motivation. It becomes clear that motivation could be an understudied, but most valuable by-product of dog-assisted interventions – and that motivation may be an essential outcome variable to support behavioural conduct and academic performance.

#### 4.3. Reading abilities

Given the great popularity of dog-assisted reading programs, it comes as a surprise that research on their efficacy is still scarce. Especially from the US various reading programs with dogs are known, for example the “Classroom Canines Program” (Sorin et al., 2015), “Sit Stay Read” (Smith, 2009) or “Reading to dogs-programs (R.E.A.D)” (Noble & Holt, 2018). In general education, reading interventions with dogs were found to have overall positive effects, mainly in terms of improved behaviour and motivation, as well as by creating a beneficial reading-environment (for review see Hall et al., 2016). However, the majority of the studies is of low quality, anecdotal, non-blinded and, again, only short-termed.

Likewise, there is no sound evidence that dog-assisted reading interventions can improve reading skills in children with special educational needs. None of the three included studies reported on long-term improvements and two of them

found no immediate effect either. It must be noted, however, that all three studies report increased motivation to read, more confidence and/or less anxiety in children reading to a dog instead of a human. For children with special educational needs, who often struggle with a history of academic failure and consequently poor self-esteem (Fung, 2017), dogs can be non-judgemental partners, perceived by the child as supportive and potentially also as someone lower in hierarchy and someone whom they themselves can teach. This seems to play an important role in reading interventions: The dog as an attentive, benevolent listener that is neither criticising nor judging can take away pressure and ease anxiety. The findings of the included studies (Clune, 2020; Le Roux et al., 2014; Uccheddu et al., 2019) support this hypothesis: Children may not always show a better reading performance towards a dog than towards an adult, but they were enjoying it more, being less anxious and more confident. A more positive attitude towards reading can provide the basis for more and better reading in the long term – which, however, has not been investigated yet. A number of studies in normally developing children reveal mostly positive effects of a dog on reading performance (Hall et al., 2016). However due to the scope of my review such reports were not included. It seems that dog-assisted reading interventions bear great potential to improve reading skills and motivation to read, but long-termed studies with adequate sample sizes are needed.

#### 4.4. Other outcomes

Positive effects on performance in a cognitive task were found in children who collaborated with a dog (Gee, Church, et al., 2010; Gee, Belcher, et al., 2012). However, the authors attribute these results rather to increased motivation and concentration due to the presence of the dogs than to a general improvement in cognitive skills due to the dog. Again, long term effects of dog-assisted interventions on cognitive abilities were not being investigated. Also, if dogs can increase academic performance of children with special educational needs or lead to better grades remains unclear, as there seem to be not studies investigating this.



A majority of the included studies indicate that dogs can act as a social catalyst and “ice breaker” towards a normal communication and social performance (e.g. Guéguen & Ciccotti, 2008), particularly for children with special educational needs. The presence of a dog may induce positive group dynamics by reducing tension and aggression and foster positive and trustful social behaviour and communication (Correale et al., 2017; Hergovich et al., 2002; Hutter, 2015; Kotrschal & Ortbauer, 2003; Lehner, 2017; Martens, 2015; Sprinkle, 2008). Especially children with suboptimal attachment may suffer from negative mental representations of relationships, find it hard to socially connect with people or replicate the negative social representations they formed in early childhood with any new human social partner (Julius et al., 2013). Those children could gain social support from dogs, and see them as their allies in a challenging environment, as demonstrated by Beetz and colleagues (2011 and 2012). In addition, dogs can make pedagogues and therapists appear in a better light and less threatening or make them be perceived as “outside the complications of normal educational settings” (Friesen, 2010). Via such mechanisms, dogs may support more trustful modes of communication.

Although in this review I rarely found conclusive effects on communication, it has been proposed that children with impaired social and communicative skills (e.g. children with autism spectrum disorders) could profit from the simplicity and clarity inherent in the communication with a dog. The easy-to-read body language and precise commands given to dogs such as “sit” or “stay” might suit them more than the complex mixture of verbal and non-verbal communication patterns between humans and could create a comprehensible speech environment for them (Prothmann et al., 2009; for review see Fung, 2017).

