

# **Theoretical Development of Equine-assisted Activities and Therapies for Children with Autism: A Systematic Mapping Review**

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In this systematic mapping review, we mapped the state of theoretical development of equine-assisted activities and therapies for children with autism to help illuminate promising theoretical frameworks. Across 42 studies and 22 non-research reports, we identified 10 explanatory formal theories related to equine-assisted activities and therapies, and several informally hypothesized change mechanisms. Guided by findings, we propose that (1) equine movement, intentionally used by a therapist, challenges and improves postural control and motor skills, and that an equine-assisted activity or therapy can (2) promote engagement, a platform for social development, and (3) provide structured support for social interaction and positively reinforce communication. While promising, these three nascent theoretical frameworks merit further critique, testing, and refinement.

*Keywords:* equine-assisted activities and therapies, autism, review, theory, hippotherapy, therapeutic riding

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## THEORETICAL DEVELOPMENT OF EAATS FOR CHILDREN WITH ASD

This paper reports on a systematic mapping review that details the current state of theoretical development of equine-assisted activities and therapies (EAATs) for children with autism spectrum disorders (ASD). ASD is characterized by restricted and repetitive behaviors, and impairments in social communication (American Psychiatric Association, 2013). While a myriad of treatment options is available, children with ASD often participate in EAATs as complementary treatments (Lindly, Thorburn, Heisler, Reyes, & Zuckerman, 2017). EAATs incorporate horses and the equine environment into interventions aimed at promoting the health and well-being of individuals with a variety of health conditions. For the past decade, centers accredited by the Professional Association of Therapeutic Horsemanship, International (PATH, Intl) have served individuals with ASD more than any other group (PATH, Intl, 2017). There are several different types of EAATs, and historically the terminology to describe them has not been used consistently across peer-reviewed research or in practice. According to PATH, Intl, therapeutic riding (TR) is an equine-assisted activity provided by a riding instructor that consists of teaching participants with various disabilities riding and horsemanship skills, contributing to their well-being (PATH, Intl, 2019). According to the American Hippotherapy Association ([AHA]; AHA, 2019), hippotherapy (HPOT) involves the use of equine movement as a treatment tool by occupational therapists, physical therapists, and speech-language pathologists who aim to achieve functional goals specific to the health professional's area of practice.

In a previous paper reporting a subset of findings from this systematic mapping review, our team found proof of concept for EAATs for children with ASD (McDaniel-Peters & Wood, 2017). TR was the most frequently studied equine-assisted *activity* for

children with ASD; TR studies often found improvements in behavior, social interaction, and communication. HPOT was the most frequently studied equine-assisted *therapy*; HPOT studies often found improvements in motor control and related functional activities. Across different types of EAATs for different populations, there are several theoretical speculations concerning elements of interventions that promote positive outcomes, including what horses contribute (Hallberg, 2008). Considering the diverse nature of EAATs for children with ASD, the theoretical frameworks that guide different types of EAATs may also be quite diverse.

A well-developed theoretical framework explains why and how the intervention occurs as it does and identifies these elements: 1) the problem being addressed, 2) mediating processes, 3) an intervention that addresses the problem, and 4) outcomes produced by the intervention (Fleury & Sidani, 2012). For the purpose of this paper, we will refer to “problems” targeted by the intervention as challenges experienced by the participant. Children with ASD may experience challenges in many aspects of their development, including motor, social, sensory, behavioral, and occupational performance; hence, theoretical frameworks guiding EAATs for children with ASD need to delineate the nature of the challenge(s) targeted by the intervention. A theoretical framework then directly links the identified challenge(s) to mediating processes, or *mechanisms*, defined by Kazdin (2007) as “the basis for the effect, i.e., the processes or events that are responsible for the change; the reasons why change occurred or how the change came about” (p. 3). Mechanisms of change are perhaps the most elusive elements of a theoretical framework; yet clear understandings of such mechanisms allow for optimization of the process of change, likely leading to more effective interventions. Clear causal links among all

elements of a theoretical framework are essential and allow the intervention to be tailored to individuals' unique needs.

The development of a theoretical framework guiding an intervention is no simple task. Theories in applied fields often originate in "personal theories-in-practice" (Lynham, 2002, p. 223); or, as applied here, in how people who have been immersed in EAATs for ASD understand and explain their experiences. To develop into credible and trustworthy theories, the premises of personal theories must be clearly conceptualized, operationalized, applied, and confirmed, and continuously refined in practice and through research (Lynham, 2002). Such systematic development of theoretical frameworks allows investigators "to move beyond a simplistic, outcomes-focused approach to examining the central processes underlying program effects" (Fleury & Sidani, 2012, p. 12). To advance the science of EAATs for children with ASD, identification and development of theoretical frameworks that may drive various interventions is thus imperative. To our knowledge, however, no review of the literature has synthesized the state of theoretical development of diverse approaches to EAATs for children with ASD.

We derived findings reported herein from a systematic mapping review of peer-reviewed papers published from 1980 through 2017 concerning EAATs for children with ASD. In a previous paper derived from this review, we described participants, interventions, and outcomes evident in research on EAATs for children with ASD (McDaniel-Peters & Wood, 2017). This previous paper also established that TR and HPOT have been the two most studied EAATs for individuals with ASD. In the current paper, we describe the state of theoretical development of EAATs for children with ASD as a basis for illuminating

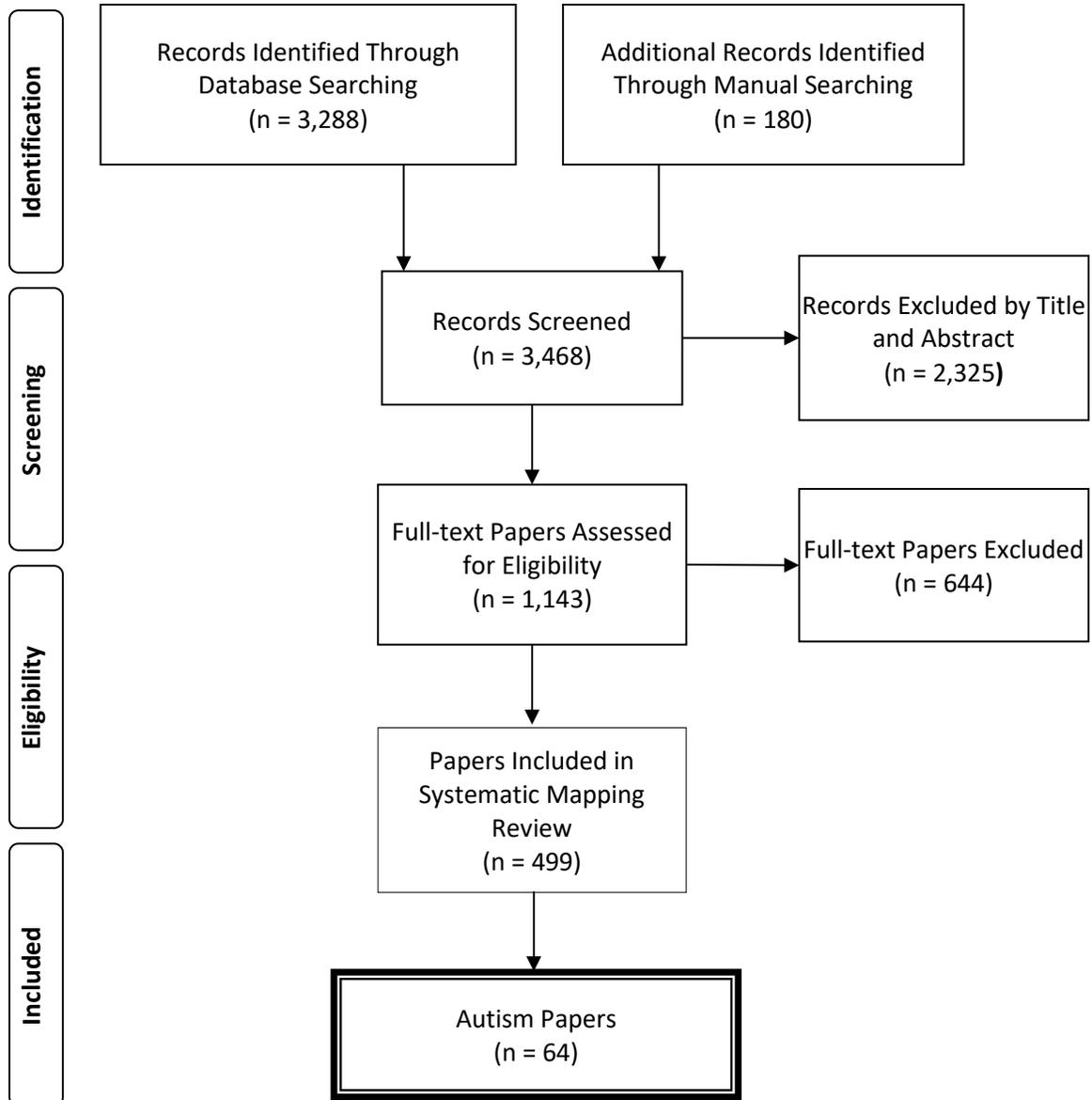
promising theoretical frameworks that may help guide future practice and research. Two specific aims are to:

1. Describe a) informally theorized mechanisms of change, and b) formally developed theories evident across peer-reviewed literature on EAATs for children with ASD; and
2. Describe mechanisms of change in research studies on TR and HPOT, the two most prevalent types of EAATs for children with ASD in peer-reviewed literature.

### **Methods**

Systematic mapping reviews are a method of choice when researchers want to create a 'map' or topography of current knowledge related to a focused area of inquiry. This type of review allows for inclusion of descriptive and conceptual papers along with research reports at varying levels of rigor (Hammick, 2005), making it the review of choice for bodies of literature in early stages of scientific development (Grant & Booth, 2009). The comprehensive nature of systematic mapping reviews allows for broad inclusion of diverse perspectives, thus creating fertile ground for hypothesis generation and theoretical development. Because systematic mapping reviews do not assess the quality of papers included in the review, assessments of strength or rigor of the research are outside the scope of this paper. Systematic mapping reviews are conducted in a three-step process: (a) gathering relevant literature through comprehensive searching, (b) selecting papers through inclusion and exclusion coding, and (c) extracting important information from each included paper. McDaniel-Peters & Wood (2017) detailed each of these steps that were conducted for the larger systematic mapping review, which we summarize next.

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**Figure 1.** Paper identification, screening, eligibility, and inclusion.

Figure 1 provides an overview of the search and inclusion process for this review. A library scientist executed comprehensive searches in nine databases to serve a larger systematic mapping review of EAATs for all populations, a large study that this review is nested within. The search strategy was adapted for each database, and included over 45 search criteria, which resulted in 3,288 unique papers published 1980 - 2017.

Manual searches of reference lists identified an additional 180 papers. A process of inclusion and exclusion narrowed the database to 499 papers pertinent to EAATs for all populations, of which 64 papers were relevant to ASD. Table 1 presents inclusion and exclusion criteria; we determined that papers were relevant to ASD if 1) authors of research papers described at least 20% of participants as having ASD, Asperger’s

syndrome (AS), or pervasive developmental disorder (PDD), or 2) authors of non-research papers mentioned ASD, AS, or PDD as diagnoses of participants served by EAATs. Therefore, some papers included in this review

discussed interventions and theoretical frameworks that were intended for a broader population than ASD alone (i.e. children with balance impairments, [Silkwood-Sherer, Killian, Long & Martin, 2012]).

