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RETAINED PRIMITIVE REFLEXES AND ADHD? EXAMINING ATYPICAL
SYMPTOMOLOGY IN THE SCHOOL-AGED POPULATION

by

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A Scholarly Project

Submitted to the Occupational Therapy Department

of the

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This Scholarly Project, submitted by Quincey Adams, MOT and Jamie Craft, MOT in partial fulfillment of the requirements for the Degree of Master's of Occupational Therapy from the University of North Dakota, has been read by the Faculty Advisors under whom the work has been done and is hereby approved.

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Department Occupational Therapy

Degree Master's of Occupational Therapy

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Abstract

Purpose

Typical development begins in-utero and progresses throughout the lifespan. Jean Piaget authored a theory that encompasses core aspects of the lifespan stages related to typical development of sensory and motor systems. Piaget outlined the developmental stages as: sensorimotor stage, preoperational stage, concrete operational stage, and formal operational stage. Within these stages, the typically developing child learns to adapt and respond effectively to his or her environment (Cole & Tufano, 2008). Dr. Jean Ayres described a similar developmental process, termed Sensory Integration. This process is defined as the coordination of the sensory systems in order for an individual to effectively interact with his or her environment (Ayres, 1979). For this scholarly project, Piaget and Ayres' theories will be used in parallel to create a framework of typical and atypical development throughout the lifespan.

Another facet of typical development is the presence of primitive reflexes, which are initially used for protection against external stimuli, and later integrated into purposeful movement (Berne, 2006). The retention of certain primitive reflexes may cause sensory and motor dysfunction in the school-aged child (Goddard, 2002). Another cause of sensory and motor dysfunction in this population is attention-deficit hyperactivity disorder (ADHD), which impacts approximately 9.5% of Americans under the age of seventeen (CDC, 2010, p.1439).

ADHD is defined as “a disorder of childhood and adolescence manifested at home, in school, and in social situations by developmentally inappropriate degrees of inattention, impulsiveness, and hyperactivity” (Stedman, 2005, p. 136). Many of the characteristics of ADHD symptomology and retained primitive reflexes are very similar in presentation, and the purpose of this scholarly project is to explore possible correlations between the two (Konicarova & Bob, 2012; Konicarova & Bob, 2013; Taylor, Houghton, & Chapman, 2004).

Methodology

An extensive literature review was conducted on typical human development, including primitive reflexes, and atypical developmental behaviors that may occur if these reflexes are retained. ADHD was also thoroughly researched, specifically with regard to how sensory integrative behaviors are presented throughout development. Research exploring any possible correlation between retained primitive reflexes and ADHD was reviewed and analyzed.

Conclusions

A product was developed in the form of a scholarly article to explore a possible correlation of retained primitive reflexes and sensory-integrative behaviors in school-aged children diagnosed with ADHD. Included in the article is an explanation of atypical behaviors presented with retained primitive reflexes, ADHD and atypical behaviors, as well as research conducted on any possible correlations between retained primitive reflexes and ADHD. It is intended that this article will be submitted for publication in *OT Practice*, a scholarly magazine published by the American Occupational Therapy

Association (AOTA). This scholarly article will be used to demonstrate the need for further research on this topic.

Chapter I Introduction

Attention-deficit hyperactivity disorder (ADHD) affects approximately 9.5% of American youth (CDC, 2010, p. 1439). Occupational therapists are well suited to provide treatment for this population; however, optimal intervention approaches have yet to be discovered (Hardy, Warmbrodt, & DeBasio, 2004). The authors learned the importance in identifying effective treatment approaches throughout fieldwork experiences. A fieldwork supervisor brought attention to multiple factors that may be correlated with ADHD symptomology, including the retention of primitive reflexes. There was evidence of retained primitive reflexes and ADHD symptomology among several of the practicing clinician's clients, and one of the authors observed the presence of motor patterns associated with primitive reflexes in children diagnosed with ADHD. This motivated the authors to explore the topics through the development of a scholarly project.

There is limited research regarding a correlation between retained primitive reflexes and the sensory-integrative behaviors associated with ADHD. The research that has previously been conducted on a correlation between retained primitive reflexes and ADHD was primarily conducted by two authors (Konicarova & Bob, 2012; Konicarova & Bob, 2013). Therefore, additional research needs to be conducted based on the parallels of atypical behaviors presented with retained primitive reflexes and an ADHD diagnosis.