#### 4.5. Animal welfare and other important considerations

Although the majority of children seems to be curious and excited about dogs, there is a great individual variability in the attitude towards dogs (Wedl & Kotrschal, 2009) and fear of dogs is quite common among children. This should be considered when integrating dogs in (special) education. Naturally, children

who do not want to interact with dogs (e.g. because of fear or for cultural reasons), are excluded from studies on dog-assisted interventions. Although unavoidable, this pre-selection could have led to some recruitment bias and to a distorted picture of the overall study population. The available studies are not able to answer the question, if (a minority of) children who do not like to interact with dogs can benefit from dog-assisted interventions and how possible aversions should be dealt with when implementing dogs in a school routine.

None of the included authors reported injuries or even minor negative effects of the dog-assisted intervention. Animal welfare was addressed in most of these studies and the dogs' wellbeing was taken into account in the study designs. Especially when working with children with special educational needs, the possibility of unpredicted or aggressive behaviour on the children's part should always be considered and pedagogues should be prepared to ensure the dogs' safety at all times. During the intervention, the dog should be monitored closely for signs of stress and get regular breaks (Ng et al., 2015).

#### 4.6. Problems and limitations

Reviewing the field in question is particularly constrained by the quality of the studies available. In their comprehensive review, Serpell et al. (2017) pointed out the methodological flaws that characterised research on animal-assisted interventions in the past. All of them still apply to the majority of the included studies in this review: small sample size, non-random sample selection and assignment to conditions, inadequacy of control conditions, lack of standardised procedures and researcher expectancy effect severely impair quality and reliability in many of the studies. In addition, due to the nature of the intervention, blinding of both participants and researchers is rarely possible in studies on animal-assisted interventions. And none of them looked into the long-term effects of animal-assisted interventions. Consequently, there are no standards for the ideal duration, frequency or number of sessions required (Friedman & Krause-Parello, 2018).

Furthermore, expectations of both researchers and the public also gives way to publication bias: Brelsford et al. (2017), for example, noted that most of the studies included in their review that lacked significant positive results originated through grey literature databases. Therefore, serious publication bias in this field of research can be assumed. The fact that selective reporting and missing data was an issue in some of the included studies here reinforces these concerns.

## 5. Conclusion

As is now widely accepted, settings that promote concentration, positive mood and motivation and counteract fear and stress create a beneficial learning environment (Beetz, 2017). Research indicates that dogs promote such settings via different routes. The presence of a dog can reduce stress, be a source of motivation and create a better social atmosphere in the classroom or within groups. Although a number of studies failed to show significant positive effects, to my knowledge dog-assisted interventions were never found to have negative effects either. Unfortunately, small sample size, short duration and methodological flaws constrain the general validity of the results of a limited set of studies that has been conducted on dog-assisted interventions in a special education context.

Therefore, important questions are still unanswered: For example, what is the minimum duration of a certain quality of dog-assisted intervention required in order to be effective? Is there a cumulative effect of repeated interventions or does habituation occur? How should cultural differences in animal-perception, aversion and fear of dogs be dealt with? Furthermore, there are no studies on the long-term effects of repeated interventions. Subsequently, no standards for the ideal duration, frequency or number of sessions required have been developed yet.

The studies available together with the positive experiences reported by the pedagogues in dog-assisted settings indicate their great potentials. But scientifically, this is still an ill-supported working hypothesis. To fathom the possibilities and potential of dog-assisted interventions in special education, well designed and long-termed studies are much needed.