**Table 1**  
*Inclusion and Exclusion Criteria*

Inclusion	Exclusion
Peer-reviewed Primary source Written in English Published between 1980 – 2017 Primarily focused on: <ul style="list-style-type: none"> <li>• One or more kinds of EAAT; OR</li> <li>• Simulated horse of relevance to EAATs</li> </ul>	EAATs are only a minor focus Provides a synopsis of a paper published elsewhere Not relevant to autism as determined by: <ul style="list-style-type: none"> <li>• &lt; 20% of participants characterized as having ASD, AS, or PDD in research studies</li> <li>• Does not mention ASD, AS, or PDD as a population served by EAATs in non-research papers</li> </ul>

*Note.* EAATs = equine-assisted activities and therapies; ASD = autism spectrum disorder; AS = Asperger syndrome; PDD = pervasive developmental disorder

To achieve the aims of the overall systematic mapping review, the research team developed a data extraction tool (DET). A consultant uploaded the DET into a Microsoft Access database so that trained reviewers could electronically extract information from each included paper. During the data extraction process, reviewers remained as close to the authors' language and use of theory as possible. Therefore, reviewers categorized the type of EAAT based on terminology used by the authors, even if this terminology was inconsistent with the definitions provided by PATH, Intl or AHA. The DET guided extraction of references to *formal* theories in the social sciences or health professions that were posed as helping to explain the mechanisms or benefits of EAATs. We considered formal theories to be those that authors explicitly named or cited (e.g., Dynamic Systems Theory [Lewis, 2000]). Furthermore, the

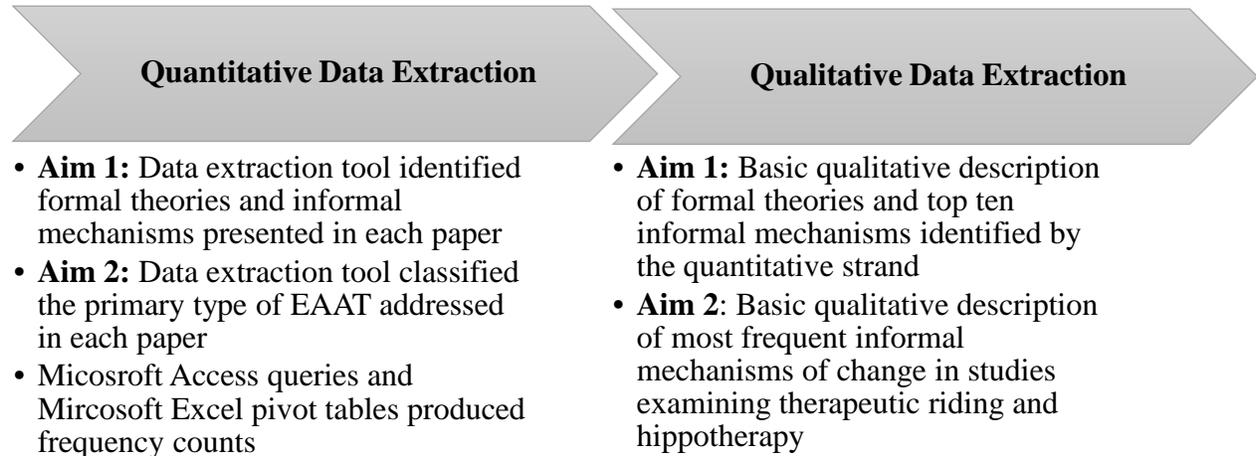
DET guided extraction of *informally* theorized mechanisms that authors proposed concerning how and why EAATs lead to benefits. Papers were categorized as “research” if they included methods and results sections. Six members of the research team attained 90% agreement on use of the DET; kappa coefficients ranged from .65 - .71 indicating substantial agreement (Viera & Garrett, 2005). The first author coded all 64 papers included in this review, and created Microsoft Access queries and Microsoft Excel pivot tables to produce frequency counts of each formal theory or informal mechanism of change.

Quantitative analyses of extracted data produced ranked frequencies of the most-oft-cited formal theories and informal mechanisms of various types of EAATs. We also qualitatively analyzed included papers to generate rich and contextualized basic qualitative descriptions of all theoretical

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content. Basic qualitative descriptions are “straight” descriptions of phenomenon not overlaid by layers of interpretation (Sandelowski, 2000). To generate such basic descriptions, we uploaded all included papers

into the software program, NVivo (Edhlund, 2012) for qualitative analysis; Figure 2 describes the methods guiding quantitative and qualitative analyses specific to each aim.



**Figure 2.** Summary of database searches, inclusion and exclusion coding, and quantitative and qualitative data extraction for each study aim.

For Aim 1a (informal theories), we used the ten informal mechanisms that had been most often cited *in research studies*, identified through the quantitative analyses of ranked frequencies, as start codes for our qualitative analysis. We then qualitatively coded *all included papers* to provide rich descriptions of these ten informal mechanisms. For Aim 1b (formal theories),

we coded *all included papers* for information about formal theories.

We answered Aim 2 (mechanisms of change in TR and HPOT) using both quantitative and qualitative data. First, we identified which mechanisms were most often cited in TR and HPOT *research studies*, and then we provided qualitative description of these mechanisms.

**Table 2**  
*Mechanisms of Change Identified in Research Pertaining to EAATs for Children with ASD*

1 <sup>st</sup> Author (year)	Country	Type of EAAT		Diagnoses	Aim 1a: Informal Mechanisms of Change											
		EAA	EAT		Horse- Human Interaction (25)	Equine Movement (20)	Social Interactions (18)	Sensory Experience of Riding (17)	Motivation (15)	Communication (13)	Equine Qualities (12)	Recreational Benefits (7)	Mastery (6)	Cerebellar Stimulation (5)		
Candler (2003)	US	TR	-	50% ASD/AS	-	-	-	-	-	-	-	-	-	-	-	-
Leitão (2003)	Portugal	PER	-	All ASD	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
Zabriskie (2005)	US	CTR	-	22% ASD	-	-	✓	-	-	-	-	✓	✓	-	-	-
Evans (2007)	New Zealand	RDA	-	38% ASD	-	-	-	-	-	-	-	✓	✓	-	-	-
Bass (2009)	US	TR	-	All ASD/AS	✓	-	-	✓	✓	-	-	-	-	-	-	✓
Keino (2009)	Japan	PER	-	All PDD	✓	-	-	-	-	-	-	-	-	-	-	-
Keino (2009)	Japan	PER	-	All PDD/ASD	✓	✓	✓	-	-	✓	✓	-	-	-	-	-



Kang (2013)	South Korea	TR	-	23% ASD	-	✓	-	✓	-	-	-	-	-	✓
Ward (2013)	US	TR	-	All ASD	✓	✓	✓	✓	✓	✓	-	-	-	✓
Chen (2014)	US	GRM	-	50% ASD 50% TD	✓	-	-	-	-	-	✓	-	-	-
Garcia-Gomez (2014)	Spain	TR	-	All ASD	-	-	✓	-	✓	-	✓	✓	-	-
Hawkins et al. (2014)	US	-	EAT-U	All ASD/ PDD	✓	✓	✓	-	-	-	-	✓	-	-
Holm (2013)	US	TR	-	All ASD	-	-	-	-	-	✓	-	-	-	-
Lanning (2014)	US	TR	-	All ASD	✓	✓	✓	✓	-	-	-	-	-	-
Naidoo (2014)	South Africa	TR	-	All ASD	✓	✓	✓	✓	-	-	-	-	-	-
Page (2014)	US	TR	-	All ASD/AS	-	-	✓	✓	-	-	-	-	-	✓
Erdman (2015)	US	EFL	-	50% ASD 50% TD	✓	-	✓	-	-	✓	✓	-	-	-
Gabriels (2015)	US	TR	-	All ASD	✓	✓	-	✓	-	-	✓	-	-	-
Minoei (2015)	Iran	TR	-	All ASD	✓	-	-	-	-	-	✓	-	-	-
Steiner (2015)	Hungary	TR	-	All ASD	✓	✓	✓	-	✓	-	-	✓	-	-

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Anderson (2016)	England	TR	-	All ASD	✓	-	-	✓	✓	✓	✓	-	-	-
Borgi (2016)	Italy	-	EAT	All ASD	✓	✓	✓	-	-	✓	✓	-	-	-
Goodwin (2016)	US	TR	-	All ASD <sup>a</sup>	-	-	✓	-	-	-	-	-	✓	-
Llambias (2016)	Canada	-	EAOT	All ASD	✓	✓	-	✓	✓	-	-	✓	-	-
Mapes <sup>b</sup> (2016)	US	TR	HPOT, EAT	All ASD	✓	✓	✓	✓	✓	✓	✓	-	-	-
Nqwena (2016)	South Africa	TR	-	41% ASD	-	✓	-	-	-	-	-	-	✓	-
Harris (2017)	Scotland	“horse riding”	-	All ASD	✓	✓	✓	-	-	✓	✓	-	-	-
Malcolm (2017)	Scotland	-	“equine therapy”	All ASD <sup>a</sup>	✓	✓	-	✓	-	✓	✓	-	✓	-
Petty (2017)	US	TR	-	All ASD	✓	-	-	-	-	-	-	-	-	-

*Note.* US = United States; EAAT = equine-assisted activity or therapy; EAA = equine-assisted activity; EAT = equine-assisted therapy; TR = therapeutic riding; PER = psychoeducational horseback riding; CTR = community-based therapeutic recreation; RDA = riding for the disabled; GRM = grooming activity; EFL = equine-facilitated learning; HPOT = hippotherapy; ST-EAT = short-term equine-assisted therapy; SDHR = simulated developmental horseback riding; EAT-U = equine-assisted therapy unspecified; EAOT = equine-assisted occupational therapy ASD = autism spectrum disorder; AS = Asperger’s Syndrome; PDD = pervasive developmental disorder; TD = typically developing.

<sup>a</sup> These papers interviewed parents or other key stakeholders of EAATs for children with ASD—the children with ASD were not the primary research participants.

<sup>b</sup> This paper reviewed research on EAAT for children with ASD

Table 3  
*Non-research Papers that Mention ASD as a Population Served by EAATs*

1 <sup>st</sup> Author (Year)	Country	Primary Type of EAAT
Biery (1985)	US	Multiple EAATs
DePauw (1986)	US	Multiple EAATs
Decker (1988)	New Zealand	EAA: Riding for the Disabled
Tyler (1994)	US	EAT: Equine Psychotherapy
Parsons (1996)	Canada	EAA: Therapeutic Riding
Bracher (2000)	England	EAT: Therapeutic Horse Riding and Occupational Therapy
Lessick (2004)	US	EAA: Therapeutic Riding
Hornacek (2005)	Slovak Republic	EAT: Hippotherapy
MacKinnon (2005)	Canada	EAT: Hippotherapy
Rothe (2005)	Spain	EAT: Equine-facilitated Psychotherapy
Young (2005)	England	EAT: Horsemastership and Occupational Therapy
Westerman (2008)	US	EAA: Therapeutic Riding
Luna (2009)	US	EAA: Therapeutic Riding
Ratliffe (2009)	US	EAT
Masini (2010)	US	EAT: Equine-assisted Psychotherapy
Granados (2011)	Spain	EAT: Hippotherapy
Thomas (2011)	US	EAT: Equine-assisted Psychotherapy
Siporin (2012)	US	EAT: Equine Psychotherapy
Westerman (2012)	US	EAA: Therapeutic Riding
Brandt (2013)	US	EAT: Equine-facilitated Psychotherapy
Berg (2014)	US	Multiple EAATs
Koca (2016)	Turkey	EAT: Hippotherapy

*Note.* EAAT = equine-assisted activity and therapy; US = United States; EAA = equine-assisted activity; EAT = equine-assisted therapy.

## Results

In this systematic mapping review, we identified 42 research studies (Table 2) and 22 non-research papers (Table 3) pertinent to EAATs for children with ASD. The earliest non-research paper was published in 1985, while the earliest research study was published in 2003. All non-research papers addressed EAATs for people with various diagnoses; hence none was exclusively about EAATs for children with ASD. As authors mentioned ASD only briefly in some non-research papers, we only coded theoretical content pertinent to children with ASD in non-research papers. Thirty-three of the 42 studies (79%) exclusively included children with ASD, while the other studies included participants with a variety of diagnoses, including ASD. Research participants with ASD ranged in age from 2 to 16 years old.

### **Aim 1a: Rich Descriptions of the Most Prevalent Mechanisms of Change**

Table 2 lists the ten most prevalent informal mechanisms found in the research studies, ordered by frequency from left to right, and illustrates which studies identified each mechanism. The following sections provide rich descriptions, generated from both research and non-research papers, of each of the most prevalent mechanisms. These mechanisms were not always found to be completely distinct from one another, but rather, to be occasionally co-defining or mutually influential. Therefore, we next present the mechanisms of change in an order relevant to how they relate to one another to help illuminate logical linkages among them.