An expansion of research on these two topics could enhance evidence-based practice when treating individuals affected by the retention of primitive reflexes or ADHD. This could lead to increased recognition of primitive reflexes and advancement in ADHD interventions. Possible findings may also increase collaboration between occupational therapists and other professionals interacting with the school-aged population. Occupational performance in meaningful childhood occupations, including education, leisure, play, and social participation, may be enhanced with a better understanding of the atypical behaviors associated with retained primitive reflexes and ADHD.

The literature review encompasses development throughout the lifespan, however, the stages of development in focus reflect children and adolescents. This population was chosen primarily due to the prominent presentation of ADHD behaviors between the ages of seven and twelve, thus guiding the diagnostic criteria for the diagnosis. Children in these age groups continue to develop adaptive responses in order to address atypical behaviors that are present with ADHD and other motor dysfunction. In addition, a child's primary occupation is participating in school, and underdeveloped adaptive responses may directly impact school performance.

Jean Piaget's theory of development and Dr. Jean Ayres' Sensory Integration Theory are used in parallel to one another for this scholarly project in order to develop a framework of typical and atypical development throughout the lifespan. The developmental stages outlined by Piaget include sensorimotor, preoperational, concrete operational, and formal operational, which are all described in detail in the literature

review (Piaget 1962/2006). The sensorimotor and preoperational stages are modified to more thoroughly describe typical development within these stages. The sensorimotor stage is divided into two substages (zero to twelve months and twelve to 24 months) in order to separate typical from atypical development in terms of integration of primitive reflexes. The preoperational stage is also divided into two substages; two to five years and five to seven years. The concrete and formal operational stages were not modified. Piaget's developmental stages were used to outline primitive reflexes presented in typical development, atypical behavior presented when these reflexes are retained, as well as the sensory-integrative behaviors presented with ADHD symptomology.

This scholarly project is not to identify treatment interventions, but rather to provide more information for nuanced treatment in upcoming years. There is no single, optimal approach for treatment of the symptomology associated with the retention of primitive reflexes or ADHD (Hardy et al., 2004; Konicarova & Bob, 2012; Konicarova & Bob, 2013; Taylor, et al., 2004). This scholarly project can lead professionals to explore possible unconventional interventions strategies, which can ultimately lead to increased occupational performance of the individuals (specifically school-aged children) experiencing retained primitive reflex and/or ADHD symptomology.

In order for this issue to be addressed, the authors have created a scholarly article, which will be submitted for publication in *OT Practice* magazine. The article discusses the research regarding possible correlations between retained primitive reflexes and sensory-integrative behaviors in school-aged children diagnosed with ADHD. The

scholarly article will be used to inform readers of the hypothesized correlation and identify avenues for continued research.

The following definitions of key terms and concepts throughout the remainder of the scholarly project are as follows:

- **Typical Development:** “the act or process of natural progression in physical and psychological maturation from a previous, lower, or embryonic stage to a later, more complex, or adult stage” (Stedman, 2005, p. 403).
- **Atypical Development:** consists of behaviors that fall outside of the normal, or expected range of development; occurs in a way or pace that differ from peers (NCLD, 2000).
- **Primitive Reflex:** “any of a group of reflexes seen during gestation and infancy that typically become integrated by an early age” (Stedman, 2005, p. 1188).
- **Retained Primitive Reflex:** a primitive reflex that persists longer than it should; it upsets or disrupts the typical development process and the brain’s ability to process sensory information (Goddard, 1996).
- **Attention-deficit hyperactivity disorder (ADHD):** “a disorder of childhood and adolescence manifested at home, in school, and in social situations by developmentally inappropriate degrees of inattention, impulsiveness, and hyperactivity” (Stedman, 2005, p. 136).

An extensive literature review based on the current scientific readings and research of this scholarly project is provided. The methodology chapter contains a description of the process that was used in designing the scholarly article. An introduction and description of the scholarly article, as well as the rationale for choosing Piaget's developmental theory and Ayres' Sensory Integration Theory to guide the scholarly project are located in the product chapter. The appendix includes the finished product, which will be submitted for possible publication in *OT Practice* magazine. The last chapter summarizes the scholarly project and its purpose, highlights key information identified throughout the process, and provides recommendations for future actions. The scholarly project concludes with the references used to provide evidentiary support throughout the scholarly project process and guide the development of the scholarly article to be submitted for publication.

Chapter II Literature Review

Sensorimotor (Infancy) Stage

Typical development of a human begins in-utero and progresses throughout the lifespan. The sensorimotor stage in an infant, as described by developmental theorist Jean Piaget (1964/2003), begins at birth and ends at approximately 24 months of life. The authors chose to divide this stage into two groups in order to separate the typical and atypical development in terms of integration of primitive reflexes. The two substages are zero to 12 months and 12 to 24 months.