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## 7. Appendix

### 7.1. Search strategy

PICO		
Do Animal-Assisted-Interventions involving <b>dogs</b> improve <b>emotional wellbeing, stress levels, behaviour or social and cognitive abilities</b> of <b>children in a special education context</b> ?		
	Include	Exclude
<b>Population</b>	children with special educational needs (e.g. attachment problems, ADHD, autistic spectrum disorder, learning or behavioural problems) in special education facilities	adults (>18 y); caregivers/educators of children with special educational needs; interventions with typically developed children without special educational needs;
<b>Intervention</b>	animal-assisted intervention (AAI) with a dog in a special education setting	AAIs involving other animals than dogs; animal-assisted therapy (e.g. speech therapy, canine assisted psychotherapy); interventions in a non-educational setting (e.g. AAIs in hospitals, group therapy sessions); pet dogs (e.g. assistant dog programs for ASD children);
<b>Comparison</b>	no intervention or any other intervention without dog; within-subject-comparison;	no comparison at all; single case studies lacking comparable baseline-data
<b>Outcome</b>	any outcome related to stress, well-being, motivation or academic, communicative, social or cognitive performance	other outcomes
<b>Time</b>	Any duration	-
<b>Study design</b>	published primary experimental studies involving quantitative data; unpublished dissertations or master theses involving	Case series and case reports, cross-sectional studies or anecdotal reports without experimental design, surveys, opinions, qualitative

	experimental studies with quantitative data;	interviews, reviews and meta analyses (used for reference list checking);
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#### Databases searched

Pubmed, EMBASE, Scopus, Taylor & Francis Online, PsycINFO

#### EMBASE, 14 May 2020

('special education\*':ab,ti OR 'youth welfare':ab,ti OR 'special pedagog\*':ab,ti OR 'developmental disorder':ab,ti OR 'attachment style':ab,ti OR autism:ab,ti OR autistic:ab,ti OR adhd:ab,ti OR 'attention deficit':ab,ti)

AND

(dog:ab,ti OR dogs:ab,ti OR 'canine assisted':ab,ti OR 'canine-assisted':ab,ti OR 'animal assisted':ab,ti)

#### Pubmed, 14 May 2020

"Education, Special"[Mesh] OR special education\*[Title/Abstract] OR "youth welfare"[Title/Abstract] OR special pedagog\*[Title/Abstract] OR "developmental disorder"[Title/Abstract] OR "attachment style"[Title/Abstract] OR autism[Title/Abstract] OR autistic[Title/Abstract] OR ADHD[Title/Abstract] OR "attention deficit"[Title/Abstract]

AND

Dog[Title/Abstract] OR dogs[Title/Abstract] OR "animal assisted"[Title/Abstract] OR animal-assisted[Title/Abstract]

#### Scopus, 14 May 2020

TITLE-ABS-KEY("special education\*" OR "youth welfare" OR "special pedagog\*" OR "developmental disorder\*" OR "attachment style\*" OR autism OR autistic OR ADHD OR "attention deficit")

AND

TITLE-ABS-KEY(dog OR canine OR "animal assisted")

#### Taylor & Francis Online, 14 May 2020

#### Search Title:

children OR education OR "attachment style" OR autism OR "attention deficit" OR ADHD

AND

dog OR dogs OR canine OR animal-assisted OR "animal assisted"

**Search Keywords:**

children OR "special education" OR "attachment style" OR autism OR asd OR "attention deficit disorder" OR  
adhd

AND

dogs OR canine OR "animal-assisted intervention" OR "animal assisted intervention"

**PsycINFO, 14 May 2020****Search abstract:**

"special education\*" OR "youth welfare" OR "special pedagog\*" OR "developmental disorder\*" OR  
"attachment style" OR autism OR autistic OR ADHD OR "attention deficit"

AND

dogs OR animal-assisted OR canine

**Search keywords:**

"special education\*" OR "youth welfare" OR "special pedagog\*" OR "developmental disorder\*" OR  
"attachment style" OR autism OR autistic OR ADHD OR "attention deficit"

AND

dogs OR "animal-assisted intervention"

**Handsearch/ search of reference lists 21 May 2020**

11 additional records

**Search results****Search on 21 May 2020**

Database	Search results
Embase	175
Pubmed	168
Scopus	489
Taylor & Francis Online	116
PsycINFO	224
Additional results from reference lists	12
<b>Abstracts to screen after duplicates removed</b>	<b>746</b>
Abstracts included for FT screening	52
FT excluded	34
<b>FT included</b>	<b>18</b>