**Horse-human interaction.** Twenty-five of the 42 studies (60%) proposed that there was therapeutic value in the horse-human relationship. For instance, some authors suggested that if a child is bonded to the horse, then the child may exhibit fewer problem behaviors throughout the therapy session (Hawkins, Ryan, Cory, & Donaldson,

2014). Other authors suggested that children may be able to first form a social connection with the horse, which would then allow them to form a social attachment to people (Erdman, Miller, & Jacobson, 2015; Keino et al., 2009; Kern et al., 2011). For example, Erdman et al. (2015) wrote, “horses can serve as ‘transactional objects’ allowing a child to bond first to the animal and then to other people” (p. 21). Similarly, Siporin (2012) referenced attachment theory and claimed that “a friendly therapy horse can serve as a supplemental attachment figure” (p. 460). Some authors posited that the presence of horses was beneficial because horses promote social interaction (Chen, Crews, Mundt, & Ringenbach, 2015; Erdman et al., 2015; Rothe, Vega, Torres, Soler, & Pazos, 2005). For example, Rothe et al. (2005) wrote, “conversation and socialization are stimulated through interaction with the animal” (p. 380). Furthermore, some authors suggested that interaction with horses can teach children with ASD improved self-control because aggressive behaviors are not tolerated around the horses. For example, Biery (1985) wrote that a boy “now modifies his behavior while mounted, knowing that lack of self-control will lose him the one experience that he craves—contact with the pony” (p. 350). Other authors proposed that interacting with animals may foster the development of empathy; for example, it was posed that interacting with animals fosters empathy because “animals’ signaling of emotion may be more behaviourally salient than humans’. This may make interactions with animals less socially complex and cognitively demanding” (Harris & Williams, 2017, p. 2). As next described, several authors proposed that horse-human interaction was particularly beneficial due to the unique nature of horses.

**Equine qualities.** Twelve of 42 studies (29%) described how unique equine qualities contributed to the value of EAATs.

Several authors described how the horse's sensitivity and reactions to human behaviors can benefit children with ASD. For example, Gabriels et al. (2012) wrote, "While ASD is characterized by a lack of human social understanding, horses are highly social animals who will respond to subtle human cues (Grandin, 1997). Such responsiveness is important for the cause-and-effect concrete learning styles of individuals with an ASD" (p. 586). In addition to horses' social sensitivity, several physical aspects of a horse were hypothesized to contribute favorably to the intervention. Granados and Agis (2011) hypothesized the horse's temperature contributed to participants' relaxation, and Erdman et al. (2015) hypothesized the horse's size and power inspired a sense of awe in participants. Horses' calm and social temperament also may contribute to their therapeutic value. For instance, Harris and Williams (2017) proposed "horses selected as therapy animals typically have calm temperaments and slower, steadier movements than smaller therapy animals. Therefore, horses selected for use in [animal-assisted interventions] are less likely to move in a rapid unpredictable way, which children with ASD characteristically dislike" (p. 2). Furthermore, Borgi et al. (2016) noted that animals, including horses, have a "recognized ability... to positively engage people, thus potentially counteracting the social withdrawal characterizing [individuals with autism]" (p. 2). Several authors also proposed that the quality of movement produced by the horse and transferred to the participant can be therapeutic, which we describe further in a separate section. These unique characteristics of horses may all offer important contributions to EAATs.

**Communication.** Thirteen of the 42 studies (31%) proposed that the communication involved in EAATs is beneficial for the participant. Authors claimed that receptive, expressive, verbal,

and nonverbal communications are all emphasized in various EAATs. For example, Ajzenman, Standeven, and Shurtleff (2013) claimed, "The social opportunities provided in the HPOT setting could enhance receptive communication, because participants practiced attending, comprehending, and completing instructions provided by their therapists during turn taking, planning, and sequencing activities" (p. 660). Furthermore, Rothe et al. (2005) suggested, "When the horse responds to [a] request when being led or ridden, the horse subordinates power to the child [and] the therapist can observe, comment and instruct the child in effective development of communication skills, both verbal and nonverbal" (p.381). This need for effective communication was present during mounted and unmounted activities. Erdman et al. (2015) described, for instance, that "in groundwork activities, the child is solely responsible for the movement and behaviors of the horse so the need for effective interactive skills is particularly emphasized" (p. 24). Ratliffe and Sanekane (2009) similarly noted that "Verbal and nonverbal communication is essential between horses and humans in order to cooperate during riding" (p. 37).

Many authors posited that opportunities for communication are particularly valuable because the horse provides an immediate reward for effective communication. For example, Biery (1985) wrote, "the student strives to coordinate his hands and legs, to master a skill such as halting the horse. The horse consistently refuses to respond until the task is done correctly and then he gives credit where credit is due" (p. 352). Furthermore, Gabriels et al. (2012) wrote:

If the child says 'Walk on', the horse responds... A horse's immediate response to the behaviors (however subtle) of an ASD child can be used in treatment to help the child better

understand or become more aware of the impact of his or her social-communication behavior (p. 586).

Nelson et al. (2011) referenced applied behavioral analysis while making a similar claim, suggesting equine movement can be used to reinforce social behavior. Therefore, in addition to effective communication, several authors also suggested that EAATs can foster appropriate social interaction.

**Social interactions with people.**

Eighteen of the 42 studies (43%) suggested that social interactions occurring throughout the intervention are beneficial; these interactions were with the instructor, volunteers, other participants, and even family members. For instance, Bracher (2000) claimed that equine-assisted therapies “require appropriate skills to effect a positive working relationship with the horse and other riders” (p. 279). Lanning, Baier, Ivey-Hatz, Krenek, and Tubbs (2014) claimed that equine-assisted activities provide “structure and support for social skills development” (p. 1905). The presence of the horse may serve to promote social interaction between the child and other people in the environment. Harris and Williams (2017) suggested that animal-assisted interventions “may create a ‘social catalyst’ or ‘social facilitation’ effect, where an animal facilitates social interactions between humans. This may be achieved through an animal’s presence and spontaneous behavior providing a neutral focal point between the child and their interventionist/therapist” (p. 2).

Furthermore, some authors suggested that EAATs promote joint attention skills; joint attention is commonly impaired in children with ASD. For example, Ward, Whalon, Rusnak, Wendell, and Paschall (2013) claimed, “It may be that during TR the horse provides a shared reference for children with ASD and the instructor, and the behavior expectation is isolated so that the child with ASD knows what to attend to” (p.

2197). Gabriels et al. (2015) furthermore suggested, “One hypothesis is that riding and working together with the horse to engage in therapeutic riding activities involves a nonverbal joint attention or shared attention experience that may serve as a platform for improving behaviors and social-communication skills” (p. 547). Granados and Agis (2011) claimed that equine-assisted therapies affect social interaction on three levels:

On one level, ... especially with peers who come to the group or other sessions, the child has the opportunity to share experiences and stories. On another level, because a number of helpers are needed in the therapy sessions, the child must develop relationships with them in order to communicate more successfully with the horse. On a third level, when the child leaves the therapeutic setting, the child returns to the world eager to report to those around him or her about their riding experiences. (p. 195)

These social interactions may also contribute to the recreational nature of EAATs.

**Recreational benefits.** Seven of the 42 studies (17%) suggested that participants benefit from the recreational nature of EAATs. Many authors suggested that the nature of horseback riding makes it an ideal recreational pursuit for children with autism, who are often recreationally-deprived.

This activity is particularly well matched to the specific characteristics of persons with autism, since it is based on an individual activity but at the same time brings into play multiple interactions in a context which is more structured and less chaotic than other team sports. Its essence is communication that is tactile and epidermal with the animal rather than verbal (which is usually

altered in persons with ASD), and it is performed in a highly motivating natural environment. Thus, horse-riding, with the necessary adjustments to adapt it to this group of persons, is a sports and leisure activity that can well form part of the repertoire of activities suggested for persons with ASD. (García-Gómez, Risco, Rubio, Guerrero, & García-Peña, 2014, p. 121)

Several authors suggested that children who participate in EAATs may reap physical, social, and emotional benefits associated with engagement in recreational pursuits. For example, Zabriskie, Lundberg, and Groff (2005) claimed, “sport can have a positive impact on the identity formation of youth with disabilities by increasing their skills and competence; offering outlets for emotional expression, social interaction, and connections with others with a disability; and decreasing awareness of disability” (p.180). Furthermore, Liddiard (2009) reported that “increased self-confidence and esteem, fitness and social benefits have been associated with engagement in a physical activity, particularly for children who have disabilities, whose physical activity levels are typically lower than non-disabled peers” (p. 85). Self-confidence and esteem may also be promoted by the experiences of mastery often afforded by EAATs.

**Mastery.** Six of the 42 studies (14%) asserted that EAATs offered children a chance to experience a sense of mastery. For example, Bracher (2000) asserted that riding and caring for the horse offers participants a sense of control. Riding in particular often offered an opportunity for a sense of mastery; “riding up high and controlling a strong, powerful animal was regarded as an empowering experience: when riding a horse, an autistic person is offered an all too infrequent opportunity to embody a position of power” (Malcolm, Ecks, & Pickersgill,

2017, p. 9). Authors often connected these mastery experiences to improved psychological and social outcomes; “Moreover, successful mastery of horseback riding skills improves self-efficacy, self-concept, self-esteem and self-control (Macauley & Gutierrez, 2004) and affects positively on social skills of children with autism spectrum disorder” (Ghorban, Sedigheh, Marzieh, & Yaghoob, 2013, p. 82). Three papers specifically connected mastery experiences to Bandura’s theory of self-efficacy, discussed further in Aim 1b (Goodwin, Hawkins, Townsend, Van Puymbroeck, & Lewis, 2016; Westerman, Stout, & Hargreaves, 2012; Westerman, Westerman, Hargreaves, & Verge, 2008). These experiences of mastery may contribute to the motivating nature of EAATs.

**Motivation.** Fifteen of the 42 studies (36%) suggested that EAATs may be particularly motivating. Authors hypothesized that several different aspects of interventions may be motivating. Bass, Duchowny, and Llabre (2009) proposed that riding the horse is rewarding, and Berg and Causey (2014) claimed that the horse-human bond is motivating. Liddiard (2009) proposed that the context in which therapy occurs may be motivating: “performing therapy away from the clinic or classroom, while participating in an enviable activity, can foster necessary motivation and engagement to attempt challenging tasks and learn skills” (p. 75). Finally Biery (1985) posed that the element of risk involved in riding may improve motivation:

A hormone is released into the body during a risk activity and this might explain the feelings of euphoria and elation experienced by the student in a therapeutic riding session. Instructors and parents frequently observe this euphoria; many believe this elation may account for the increased motivation on the part of

the student. (p. 346)

Regardless of what element of an intervention is motivating, most authors agreed that this motivation encourages active and sustained engagement in the therapy session, therefore improving outcomes. Lessick, Shinaver, Post, Rivera, and Lemon (2004) wrote, for instance, that “while traditional therapies often reach a plateau where a patient may lose motivation to keep trying, the excitement of riding stimulates the rider and encourages many patients to work through discomfort and increasing challenges” (p. 49). Furthermore, Ajzenman et al. (2013) claimed that “performance of goal-oriented motor and imitation activities in children with ASD is typically more meaningful in purposeful situations, promoting willingness to engage in motor-based activities with peers (Baranek, 2002). HPOT has been suggested to have similar effects” (p. 654). Therefore, the motivating nature of EAATs may make other aspects of the intervention, such as the therapeutic effect of equine movement, more salient.

**Equine movement.** Twenty of the 42 studies (48%) claimed that the movement of the horse had positive effects on the participant. Several authors claimed that equine movement challenged and developed postural control or balance. As explained by Ajzenman et al. (2013), equine movement can be used to target postural control, ultimately improving participants’ ability to perform functional tasks:

Postural control was further challenged because the horse took several thousand steps during each treatment session. We theorize that the participants had to repeatedly respond to the variability in the horse’s movement, promoting learned righting and equilibrium reactions to remain stable to perform activities during therapy (Shurtleff, Standeven & Engsberg, 2009).