Update search on 7 February 2021

Database	Search results
Embase	20
Pubmed	16
Scopus	64
Taylor & Francis Online	16
PsycINFO	14
Additional results from reference lists	0
<b>Abstracts to screen after duplicates removed</b>	<b>76</b>
Abstracts included for FT screening	2
FT excluded	2
<b>FT included</b>	<b>0</b>

## 7.2. Quality assessment

Appendix 1 Quality assessment<sup>14</sup>

Study	Selection	Comparability	Data collection	Attrition	Overall RoB
Becker 2017					
Beetz 2011					
Beetz 2012					
Clune 2020					
Esteves 2008					
Gee 2009					
Gee 2010a,b					
Gee 2010c					
Gee 2012a					
Gee 2012b					
Hutter 2015					
Kirnan 2020					
LeRoux 2014					
Limond 1997					
Martens 2015 <sup>1</sup>					
Martens 2015 <sup>2</sup>					
Somervill 2009					
Uccheddu 2019					

Appendix 2 Quality assessment domains

Domain	Bias due to...
<b>Selection</b>	<ul style="list-style-type: none"> <li>recruitment</li> <li>unbalanced baseline characteristics</li> </ul>

<sup>14</sup> green: low risk of bias; yellow: moderate risk of bias; red: high risk of bias; grey: no information or not applicable;

Martens 2015<sup>1</sup>: Outcome behaviour/social atmosphere; Martens 2015<sup>2</sup>: Outcome cortisol

	<ul style="list-style-type: none"> <li>• randomisation process</li> </ul>
<b>Comparability</b>	<ul style="list-style-type: none"> <li>• differences in intervention- and control-conditions</li> </ul>
<b>Data collection</b>	<ul style="list-style-type: none"> <li>• lack of blinding of researchers and/or participants</li> <li>• inappropriate methods or measurements</li> </ul>
<b>Attrition</b>	<ul style="list-style-type: none"> <li>• high drop-out rate</li> <li>• selective reporting</li> <li>• missing data</li> </ul>

### 7.3. Studies excluded after fulltext screening (reason for exclusion)

Albasha, H., Kelly, M., Andrews, J., & Rice, S. (2016). The effects of animal assisted intervention on the social initiation behaviors of children with an autism spectrum disorder. *Journal of Investigative Medicine*, 64(1), 264. (no fulltext available)

Alison, C. E. (2011). Using dogs in a home-based intervention with children with autism spectrum disorders. (72), ProQuest Information & Learning (wrong setting)

Anderson, K. L., & Olson, M. R. (2006). The value of a dog in a classroom of children with severe emotional disorders. *Anthrozoos*, 19(1), 35-49. (wrong study design, qualitative)

Avila-Alvarez, A., Alonso-Bidegain, M., De-Rosende-Celeiro, I., Vizcaino-Cela, M., Larraneta-Alcalde, L., & Torres-Tobio, G. (2020). Improving social participation of children with autism spectrum disorder: Pilot testing of an early animal-assisted intervention in Spain. *Health Soc Care Community*. (wrong setting)

Bassette, L. A., & Taber-Doughty, T. (2013, June). The effects of a dog reading visitation program on academic engagement behavior in three elementary students with emotional and behavioral disabilities: A single case design. In *Child & Youth Care Forum* (Vol. 42, No. 3, pp. 239-256). Springer US. (wrong or no comparison)

Brandes, H. (2018). *The potential of green care interventions to promote positive youth development with a one health lens*. (79), ProQuest Information & Learning, (wrong study design)

Connell, C. G., Tepper, D. L., Landry, O., & Bennett, P. C. (2019). Dogs in Schools: The Impact of Specific Human–Dog Interactions on Reading Ability in Children Aged 6 to 8 Years. *Anthrozoos*, 32(3), 347-360. (wrong population)