Involvement in HPOT thus has the potential to enable children with ASD to use newly improved automatic postural mechanisms to improve stability while standing and performing functional tasks. (p. 660)

Several authors also claimed that the three-dimensional movement of the horse, transferred to the participant, mimicked the typical pelvic motion of walking and therefore improved gross motor skills. Furthermore, Liddiard (2009) claimed that equine movement promoted attention: “rapidly changing speed or direction challenged attention and promoted active engagement in the session activities” (p. 80). In addition to challenging gross motor skills and promoting optimal attention throughout the therapy session, many authors claimed that the movement of the horse provided a beneficial sensory experience for children with ASD, as next described.

**Sensory experience of riding.** Seventeen of the 42 studies (40%) claimed that the sensory experience of riding a horse was beneficial for participants. Several authors claimed that the demand to integrate sensory information during challenging motor tasks further improved gross motor outcomes. For example, Silkwood-Sherer et al., (2012) wrote, “Not only is the child required to react to the pelvic perturbations, but also the simultaneous forward movement through space provides an opportunity to respond to a variety of somatosensory, vestibular, and visual stimuli” (p. 708). Going beyond the focus on motor skills, some authors suggested that the sensory experience of riding a horse can promote optimal arousal during therapy. As posed by Gabriels et al. (2012), “Horses may help organize or provide input to the ASD child’s sensory system. This factor may contribute to helping the child feel calm” (p. 586). Llambias, Magill-Evans, Smith, and Warren

(2016) similarly posed that “The horse’s gait and speed may stimulate the vestibular system with either a calming effect by means of a quiet, unvarying gait or an alerting effect by means of a fast walk or trot” (p. 2). Several authors commented on the multisensory nature of EAATs, which provide a multitude of vestibular, proprioceptive, tactile, auditory, olfactory, and visual inputs. Granados and Agis (2011) brought in the theory of neuronal group selection when they hypothesized the value of this multisensory experience, stating, “Neuronal plasticity allows children undergoing hippotherapy to learn and develop new connections in the brain through the multisensorial stimulation that hippotherapy offers. In turn, these connections allow the learning of new skills for functioning in the world” (p. 194). Similarly, Liddiard (2009) wrote, “Hippotherapy provides a whole body experience, engaging all of the senses in a repetitive and graded motor activity that requires an active response, thus optimising neural reorganisation for skilled performance” (p.76). Some authors proposed that this neurological reorganization and development occurs specifically in the cerebellum.

**Cerebellar stimulation.** Five of the 42 studies (12%) hypothesized that TR may stimulate the cerebellum, a neuroanatomical structure often implicated in ASD. Within the included papers, the cerebellum was first mentioned in 1985, when Biery claimed that “the horse becomes the cerebellum, the unconscious part of the brain responsible for posture, balance, and coordination” (p. 348). However, in 2009 Bass et al. offered a more in-depth and ASD-specific hypothesis by describing that cerebellar abnormalities are common in individuals with ASD, and summarizing the cerebellum’s role in motor, sensory, and social functioning. Bass et al. (2009) then suggested, “it is possible that therapeutic horseback riding, an activity that

demands motor learning skills, motor control, and social engagement, is linked to cerebellar functioning,” which may explain improvements in ASD symptoms (p. 1266). Several authors have since cited Bass’ hypothesis about the role of the cerebellum (see Table 2), but none has expounded upon or tested this hypothesis.

### **Aim 1b: Rich Descriptions of Formal Theories**

Throughout the 64 papers in this review, we identified 10 formal theories that authors cited in relation to EAATs. We found no evidence of a formally developed theory specific to EAATs; rather, authors applied theories from outside fields to the equine context. In addition, although authors often used formal theories to explain why certain components of interventions were beneficial, they rarely explicated whether or how formal theories had informed their designs of interventions.

#### **Theories of sensory integration.**

Five of the 64 papers (8%) referenced a theory of sensory integration. Three papers drew from Ayres’ (1972) theory of sensory integration, while the other two papers referenced sensory processing theories in general, or Reeves’ (2001) expansion on sensory integration theory. Drawing on Ayres, two non-research papers describe that integration of information from all the senses is necessary for learning to occur (Bracher, 2000; Granados & Agis, 2011). For example, “Learning is dependent on the ability of normal individuals to take in sensory information derived from the environment and from movement of their bodies, to process and integrate these sensory inputs within the central nervous system and to use this sensory information to plan and organise behavior” (Bracher, 2000, p. 280). Two research studies claimed that children with ASD have particular difficulty processing sensory information (Ajzenman et al., 2013; Ward et al., 2013). For instance, “sensory

processing theories suggest that children with ASD have decreased ability to regulate degree, intensity, and type of responses to sensory information, resulting in limited abilities to habituate and adapt during daily activities” (Ajzenman et al., 2013, p. 654). Three papers suggested that the multisensory experience of EAATs—including tactile, proprioceptive, vestibular, visual, auditory, and olfactory input—leads to improved sensory integration (Bracher, 2000; Granados & Agis, 2011; Wuang, Wang, Huang, & Su, 2010). For example,

Our sense of touch, smell, taste, sight and sound, as well as physical movement and body awareness must function together. Sensory integration during hippotherapy occurs when riding stimulates the tactile sense, both through touch and environmental stimulation. Also, the vestibular system is stimulated by the horse’s change of direction and speed... The olfactory system responds to many smells involved in a horse stable and ranch environment. Vision is used in controlling the horses. The many sounds of the ranch help to involve the auditory system. All of these senses work together and are integrated during the act of riding. (Granados & Agis, 2011, p. 193).

**Bandura’s theory of self-efficacy.**

Three of the 64 papers (5%) referenced Bandura’s (1977) theory of self-efficacy. Citing Bandura, these papers claimed that self-efficacy can be fostered through four main methods: “positive feedback, emotional arousal, successful performance, and vicarious experience” (Westerman et al., 2012, p. 38). Westerman et al. (2008) sought to embed these methods within an equine-assisted activity. For example, “the vicarious experience aspect of the model is implemented by offering, when needed, a model of the new behavior that the instructors

ask the riders to perform” (p. 62). Westerman et al. (2012) went on to describe how a program of TR integrated a mentoring approach, whereby volunteers served as mentors to the riders, intentionally fostering self-efficacy throughout the program. This paper also cited Vygotsky and Cole’s (1978) theory of zone of proximal development to explain how mentors can help riders achieve more difficult tasks by offering assistance. Finally, although the therapeutic riding drill team described in Goodwin’s (2016) paper was not intentionally designed to foster self-efficacy, interviews with key stakeholders illuminated that all four elements of Bandura’s theory of self-efficacy were present in the intervention; Goodwin et al. concluded, “the theory of self-efficacy can be an appropriate theory to build and evaluate therapeutic riding programs,” and suggested improved self-efficacy “could lead to improved functioning in areas such as communication, social skills, and building relationships” (p. 46).

**Dynamic Systems Theory.** Two of the 64 papers (3%) referenced dynamic systems theory (Lewis, 2000). Granados and Agis (2011) proposed that human behavior is determined by interactions among three main systems: the person, the task and the environment. Each of these systems has constraints, which determine how they interact with one another; developmental outcomes emerge from the interactions among systems. Granados and Agis claimed that “movement patterns in the patient emerge during hippotherapy as a result of the self-organizing process involving the interaction of multiple constraints” (p. 192). In particular, postural control, arousal, and motivation are important constraints in the child, while temperature and rhythm are important constraints within the horse. In contrast, Ratliffe and Sanekane (2009) referenced dynamic systems theory with

more emphasis on systems within the child, stating:

Horseback riding is believed to influence multiple systems including sensorimotor (balance, touch, awareness of body position, eye movements, body movements), cognition, respiration, speech production, and behavioral, social and psychological domains (Casady & Nichols-Larsen, 2004; Heine, 1997). The interactions between these systems cause changes in the systems themselves including improvements in balance, strength, endurance, perception, and other functional skills. (p. 37)

**Model of Human Occupation.** Two of the 64 papers (3%) referenced the Model of Human Occupation (Kielhofner & Burke, 1980), a conceptual practice model in occupational therapy. Bracher (2000) gave an overview of the model, stating “the human being should be viewed as an open system, composed of three hierarchical subsystems: volition, habituation and performance. These three subsystems closely interrelate to control the choices people make in engaging in particular occupations” (p. 279). Bracher went on to give examples of how TR may affect volition, through claims such as “the individual with a disability is able to feel in control through achievement in riding or care of the horse” (p. 279). Similarly, Taylor et al. (2009) used the Model of Human Occupation to introduce the concept of volition, which was the outcome measured in their study of HPOT.

**Other formal theories.** Each of the following formal theories was mentioned in one of the 64 included papers (2%): Vygotsky’s zone of proximal development (as cited in Westerman et al., 2012), applied behavioral analysis (as cited in Nelson et al., 2011), and theory of neuronal group selection (as cited in Granados & Agis, 2011). Siporin

(2012) cited attachment theory, psychoanalytic theory, and Kohutian theory. We have already described most of these formal theories as they were relevant to the informal mechanisms of change identified in Aim 1a.

## **Aim 2: Mechanisms of Change Associated with Specific Interventions**

The mechanisms of change presented above were not found uniformly across all studies, but rather varied based on the type of intervention, indicating that certain types of EAATs drew more strongly on certain theoretical suppositions. While most types of EAATs were only examined in a few studies, TR and HPOT were investigated in five or more studies. We next describe the prominent mechanisms of change associated with TR and HPOT.

**Therapeutic riding.** The most common mechanisms of change in the 21 studies of TR were horse-human interaction (12 studies; 57%), the sensory experience of riding a horse (10 studies; 48%), the movement of the horse (8 studies; 38%), social interactions with people (9 studies; 43%), motivation (7 studies; 33%) and communication (6 studies; 29%). A strong emphasis on social aspects of TR, including social interactions and communication with the horse and people who were present was thus evident. In addition, many authors discussed the physical experience of riding, focusing on equine movement that challenged gross motor skills and multisensory experiences of riding. Finally, many papers suggested that children actively engaged in both social and physical aspects of the intervention due to the horse’s motivating power.

**Hippotherapy.** The most common mechanisms of change in the five studies of HPOT were motivation (4 studies; 80%), movement of the horse (3 studies; 60%), and the sensory experience of riding a horse (2 papers; 40%). Three studies of HPOT

presented remarkably similar mechanisms, proposing that equine movement can be used by an occupational therapist (Ajzenman et al., 2013; Liddiard, 2009) or a physical therapist (Silkwood-Sherer et al., 2012) to challenge and improve the client's postural control. Authors drew on several mechanisms to explain how HPOT challenged postural control: the movement of the horse disrupts the child's center of balance; clients get massed and random practice in developing their own motor-responses to functional activities they find motivating; clients must integrate and respond to a variety of sensory information; and challenges to postural control can be graded by altering the horses' speed and direction, and the client's position. Silkwood-Sherer et al. (2012) summarized these mechanisms well: "Hippotherapy provides the benefits of mass practice in an activity that forces a client to develop and refine motor patterns with concurrent practice in integrating sensory information in a controlled environment as a whole-task activity" (p. 708). Conversely, two studies did not have this strong focus on motor development, but rather examined outcomes more related to social functioning, such as volition (Taylor et al., 2009) and levels of oxytocin (Tabares et al., 2012); the mechanisms leading to such improvements in social development were not clearly developed.

### **Discussion**

In this systematic mapping review, we identified 42 research papers and 22 non-research papers of relevance to EAATs for children with ASD, and systematically extracted information to illuminate the current state of theoretical development of this body of literature. Across the 64 papers included in this review, we identified several formally-developed theories that authors have related to EAATs for children with ASD. These formal theories, although not

specific to horses, provide vital underpinnings to our understandings of their respective subjects (i.e. sensory integration, human occupation, etc.) and may help providers decide how to integrate horses into different types of EAATs, guided by the needs of the participants and the goals of the program. Authors also proposed a wide variety of mechanisms of change that may help to explain the process by which different types of EAATs promote positive outcomes in children with ASD. Some mechanisms are specific to EAATs (i.e. horse-human interaction, equine movement, sensory experiences of riding, equine qualities), other are specific to individuals with autism (i.e. cerebellar stimulation), while others may be applicable to a myriad of interventions for a variety of populations (i.e. social interaction, communication, mastery).

Many of the formal theories and informal mechanisms of change complement one another, and can be used in conjunction. For example, Bandura's Theory of Self-efficacy reflects the informal mechanisms of 'mastery' and 'social interaction'. Similarly, theories of sensory integration may be complemented by the informal mechanisms of 'sensory experience of riding' and 'motivation.'

Despite the existence of several formal theories and informal mechanisms of change in the literature, authors of research studies investigating the effect of an equine-assisted activity or therapy only rarely applied these theorized mechanisms of change to the specific challenges experienced by children with ASD, related intervention components, and intended outcomes. Therefore, the current peer-reviewed literature on EAATs for children with ASD is in early stages of theoretical development.

Mechanisms of change must be more than speculative; that is, they must be explicitly linked to how interventions are devised and delivered, and to specific

targeted outcomes (Fleury & Sidani, 2012). Furthermore, conceptual development of a theoretical framework requires an explanation of the interdependence of the key elements of the theory (Lynham, 2002). There is thus a need to explore further how the many mechanisms of change identified in this systematic mapping review relate to one another and work together to effect beneficial outcomes in children with ASD. Further conceptual development of theoretical frameworks, and their operationalization into specific intervention components, will help future researchers confirm or disconfirm key elements of proposed frameworks (Lynham, 2002). This phased, systematic approach is considered best practice for developing and evaluating complex interventions, since strong emphasis on theory development in early phases of intervention development is “more likely to result in an effective intervention” (Craig et al., 2008, p. 9).

Mechanisms of change often cannot be directly tested, but rather must be inferred by the convergence of multiple criteria (see Kazdin, 2007). One important criterion is that the proposed mechanism is plausible and coherent, that is, it is reasonable and aligns with other relevant research. We integrate below several identified mechanisms of change that seemed plausible, and coherent with one another and outside research. In doing so, we propose three theoretical frameworks (Figures 3,4, and 5) that we regard as especially promising and identify the four key elements of each: participant challenges(s), mechanisms, intervention components, and outcomes (Fleury & Sidani, 2012). Lastly, we propose steps for further developing each framework, based on Lynham’s (2002) five phases of theory development in applied disciplines: conceptual development, operationalization, confirmation or disconfirmation, application, and continual refinement. While we group plausible mechanisms of change into these

three coherent theoretical frameworks, we acknowledge that a single equine-assisted activity or equine-assisted therapy may not draw from all pathways in a single framework, or may draw from multiple frameworks simultaneously.

**Proposed Theoretical Framework: Occupational Therapists And Physical Therapists May Use Equine Movement to Challenge and Improve Postural Control, Possibly Leading to Improvements in Gross and Fine Motor Skills, and Participation in Daily Activities.**

Figure 3 illustrates this proposed theoretical framework. Children with ASD demonstrate impairments (*challenges*) in postural control (Mache & Todd, 2016), and gross and fine motor skills (Green et al., 2009). Supported by several studies, we propose that occupational therapists and physical therapists can use equine movement to challenge and improve clients’ postural control. This assertion is coherent with educational materials put forward by AHA (2019), and with outside literature reporting that HPOT can improve postural control in other populations, including children with cerebral palsy (Zadnikar & Kastrin, 2011) and adults with multiple sclerosis (Bronson, Brewerton, Ong, Palanca, & Sullivan, 2010). Improvements in postural control may occur through several different *mechanisms* identified in these studies: movement of the horse, changed and graded by the therapist, disrupts the child’s center of balance; children experience massed and random practice in developing motor-responses in context of a functional, motivating activity; and children must integrate and respond to a variety of sensory information. These principles are coherent with clinical recommendations for habilitating postural control in children, which include massed and random practice in reacting to disturbances in postural control, “functionally meaningful movements under

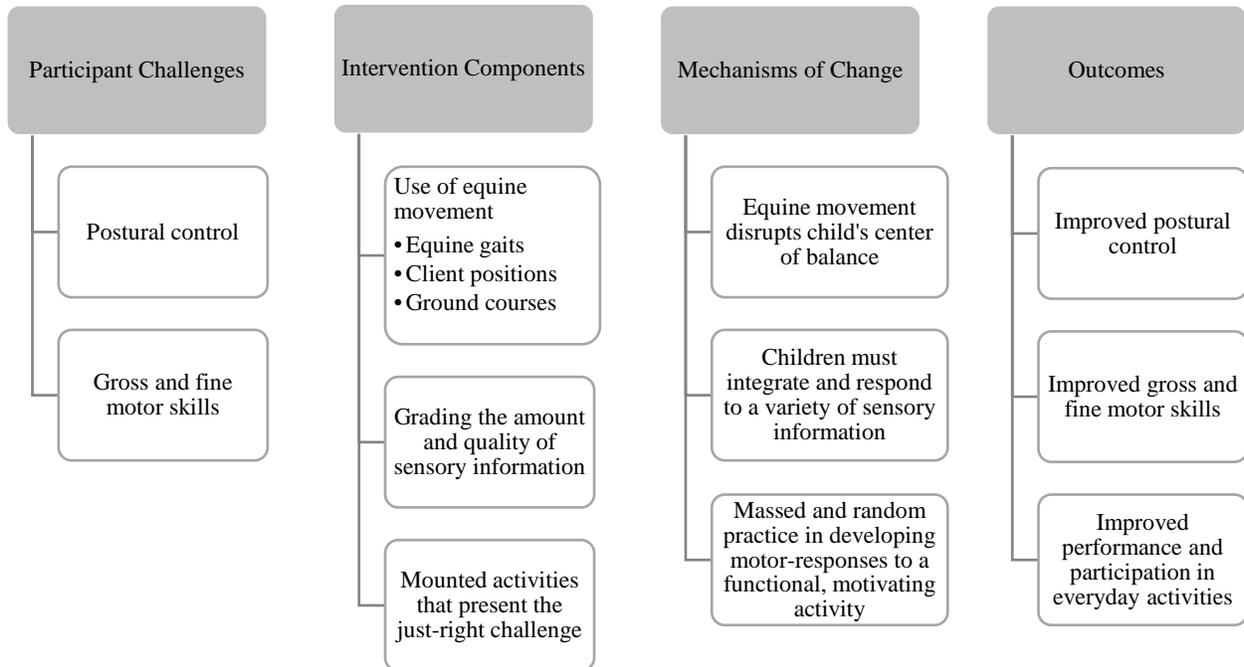
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varied conditions” (p. 39) and “gradually increasing the complexity of the sensory information” (Westcott & Burtner, 2004, p. 42).

Authors posited that improved postural control would also lead to improved gross motor and fine motor skills (*outcomes*), which is coherent with research that suggests postural control predicts motor abilities in children with ASD (Mache & Todd, 2016). In addition, authors hypothesized that improved motor control would lead to improved performance or participation in daily activities. While there is evidence that motor skills are related to daily living skills in children with ASD (Jasmin et al., 2009), prevailing thought in occupational therapy suggests that interventions solely targeting motor skills are insufficient; targeting of the environment and task demands is also necessary (e.g. Egilson & Traustadottir, 2009; Sood, LaVesser, & Schranz, 2014). Therefore, we suggest that treatment strategies focused on the use of

equine movement, or HPOT, may be one part of more comprehensive professional services by occupational therapists.

This theoretical framework is the most developed thus far. Silkwood-Sherer et al. (2012) provided a treatment protocol that operationalized this theoretical framework into *intervention components*, and three studies provided preliminary efficacy evidence that HPOT can indeed improve postural control, gross and fine motor skills, and performance or participation in everyday activities (Ajzenman et al., 2013; Liddiard, 2009; Silkwood-Sherer et al., 2012). However, all three studies implemented small sample sizes without control groups, and only one study was specific to children with ASD (Ajzenman et al., 2013). Thus, future research can assess the efficacy of HPOT on improving postural control and gross and fine motor skills of children with ASD using larger, more rigorous research designs such as a randomized clinical trial.



**Figure 3.** Proposed theoretical framework: occupational therapists and physical therapists may use equine movement to challenge and improve postural control, possibly leading to improvements in gross and fine motor skills, and participation in daily activities.

**Proposed Theoretical Framework: An Equine-Assisted Activity or Therapy May Simultaneously Motivate, Capture Attention, and Provide Physiological Regulation, Therefore Promoting the Child’s Engagement in the Intervention, Which May Serve as a Platform for Social Development and Optimize Other Targeted Outcomes.**

Figure 4 illustrates this theoretical framework. Children with ASD generally have impairments (*challenges*) in social attention (Dawson et al., 2004) and joint engagement (Adamson, Bakeman, Deckner, & Ronski, 2009). A lack of social engagement and preference for non-social activities leads to further social impairment in children with ASD throughout the course of development, as children miss opportunities to learn from social situations (Jones & Klin, 2009).

Drawing upon several of the *mechanisms* identified in this review, we propose that an equine-assisted activity or therapy may promote active engagement in children with ASD. First, horses may be a particularly powerful motivator for children, motivating them to actively engage in intervention activities, which is coherent with outside literature that demonstrates that children with ASD are more social in the presence of animals (Fung & Leung, 2014; O’Haire, McKenzie, Beck, & Slaughter, 2013; Silva, Correia, Lima, Magalhães, & de Sousa, 2011). In line with this mechanism, Beetz (2017) suggests that humans’ innate affinity toward nature (i.e. the biophilia hypothesis), in addition to the experiential quality of interacting with animals triggers participants’ intrinsic motivation. Second, the very nature of learning to ride a horse requires joint attention between the participant and the instructor/therapist, therefore capturing the participant’s attention and promoting engagement. Third, the horse’s movement and the participants’

positions on the horse can be altered to be alerting or calming to the participant, to promote the participant’s optimal physiological arousal, and to support the participant’s ability to remain engaged. The use of equine movement to regulate arousal is in line with the common practice of using tactile, vestibular, and proprioceptive input to help regulate children’s arousal levels (Lane, in press). Each of these three mechanisms, identified in this review, may work in concert to promote the child’s active and sustained engagement in the intervention. Furthermore, these mechanisms are aligned with outside research. Three common components of best-evidence interventions for social communication in children with ASD include: (a) adult direction inserted into an (b) interactive activity that is motivating to the child, and that also (c) addresses physiological regulation (Bottema-Beutel, Yoder, Woynaroski, & Sandbank, 2014).

A recent study investigated equine-assisted occupational therapy aimed at maximizing engagement in children with ASD (Llambias et al., 2016). The authors monitored the fidelity of the intervention, therefore operationalizing this theoretical framework into *intervention components*. Children with ASD were more engaged during the occupational therapy that included horses, than they were during activities in a playroom, thus providing preliminary evidence in support of this theoretical framework.