Correale, C., Crescimbeni, L., Borgi, M., & Cirulli, F. (2017). Development of a Dog-Assisted Activity Program in an Elementary Classroom. *Veterinary sciences*, 4(4), 62. (wrong population)

Crossman, M. K., Kazdin, A. E., Matijczak, A., Kitt, E. R., & Santos, L. R. (2018). The Influence of Interactions with Dogs on Affect, Anxiety, and Arousal in Children. *Journal of Clinical Child & Adolescent Psychology*, 1-14. (wrong population)

Fung, S. C. (2019). Effect of a canine-assisted read aloud intervention on reading ability and physiological response: A pilot study. *Animals*, 9(8), 474. (wrong population)

Gee, N. R., Harris, S. L., & Johnson, K. L. (2007). The Role of Therapy Dogs in Speed and Accuracy to Complete Motor Skills Tasks for Preschool Children. *Anthrozoos*, 20(4), 375-386. (wrong outcome)



- Geldhof, G. J., Flynn, E., Olsen, S. G., Mueller, M. K., Gandenberger, J., Witzel, D. D., & Morris, K. N. (2021). Emotion regulation and specificity: The impact of animal-assisted interventions on classroom behavior. *Journal of Applied Developmental Psychology*, 73, 101253. (wrong intervention)
- Germone, M. M., Gabriels, R. L., Guérin, N. A., Pan, Z., Banks, T., & O'Haire, M. E. (2019). Animal-assisted activity improves social behaviors in psychiatrically hospitalized youth with autism. *Autism*, 23(7), 1740-1751. (wrong setting, wrong population)
- Griffioen, R. E., van der Steen, S., Verheggen, T., Enders-Slegers, M. J., & Cox, R. (2020). Changes in behavioural synchrony during dog-assisted therapy for children with autism spectrum disorder and children with Down syndrome. *J Appl Res Intellect Disabil*, 33(3), 398-408. (wrong intervention, AAT)
- Grigore, A. A., & Rusu, A. S. (2014). Interaction with a therapy dog enhances the effects of social story method in autistic children. *Society and Animals*, 22(3), 241-261. (wrong intervention, AAT)
- Jorgenson, C. D., Clay, C. J., & Kahng, S. (2019). Evaluating preference for and reinforcing efficacy of a therapy dog to increase verbal statements. *J Appl Behav Anal*. (wrong intervention, AAT)
- Juríčková, V., Bozděchová, A., Machová, K., & Vadroňová, M. (2020). Effect of Animal Assisted Education with a Dog Within Children with ADHD in the Classroom: A Case Study. *Child and Adolescent Social Work Journal*, 37(6), 677-684. (no comparison)
- Kirnan, J., Siminerio, S., & Wong, Z. (2016). The Impact of a Therapy Dog Program on Children's Reading Skills and Attitudes toward Reading. *Early Childhood Education Journal*, 44(6), 637-651. (wrong population)
- Michelotto, A. L. L., Anater, A., Guebert, M. C. C., Borges, T. D., Michelotto, P. V., Jr., & Pimpao, C. T. (2019). Animal-Assisted Activity for Children with Autism Spectrum Disorder: Parents' and Therapists' Perception. *J Altern Complement Med*, 25(9), 928-929. (wrong study design, qualitative)
- Noble, O., & Holt, N. (2018). A study into the impact of the Reading Education Assistance Dogs scheme on reading engagement and motivation to read among Early Years Foundation-Stage children. *Education 3-13*, 46(3), 277-290. (wrong study design, qualitative)
- Obrusnikova, I., Bibik, J. M., Cavalier, A. R., & Manley, K. (2012). Integrating Therapy Dog Teams in a Physical Activity Program for Children with Autism Spectrum Disorders. *Journal of Physical Education, Recreation & Dance*, 83(6), 37-48. (wrong study design)
- O'Haire M, E., McKenzie, S. J., McCune, S., & Slaughter, V. (2014). Effects of classroom animal-assisted activities on social functioning in children with autism spectrum disorder. *Journal of Alternative and Complementary Medicine*, 20(3), 162-168. (wrong intervention, guinea pigs)
- Prothmann, A., Christine, E., & Sascha, P. (2009). Preference for, and responsiveness to, people, dogs and objects in children with autism. *Anthrozoos*, 22(2), 161-171. (wrong outcome, preference test)
- Protopopova, A., Matter, A. L., Harris, B. N., Wiskow, K. M., & Donaldson, J. M. (2020). Comparison of contingent and noncontingent access to therapy dogs during academic tasks in children with autism spectrum disorder. *J Appl Behav Anal*, 53(2), 811-834. (wrong setting, no educational setting)
- Rousseau, C. X., & Tardif-Williams, C. Y. (2019). Turning the Page for Spot: The Potential of Therapy Dogs to Support Reading Motivation Among Young Children. *Anthrozoos*, 32(5), 665-677. (wrong population)
- Schuck, S. E. B., Johnson, H. L., Abdullah, M. M., Stehli, A., Fine, A. H., & Lakes, K. D. (2018). The Role of Animal Assisted Intervention on Improving Self-Esteem in Children With Attention Deficit/Hyperactivity Disorder. *Front Pediatr*, 6, 300. (wrong intervention, AAT)
- Schuck, S. E., Emmerson, N. A., Fine, A. H., & Lakes, K. D. (2015). Canine-assisted therapy for children with ADHD: preliminary findings from the positive assertive cooperative kids study. *Journal of attention disorders*, 19(2), 125-137. (wrong intervention, AAT)