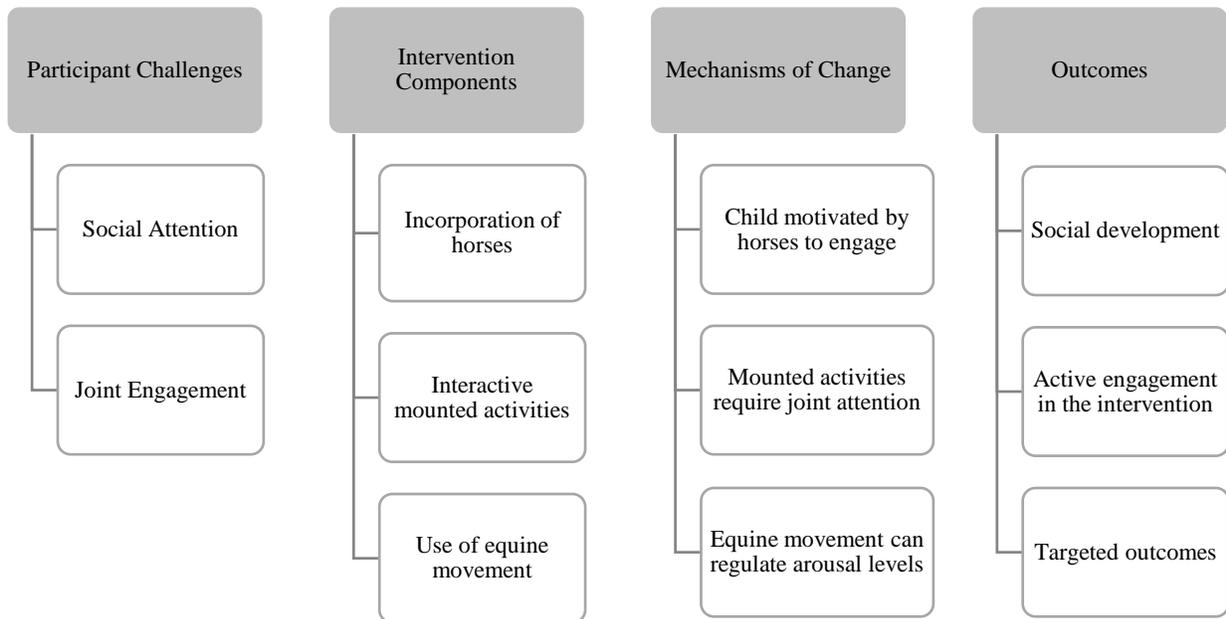
Increased engagement during the intervention could plausibly contribute to a variety of *outcomes*. First, it is theorized that if children are engaged in their social environment, social learning naturally occurs (e.g., body language, facial expressions, language, emotions) (Jones & Klin, 2009); therefore, simply being engaged in an equine-assisted activity or therapy could serve as a platform for social development. This potential outcome is coherent with research

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that found children with ASD who received an intervention targeting shared engagement also demonstrated improvements in language, play, and cognition (Chang, Shire, Shih, Gelfand, & Kasari, 2016). Second, increased engagement in an equine-assisted activity or therapy could make the intervention itself more potent, thus optimizing a variety of targeted outcomes. Take, for example, HPOT aimed at improving postural control. Children in this context may be very engaged in challenging motor tasks presented to them; hence they may experience larger improvements in postural control than would have otherwise occurred had they been distracted or un-engaged. In other words, increased engagement during an equine-assisted activity or therapy is a potential mediator of

a variety of targeted outcomes.

One study thus far has addressed the conceptual development and operationalization of this theoretical framework (Llambias et al., 2016). Therefore, more research is needed to refine the conceptual development of the theoretical framework, continue to operationalize it into specific intervention components, and confirm or disconfirm engagement in an equine-assisted activity or therapy as a platform for social development and a mediator of other targeted outcomes (Lynham, 2002). Future research can focus on operationalizing this theoretical framework into an intervention protocol, and assessing its feasibility and efficacy.



**Figure 4.** Proposed theoretical framework: an equine-assisted activity or therapy may simultaneously motivate, capture attention, and provide physiological regulation, therefore promoting the child’s engagement in the intervention, which may serve as a platform for social development and optimize other targeted outcomes.

**Proposed Theoretical Framework: An Equine-Assisted Activity or Therapy Could Positively Reinforce Social Communication and Provide Structure and Support for Social Interactions, Thereby Improving Social Communication.**

Figure 5 illustrates this proposed theoretical framework. ASD is characterized by *challenges* in social communication and social interaction (American Psychiatric Association, 2013). Drawing on several mechanisms of change presented in the literature, we propose that an equine-assisted activity or therapy can be tailored to address social communication and social interaction (*outcomes*). Several authors proposed that EAATs require both receptive and expressive communication; we propose the provider can grade these demands for communication to present the just-right challenge for each child. Furthermore, the provider can differentially reinforce appropriate social communication, and use equine movement (i.e., walking, trotting) as particularly powerful reinforcements. The immediate and tangible nature of equine movement as a reinforcement for social communication may cater to the children's concrete learning style (Gabriels et al., 2012). This *mechanism*—concrete positive reinforcement for effective communication—is coherent with research that demonstrates reinforcement is an evidence-based practice to promote communication in children with ASD (Odom, Collet-Klingenberg, Rogers, & Hatton, 2010).

In addition to fostering communication, Lanning et al. (2014) suggested an additional *mechanism*: EAATs may provide structured support for social interactions. The specific strategies, that is, *intervention components*, for supporting social interaction within different types of EAATs have not been explicated in the

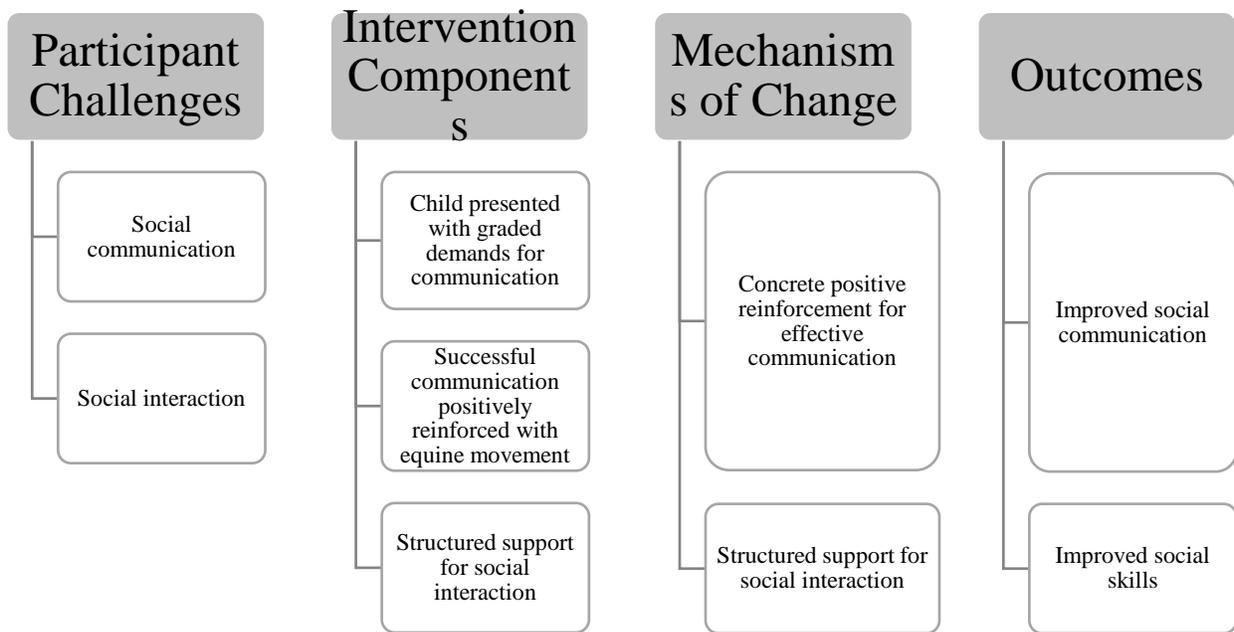
literature. However, it is conceivable that several strategies for social skill development could be incorporated into an equine-assisted activity or therapy, such as task analysis and chaining, prompting, self-management techniques, perspective taking, or knowledge of social rules (Bellini, Gardner, & Markoff, 2014; Odom et al., 2010). In addition, as piloted by Erdman et al. (2015), typically developing peers can be involved in the intervention, which is coherent with research that supports the use of peer-mediated interventions (Chang & Locke, 2016). Finally, it is conceivable that horses and the equine-environment could be incorporated into a social skills group. In their review of many social skills interventions, Reichow and Volkmar (2010) classified social skills groups as an evidence-based practice for children with ASD. These strategies for social skill development may be particularly potent when incorporated into an equine-assisted activity or therapy due to the motivating and engaging nature of the intervention, as described in the previous section. In particular, the presence of a horse may enhance a providers' ability to address social skill development, since children with ASD are often more social with other people when in the presence of animals (O'Haire et al., 2013). Perhaps contributing to this theoretical framework, recent theory-building research suggests that experiencing success in the context of an EAAT may foster self-concept and self-efficacy, thus promoting the child's improved social participation in daily life (Goodwin, Hawkins, Townsend, Van Puymbroeck, & Lewis, 2017; Martin, Graham, Taylor, & Levack, 2017).

There is preliminary evidence providing support for this proposed theoretical framework. First, Nelson et al. (2011) demonstrated that equine movement can be an effective reinforcement for social

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communication. Second, across the literature on EAATs for children with ASD, improvements in social interaction and communication are two of the most promising outcomes (McDaniel-Peters & Wood, 2017). However, the proposed mechanism that EAATs offer structured support for social interactions requires further development; that is, what exactly occurs during interventions that leads to improved social skills requires clarification.

Coherence with outside research on social skill interventions for children with ASD also requires clarification. There is a critical need to operationalize this theoretical framework into specific intervention components by creating an intervention protocol, and then confirm or disconfirm their efficacy through applied research; such investigations could illuminate the “active ingredients” that address social communication in EAATs.



**Figure 5.** Proposed theoretical framework: an equine-assisted activity or therapy could positively reinforce social communication and provide structure and support for social interactions, thereby improving social communication

### Limitations

As this review is nested within a larger systematic mapping review for all populations, the database searches were intentionally broad to capture papers related to EAATs for all populations; individual populations were not included in the search terms (e.g. autism, cerebral palsy, multiple sclerosis). We may have missed relevant papers for two reasons: (1) we did not include autism in the search terms, or (2) relevant papers may not have been indexed in databases. Additionally, we only included papers published in English, so papers published in other languages were not represented. We identified three promising theoretical frameworks, based on their plausibility and coherence with other literature, to advance the state of theoretical development and illuminate next-steps for research. Because, however, systematic mapping reviews do not include formal quality assessments of papers included in the review (Grant & Booth, 2009), we cannot verify the veracity of any identified mechanism of change or theoretical framework. Finally, we remained consistent with authors' uses of terms (e.g., rider), names of interventions (e.g., therapeutic riding) and conceptualizations of theoretical content, which may or may not be consistent with broader industry standards or relevant literature. For instance, PATH Intl (2017) requires that a credentialed health professional provide an equine-assisted therapy, yet Hawkins et al. (2014) stated that a therapeutic riding instructor provided an intervention they called "equine-assisted therapy."

### Summary and Conclusions

To our knowledge, this is the only review that has aimed to synthesize the state of theoretical development of EAATs for children with ASD. We found several formal theories and informal mechanisms of change that help to explain how horses can be

integrated into interventions to benefit children with autism. Yet, we also found that theory-driven interventions—whereby mechanisms of change were explicitly linked to participant challenges, intervention components, and targeted outcomes—were rarely studied. To help promote future theory development, we offered three plausible and coherent theoretical frameworks, each drawn from the reviewed literature and supported with outside research. We urge future researchers to continue the academic discourse by building upon, critiquing, or testing these potential theoretical frameworks. While the first proposed theoretical framework is largely specific to HPOT, the others may be generalizable to many different EAATs. Therefore, future work can also focus on the development and testing of theoretical frameworks for specific interventions. Development of the theoretical frameworks that support different types of EAATs for children with ASD can help to clarify for whom the intervention is appropriate, the processes that lead to change, essential components of the intervention, and what outcomes are likely to be produced. In conclusion, we propose that further theoretical development of different types of EAATs for children with ASD is a critical step that can ultimately lead to interventions that are most effective and most worthy of widespread dissemination.