- Silva, K., Lima, M., Fafiaes, C., Sinval, J., & de Sousa, L. (2020). Preliminary Test of the Potential of Contact With Dogs to Elicit Spontaneous Imitation in Children and Adults With Severe Autism Spectrum Disorder. *Am J Occup Ther*, 74(1) (wrong setting)
- Silva, K., Lima, M., Santos-Magalhaes, A., Fafiaes, C., & de Sousa, L. (2018). Can Dogs Assist Children with Severe Autism Spectrum Disorder in Complying with Challenging Demands? An Exploratory Experiment with a Live and a Robotic Dog. *J Altern Complement Med*, 24(3), 238-242. (wrong setting)
- Silva, K., Lima, M., Santos-Magalhães, A., Fafiães, C., & de Sousa, L. (2019). Living and Robotic Dogs as Elicitors of Social Communication Behavior and Regulated Emotional Responding in Individuals with Autism and Severe Language Delay: A Preliminary Comparative Study. *Anthrozoös*, 32(1), 23-33. (wrong setting)
- Sorin, R., Brooks, T., & Lloyd, J. (2015). The impact of the Classroom Canines program on children's reading, social and emotional skills and motivation to attend school. *The International Journal of Literacies*, 22, 23-35. (wrong or no comparison)
- Stevenson, K., Jarred, S., Hinchcliffe, V., & Roberts, K. (2015). Can a dog be used as a motivator to develop social interaction and engagement with teachers for students with autism? *Support for Learning*, 30(4), 341-363. (wrong or no comparison)
- Wedl, M., Kotrschal, K., Julius, H., & Beetz, A. (2015). Children with Avoidant or Disorganized Attachment Relate Differently to a Dog and to Humans During a Socially Stressful Situation. *Anthrozoos*, 28(4), 601-610. (wrong outcome)
- Welsh, K. C. (2010). The use of dogs to impact joint attention in children with autism spectrum disorders. (70), ProQuest Information & Learning (wrong outcome)
- Wright Hempel, A. (2007). The effects of animal-assisted therapy on the development of positive interaction skills within the cross-categorical special education population. (67), ProQuest Information & Learning (wrong or no comparison)
- Zasloff, R. L., Hart, L. A., & Weiss, J. M. (2003). Dog training as a violence prevention tool for at-risk adolescents. *Anthrozoos*, 16(4), 352-359. (wrong intervention)

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