### References

- Adamson, L. B., Bakeman, R., Deckner, D. F., & Ronski, M. (2009). Joint engagement and the emergence of language in children with autism and Down syndrome. *Journal of Autism and Developmental Disorders*, 39(1), 84.
- Ajzenman, H. F., Standeven, J. W., & Shurtleff, T. L. (2013). Effect of hippotherapy on motor control, adaptive behaviors, and participation

- in children with autism spectrum disorder: A pilot study. *American Journal of Occupational Therapy*, 67(6), 653-663. doi:10.5014/ajot.2013.008383
- American Hippotherapy Association. (2019). *Welcome to the American Hippotherapy Association, Inc.* Retrieved from <https://americanhippotherapyassociation.org/>
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5 ed.). Washington, DC: American Psychiatric Publishing.
- Anderson, S., & Meints, K. (2016). Brief report: The effects of equine-assisted activities on the social functioning in children and adolescents with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 46(10), 3344-3352. doi:10.1007/s10803-016-2869-3
- Ayres, A. J. (1972). *Sensory integration and learning disorders*. Los Angeles: Western Psychological Services.
- Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84(2), 191.
- Baranek, G. T. (2002). Efficacy of sensory and motor interventions for children with autism. *Journal of Autism and Developmental Disorders*, 32, 397-422. <http://dx.doi.org/10.1023/A:1020541906063>
- Bass, M., Duchowny, C., & Llabre, M. (2009). The effect of therapeutic horseback riding on social functioning in children with autism. *Journal of Autism and Developmental Disorders*, 39(9), 1261-1267. doi:10.1007/s10803-009-0734-3
- Beetz, A. M. (2017). Theories and possible processes of action in animal assisted interventions. *Applied Developmental Science*, 21(2), 139-149.
- Bellini, S., Gardner, L., & Markoff, K. (2014). Social skills interventions. In F. R. Volkmar, S. J. Rogers, R. Paul, & K. A. Pelphrey (Eds.), *Handbook of autism and pervasive developmental disorders* (4 ed., Vol. 2, pp. 887 - 906). Hoboken, NJ: John Wiley & Sons, Inc.
- Berg, E. L., & Causey, A. (2014). The life-changing power of the horse: Equine-assisted activities and therapies in the US. *Animal Frontiers*, 4(3), 72.
- Biery, M. J. (1985). Riding and the handicapped. *Veterinary Clinics of North America: Small Animal Practices*, 15(2), 345-354.
- Borgi, M., Loliva, D., Cerino, S., Chiarotti, F., Venerosi, A., Bramini, M., . . . Cirulli, F. (2016). Effectiveness of a standardized equine-assisted therapy program for children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 46(1), 1-9. doi:10.1007/s10803-015-2530-6
- Bottema-Beutel, K., Yoder, P., Woynaroski, T., & Sandbank, M. P. (2014). Targeted interventions for social communication symptoms in preschoolers with autism spectrum disorders. In F. R. Volkmar, S. J. Rogers, R. Paul, & K. A. Pelphrey (Eds.), *Handbook of autism and pervasive developmental disorders* (4 ed., pp. 788-812).
- Bracher, M. (2000). Therapeutic Horse Riding: What has this to do with Occupational Therapists? *British Journal of Occupational Therapy*, 63(6), 277-282.
- Brandt, C. (2013). Equine-Facilitated Psychotherapy as a Complementary Treatment Intervention. *The Practitioner Scholar: Journal of*

- Counseling and Professional Psychology*, 2, 23-42.
- Bronson, C., Brewerton, K., Ong, J., Palanca, C., & Sullivan, S. J. (2010). Does hippotherapy improve balance in persons with multiple sclerosis: a systematic review. *European Journal of Physical and Rehabilitation Medicine*, 46(3), 347-353.
- Candler, C. (2003). Sensory integration and therapeutic riding at summer camp: Occupational performance outcomes. *Physical & Occupational Therapy in Pediatrics*, 23(3), 51-64. doi:10.1080/j006v23n03\_04
- Casady R. L., & Nichols-Larsen, D. S. (2004). The effect of hippotherapy on ten children with cerebral palsy. *Pediatric Physical Therapy*, 16, 165–172.
- Chang, Y.-C., & Locke, J. (2016). A systematic review of peer-mediated interventions for children with autism spectrum disorder. *Research in Autism Spectrum Disorders*, 27, 1-10.
- Chang, Y.-C., Shire, S. Y., Shih, W., Gelfand, C., & Kasari, C. (2016). Preschool deployment of evidence-based social communication intervention: JASPER in the classroom. *Journal of Autism and Developmental Disorders*, 46(6), 2211-2223.
- Chen, C.-C., Crews, D., Mundt, S., & Ringenbach, S. D. R. (2015). Effects of equine interaction on EEG asymmetry in children with autism spectrum disorder: A pilot study. *British Journal of Developmental Disabilities*, 61(1), 56-95. doi:10.1179/2047387714Y.0000000044
- Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., & Petticrew, M. (2008). Developing and evaluating complex interventions: The new Medical Research Council guidance. *British Medical Journal*, 337, a1655.
- Dawson, G., Toth, K., Abbott, R., Osterling, J., Munson, J., Estes, A., & Liaw, J. (2004). Early social attention impairments in autism: Social orienting, joint attention, and attention to distress. *Developmental Psychology*, 40(2), 271.
- Decker, J. M. (1988). Riding for the disabled: an overview. *New Zealand Journal of Sports Medicine*, 16, 88-89.
- DePauw, K. P. (1986). Horseback riding for individuals with disabilities: Programs, philosophy, and research. *Adapted Physical Activity Quarterly*, 3(3), 217-226.
- Edhlund, B. M. (2012). *NVivo 10 essentials: Your guide to the world's most powerful data analysis software*. Stallarholmen, Sweden: Form & Kunskap AB.
- Egilson, S. T., & Traustadottir, R. (2009). Participation of students with physical disabilities in the school environment. *American Journal of Occupational Therapy*, 63(3), 264-272.
- Erdman, P., Miller, D., & Jacobson, S. (2015). The impact of an equine facilitated learning program on youth with autism spectrum disorder. *Human-Animal Interaction Bulletin*, 3, 21-36.
- Evans, I. M., & Bingham, A. O. (2007). 'Look Mum, No Hands!' Having Fun and Staying Safe Are Not Incompatible Outcomes of Exercising Choice. *Australian Journal of Rehabilitation Counselling*, 13(1), 44-61.
- Fleury, J., & Sidani, S. (2012). Using theory to guide intervention research. In B. M. Melnyk & D. Morrison-Beedy (Eds.), *Intervention research: Designing, conducting, analyzing*,

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- and funding*. New York, NY: Springer Publishing Company.
- Fung, S.-c., & Leung, A. S.-m. (2014). Pilot study investigating the role of therapy dogs in facilitating social interaction among children with autism. *Journal of Contemporary Psychotherapy*, 44(4), 253-262.
- Gabriels, R. L., Agnew, J. A., Holt, K. D., Shoffner, A., Pan, Z. X., Ruzzano, S., . . . Mesibov, G. (2012). Pilot study measuring the effects of therapeutic horseback riding on school-age children and adolescents with autism spectrum disorders. *Research in Autism Spectrum Disorders*, 6(2), 578-588.  
doi:10.1016/j.rasd.2011.09.007
- Gabriels, R. L., Pan, Z., Dechant, B., Agnew, J. A., Brim, N., & Mesibov, G. (2015). Randomized controlled trial of therapeutic horseback riding in children and adolescents with autism spectrum disorder. *Journal of the American Academy of Child and Adolescent Psychiatry*, 54, 541-549.  
doi:10.1016/j.jaac.2015.04.007  
10.1016/j.jaac.2015.04.007. Epub 2015 May 5.
- García-Gómez, A., Risco, M. L., Rubio, J. C., Guerrero, E., & García-Peña, I. M. (2014). Effects of a program of adapted therapeutic horse-riding in a group of autism spectrum disorder children. *Electronic Journal of Research in Educational Psychology*, 12(1), 107-128.
- Ghorban, H., Sedigheh, R. D., Marzieh, G., & Yaghoob, G. (2013). Effectiveness of therapeutic horseback riding on social skills of children with autism spectrum disorder in Shiraz, Iran. *Journal of Education and Learning*, 2(3), 79-84.
- Goodwin, B. J., Hawkins, B. L., Townsend, J. A., Van Puymbroeck, M., & Lewis, S. (2016). Therapeutic riding and children with autism spectrum disorder: An application of the theory of self-efficacy. *American Journal of Recreation Therapy*, 15(4), 41-47.  
doi:10.5055/ajrt.2016.0118
- Granados, A. C., & Agis, I. F. (2011). Why children with special needs feel better with hippotherapy sessions: A conceptual review. *Journal of Alternative and Complementary Medicine*, 17(3), 191-197.  
doi:10.1089/acm.2009.0229
- Grandin (1997, November). Thinking the way animals do. *Western Horseman*, 140-150.
- Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal*, 26(2), 91-108.  
doi:10.1111/j.1471-1842.2009.00848.x
- Green, D., Charman, T., Pickles, A., Chandler, S., Loucas, T., Simonoff, E., & Baird, G. (2009). Impairment in movement skills of children with autistic spectrum disorders. *Developmental Medicine & Child Neurology*, 51(4), 311-316.
- Hallberg, L. (2008). *Walking the way of the horse: Exploring the power of the horse-human relationship*. New York: iUniverse.
- Hammick, M. (2005). A BEME review: A little illumination. *Medical Teacher*, 27(1), 1-3.  
doi:10.1080/01421590500046858
- Harris, A., & Williams, J. M. (2017). The impact of a horse riding intervention on the social functioning of children with autism spectrum disorder. *International Journal of Environmental Research and Public Health*, 14(7).  
doi:10.3390/ijerph14070776

- Hawkins, B. L., Ryan, J. B., Cory, A. L., & Donaldson, M. C. (2014). Effects of equine-assisted therapy on gross motor skills of two children with autism spectrum disorder: A single-subject research study. *Therapeutic Recreation Journal*, 48(2), 135.
- Heine, B. (1997). *Introduction to hippotherapy*. Retrieved September 24, 2007, from [http://www.narha.org/PDFfiles/tr\\_hippo.pdf](http://www.narha.org/PDFfiles/tr_hippo.pdf).
- Holm, M. B., Baird, J. M., Kim, Y. J., Rajora, K. B., D'Silva, D., Podolinsky, L., . . . Minshew, N. (2013). Therapeutic horseback riding outcomes of parent-identified goals for children with autism spectrum disorder: An aba' multiple case design examining dosing and generalization to the home and community. *Journal of Autism and Developmental Disorders*, 937-947. doi:10.1007/s10803-013-1949-x
- Hornacek, K. (2005). Basic, yet overlooked factors influencing posture in horseback-riding therapy, hippotherapy with babies and toddlers. *Scientific & Educational Journal of Therapeutic Riding*, 1-11.
- Jasmin, E., Couture, M., McKinley, P., Reid, G., Fombonne, E., & Gisel, E. (2009). Sensori-motor and daily living skills of preschool children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 39(2), 231-241.
- Jenkins, S. R., & Reed, F. D. D. (2013). An experimental analysis of the effects of therapeutic horseback riding on the behavior of children with autism. *Research in Autism Spectrum Disorders*, 7(6), 721-740. doi:10.1016/j.rasd.2013.02.008
- Jones, W., & Klin, A. (2009). Heterogeneity and homogeneity across the autism spectrum: The role of development. *Journal of the American Academy of Child & Adolescent Psychiatry*, 48(5), 471-473.
- Kang, O., Kang, A., Ryu, Y., & Lee, W. (2013). The effects of therapeutic horseback riding on equilibrium for children with disabilities. *Journal of Animal Science and Technology*, 55(2), 141-146.
- Kazdin, A. E. (2007). Mediators and mechanisms of change in psychotherapy research. *Annual Review of Clinical Psychology*, 3, 1-27.
- Keino, H., Funahashi, A., Keino, H., Miwa, C., Hosokawa, M., Hayashi, Y., & Kawakita, K. (2009). Psycho-educational horseback riding to facilitate communication ability of children with pervasive developmental disorders. *Journal of Equine Sciences*, 20(4), 79-88.
- Keino, H., & Kawakita, K. (2010). Introduction of a revised HEIM scale for evaluating the psychoeducational horseback riding program in children with pervasive developmental disorder. *Scientific & Educational Journal of Therapeutic Riding*.
- Keino, H., Keino, H., Miwa, C., Kawakita, K., Hosokawa, M., & Funahashi, A. (2009). Facilitation of social and interpersonal behaviors of children with pervasive developmental disorders through psycho-educational horseback riding. *Journal of Animals in Education and Therapy*, 1, 1-8.
- Kern, J. K., Fletcher, C. L., Garver, C. R., Mehta, J. A., Grannemann, B. D., Knox, K. R., . . . Trivedi, M. H. (2011). Prospective trial of equine-assisted activities in autism spectrum disorder. *Alternative Therapies in Health and Medicine*, 17(3), 14-20.
- Kielhofner, G., & Burke, J. P. (1980). A model of human occupation, part 1:

- Conceptual framework and content. *American Journal of Occupational Therapy*, 34(9), 572-581.
- Koca, T. T., & Ataseven, H. (2016). What is hippotherapy? The indications and effectiveness of hippotherapy. *Northern Clinics Of Istanbul*, 2(3), 247-252.  
doi:10.14744/nci.2016.71601
- Lane, S. J. (in press). Disorders of sensory modulation. In A. Bundy & S. Lane (Eds.), *Sensory Integration: Theory & Practice* (3 ed.). Philadelphia: F.A. Davis.
- Lanning, B. A., Baier, M. E. M., Ivey-Hatz, J., Krenek, N., & Tubbs, J. D. (2014). Effects of equine assisted activities on autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 44(8), 1897-1907.  
doi:10.1007/s10803-014-2062-5
- Leitão, L. (2003). Psycho-educational riding (PER) and autism: An exploratory study. *Scientific and Educational Journal of Therapeutic Riding*, 9, 33-64.
- Lessick, M., Shinaver, R., Post, K. M., Rivera, J. E., & Lemon, B. (2004). Therapeutic horseback riding. Exploring this alternative therapy for women with disabilities. *AWHONN Lifelines*, 8(1), 46-53.
- Lewis, M. D. (2000). The promise of dynamic systems approaches for an integrated account of human development. *Child Development*, 71(1), 36-43.
- Liddiard, J. (2009). Hands up for hippotherapy: An investigation into the use of hippotherapy to promote handwriting legibility for children who have disabilities *Scientific and Educational Journal of Therapeutic Riding*, 19, 72-94.
- Lindly, O. J., Thorburn, S., Heisler, K., Reyes, N. M., & Zuckerman, K. E. (2017). Parents' use of complementary health approaches for young children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 1-16.
- Llambias, C., Magill-Evans, J., Smith, V., & Warren, S. (2016). Equine-assisted occupational therapy: Increasing engagement for children with autism spectrum disorder. *American Journal of Occupational Therapy*, 70(6), 7006220040p7006220041-7006220040p7006220049.
- Luna, J. T. (2009). The Horse, My Healer and Guide. *Part of a special issue, Animal-Human Relationships: Comforting, Healing, and Transforming, Part Two*, 15(1), 20-23.
- Lynham, S. A. (2002). The general method of theory-building research in applied disciplines. *Advances in Developing Human Resources*, 4(3), 221-241.  
doi:10.1177/1523422302043002
- Macauley, B. L., & Gutierrez, K. M. (2004). The effectiveness of hippotherapy for children with language-learning disabilities. *Communication Disorders Quarterly*, 25(4), 205-217.
- Mache, M. A., & Todd, T. A. (2016). Gross motor skills are related to postural stability and age in children with autism spectrum disorder. *Research in Autism Spectrum Disorders*, 23, 179-187.
- MacKinnon, J. (2005). What is the state of hippotherapy research and where should we go from here? *Scientific and Educational Journal of Therapeutic Riding*, 65-89.
- Malcolm, R., Ecks, S., & Pickersgill, M. (2017). 'It just opens up their world': Autism, empathy, and the therapeutic effects of equine interactions. *Anthropology & Medicine*, 1-15.

- doi:10.1080/13648470.2017.1291115
- Mapes, A. R., & Rosen, L. A. (2016). Equine-assisted therapy for children with autism spectrum disorder: A comprehensive literature review. *Review Journal of Autism and Developmental Disorders*, 3(4), 377-386. doi:10.1007/s40489-016-0090-0
- Martin, R., Graham, F., Taylor, W., & Levack, W. (2017). Mechanisms of change for children participating in therapeutic horse riding: A grounded theory. *Physical & Occupational Therapy in Pediatrics*, 1-17.
- Masini, A. (2010). Equine-assisted psychotherapy in clinical practice. *Journal of Psychosocial Nursing and Mental Health Services*, 48(10), 30-34. doi:10.3928/02793695-20100831-08
- McDaniel-Peters & Wood (2017). Autism and equine-assisted interventions: A systematic mapping review. *Journal of Autism and Developmental Disorders*, 47(10), 3220-3242.
- Memishevikj, H., & Hodzhikj, S. (2010). The effects of equine-assisted therapy in improving psychological functioning in children with autism. *Journal of Special Education and Rehabilitation*, 11(3-4), 57-67.
- Minoei, A., Sheikh, M., Hemayattalab, R., & Olfatian, U. (2015). Examining a horse therapy in 8, 12 year-old boy children with autism spectrum disorders. *International Research Journal of Applied and Basic Sciences*, 9(5), 761-765.
- Naidoo, R., Nqwena, Z., Reimers, L., Peters, K., Sookan, T., & McKune, A. J. (2014). Acute heart rate variability responses to a therapeutic horseback riding session in children with autism spectrum disorders: A pilot study. *Scientific and Educational Journal of Therapeutic Riding*, 19, 10-25.
- Nelson, K., Axtell, J., Derby, K. M., Moug, R., Berrera, S., & McLaughlin, T. (2011). A preliminary analysis of therapeutic horseback riding. *International Journal of Social Sciences and Education*, 1(4), 644-656.
- Nqwena, Z., & Naidoo, R. (2016). The effect of therapeutic horseback riding on heart rate variability of children with disabilities. *African Journal Of Disability*, 5(1). doi:10.4102/ajod.v5i1.248
- O'Haire, M. E., McKenzie, S. J., Beck, A. M., & Slaughter, V. (2013). Social behaviors increase in children with autism in the presence of animals compared to toys. *PloS one*, 8(2), e57010.
- Odom, S. L., Collet-Klingenberg, L., Rogers, S. J., & Hatton, D. D. (2010). Evidence-based practices in interventions for children and youth with autism spectrum disorders. *Preventing School Failure*, 54(4), 275-282.
- Page, C. (2014). The social and emotional benefits of therapeutic riding for children with autism: An exploratory study. *Scientific and Educational Journal of Therapeutic Riding*, 19, 42-63.
- Parsons, M. (1996). Riding and community building: the story of the Richmond Therapeutic Equestrian Society. *Journal of Leisurability*, 23(1), 28-32.
- Petty, J. D., Pan, Z. X., Dechant, B., & Gabriels, R. L. (2017). Therapeutic horseback riding crossover effects of attachment behaviors with family pets in a sample of children with autism spectrum disorder. *International Journal Of Environmental Research And Public*

- Health, 14(3).  
doi:10.3390/ijerph14030256
- Professional Association of Therapeutic Horsemanship International. (2017). 2016 PATH Intl Statistics. Retrieved from <https://www.pathintl.org/images/pdf/about-narha/documents/2016-fact-sheet-for-web.pdf>
- Professional Association of Therapeutic Horsemanship International. (2019). *Learn About Therapeutic Riding*. Retrieved from <https://www.pathintl.org/resources-education/resources/eaat/27-resources/general/198-learn-about-therapeutic-riding>
- Ratliffe, K. T., & Sanekane, C. (2009). Equine-assisted therapies: Complementary medicine or not? *Australian Journal of Outdoor Education, 13*(2), 33.
- Reeves, G. (2001). From neuron to behavior: Regulation, arousal, and attention as important substrates for the process of sensory integration. In *Understanding the nature of sensory integration with diverse populations* (pp. 89-108).
- Reichow, B., & Volkmar, F. R. (2010). Social skills interventions for individuals with autism: Evaluation for evidence-based practices within a best evidence synthesis framework. *Journal of Autism and Developmental Disorders, 40*(2), 149-166.
- Rothe, E. Q., Vega, B. J., Torres, R. M., Soler, S. M. C., & Pazos, R. M. M. (2005). From kids and horses: Equine facilitated psychotherapy for children. *International Journal of Clinical and Health Psychology, 5*(2), 373-383.
- Sandelowski, M. (2000). Focus on research methods: Whatever happened to qualitative description? *Research in Nursing and Health, 23*(4), 334-340.
- Shurtleff, T. L., Standeven, J. W., & Engsberg, J. R. (2009). Changes in dynamic trunk/head stability and functional reach after hippotherapy. *Archives of Physical Medicine and Rehabilitation, 90*, 1185-1195. <http://dx.doi.org/10.1016/j.apmr.2009.01.026>
- Silkwood-Sherer, D. J., Killian, C. B., Long, T. M., & Martin, K. S. (2012). Hippotherapy-an intervention to habilitate balance deficits in children with movement disorders: A clinical trial. *Physical Therapy, 92*(5), 707-717. doi:10.2522/ptj.20110081
- Silva, K., Correia, R., Lima, M., Magalhães, A., & de Sousa, L. (2011). Can dogs prime autistic children for therapy? Evidence from a single case study. *The Journal of Alternative and Complementary Medicine, 17*(7), 655-659.
- Siporin, S. (2012). Talking horses: Equine psychotherapy and intersubjectivity. *Psychodynamic Practice: Individuals, Groups and Organisations, 18*(4), 457-464. doi:10.1080/14753634.2012.719744
- Sood, D., LaVesser, P., & Schranz, C. (2014). Influence of home environment on participation in home activities of children with an autism spectrum disorder. *The Open Journal of Occupational Therapy, 2*(3), 2.
- Steiner, H., & Kertesz, Z. (2015). Effects of therapeutic horse riding on gait cycle parameters and some aspects of behavior of children with autism. *Acta Physiologica Hungarica, 102*, 324-335. doi:10.1556/036.102.2015.3.10

- Tabares, C., Vicente, F., Sanchez, S., Aparicio, A., Alejo, S., & Cubero, J. (2012). Quantification of hormonal changes by effects of hippotherapy in the autistic population. *Neurochemical Journal*, 6(4), 311-316. doi:10.1134/s1819712412040125
- Taylor, R. R., Kielhofner, G., Smith, C., Butler, S., Cahill, S. M., Ciukaj, M. D., & Gehman, M. (2009). Volitional change in children with autism: A single-case design study of the impact of hippotherapy on motivation. *Occupational Therapy in Mental Health*, 25(2), 192-200.
- Thomas, L. (2011). The EAGALA model of equine assisted psychotherapy and learning. *Scientific and Educational Journal of Therapeutic Riding*, 20-24.
- Tyler, J. J. (1994). Equine psychotherapy: Worth more than just a horse laugh. *Women & Therapy*, 15(3-4), 139-146. doi:10.1300/J015v15n03\_11
- Viera, A. J., & Garrett, J. M. (2005). Understanding interobserver agreement: The kappa statistic. *Family Medicine*, 37(5), 360-363.
- Vygotsky, L. S., & Cole, M. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Ward, S. C., Whalon, K., Rusnak, K., Wendell, K., & Paschall, N. (2013). The association between therapeutic horseback riding and the social communication and sensory reactions of children with autism. *Journal of Autism and Developmental Disorders*, 43(9), 2190-2198. doi:10.1007/s10803-013-1773-3
- Westcott, S. L., & Burtner, P. (2004). Postural control in children: Implications for pediatric practice. *Physical & Occupational Therapy in Pediatrics*, 24(1-2), 5-55.
- Westerman, P., Stout, S., & Hargreaves, H. (2012). Mentoring improves self-efficacy, competence, and connectedness in a therapeutic horseback riding program. *Reflections: Narratives of Professional Helping*, 18(3), 37-46.
- Westerman, P., Westerman, D., Hargreaves, H., & Verge, M. (2008). Horses and people healing each other: The impact of participation in a therapeutic riding program. *Part of a special issue, Animal-Human Relationships: Comforting, Healing, and Transforming*, 14(4), 57-63.
- Wuang, Y.-P., Wang, C.-C., Huang, M.-H., & Su, C.-Y. (2010). The effectiveness of simulated developmental horse-riding program in children with autism. *Adapted Physical Activity Quarterly*, 27(2), 113-126.
- Young, R. L., & Bracher, M. (2005). Horsemastership part 2: Physical, psychological, educational and social benefits. *International Journal of Therapy and Rehabilitation*, 12(3), 120-125.
- Zabriskie, R. B., Lundberg, N. R., & Groff, D. G. (2005). Quality of life and identity: The benefits of a community-based therapeutic recreation and adaptive sports program. *Therapeutic Recreation Journal*, 39(3), 176-191.
- Zadnikar, M., & Kastrin, A. (2011). Effects of hippotherapy and therapeutic horseback riding on postural control or balance in children with cerebral palsy: A meta-analysis. *Developmental Medicine & Child Neurology*, 53(8), 684-691. doi:10.1111/j.1469-8749.2011.03951.x