Zero to twelve month typical development. In this stage, an infant's primary focus is on exploration of his or her physical environment through sensory input (Cole & Tufano, 2008; Parham & Mailloux, 2010). In the 1970s, Dr. Jean Ayres introduced the concept of a sensory integration process that explains the relationship between neurological functioning and behavior in response to environmental demands and stimuli. This is now considered a foundational theory of development (Ayres, 1979). Ayres (1979) defined sensory integration as:

The organization of sensory input for use. The "use" may be a perception of the body or the world, or an adaptive response, or a learning process, or the development of some neural function. Through sensory integration, the many

parts of the nervous system work together so that a person can interact with the environment effectively and experience appropriate satisfaction (p. 184).

Ayres categorized the sensory systems into tactile, proprioceptive, auditory, visual, and vestibular, which are identified as pertinent for typical development of an infant (Cole & Tufano, 2008). The tactile system is essential to the infant's ability to develop emotional connections with others and is formed by the infant bonding through physical contact. Development of the proprioceptive system begins with the infant gathering sensory input through grasping for objects, in turn developing manipulation skills. As voluntary motor control begins to develop, the infant becomes more aware of his or her positioning in space. A newborn orients to selective auditory stimulation but is unable to form meaning to the sounds. As auditory processing improves, the infant begins to interpret sounds and vocalize. The visual system is not fully developed in the newborn, but quickly matures in the first few months of life. The infant is able to respond to visual patterns and begins to incorporate eye-hand coordination during movements (Parham & Mailloux, 2010).

The vestibular system is a sensory system that is fully functional at birth. This system assists with orienting the infant in relation to gravitational force by controlling the body's ability to detect gravity. This provides the ability to orient the body in space, position and control movements of the head and body, as well as regulate postural tone. The vestibular system is derived of structures in the inner ear and the visual system (Parham & Mailloux, 2010; Smith Roley & Jacobs, 2009). Otoliths are inner ear structures that detect gravitational positioning of the body, and semicircular canals

perceive speed and direction of body movement. To assist the vestibular system, visual input is used to monitor body movement throughout the environment (O'Brien & Williams, 2009).

Connections in the tactile, proprioceptive, auditory, visual, and vestibular systems are made during the first six months of life, leading to center of gravity awareness and increased postural control (Parham & Mailloux, 2010). At approximately eight months old, an infant should be able to sit independently and reach for toys (Edwards & Sarwark, 2005). Crawling on all fours occurs at approximately ten months of age and hand held walking at approximately 12 months (Case-Smith, 2010). Proprioceptive skills improve in this developmental stage and promote object manipulation, including the ability to self-feed (Parham & Mailloux, 2010). An infant is constantly creating new schemata that help structure intelligence and develop purposeful movement (Piaget, 1962/2006).

Body schemes, or the connection between body parts in relation to the brain, contribute to the sophistication of planned motor actions. Developed body schemes assist in the way an infant acts (and prepares for action) on his or her environment rather than solely reacting to it. Ayres addressed body scheme development throughout her sensory integration work and often referred to it as "body percept" (Ayres, 1979). Ayres hypothesized that as body percepts become more advanced, motor planning ability also improves. An infant uses sensory experiences within his or her environment to plan or navigate future actions (Ayres, 1979; Parham & Mailloux, 2010). Piaget referred to schemes as the way information is processed and categorized for learning. He explained

that beginning in infancy, body schemes are used to explore the environment through touch, feel, and grasp, also known as action schemes (Piaget, 1962/2006). The continued maturation of body schemes is important to the typical development of an infant as he or she begins to develop an awareness of their own body in relation to the surrounding environment (Case-Smith, Law, Missiuna, Pollock, & Stewart, 2010; Parham & Mailloux, 2010).

Primitive reflexes. Another key component to the development of an infant is the presence of primitive reflexes, which originate in the brainstem, emerge during the prenatal period, and are present at birth. These reflexes are extremely important in the first weeks of life for a newborn, as they help the infant integrate the overwhelming stimuli in life outside the womb. As an infant continues to develop, the primitive reflexes should integrate into more purposeful movements (Berne, 2006). Although there are several reflexes essential to development, there are five reflexes that are of focus throughout the literature review: the Moro Reflex, Tonic Labyrinthine Reflex (TLR), Asymmetrical Tonic Neck Reflex (ATNR), Symmetrical Tonic Neck Reflex (STNR), and Spinal Galant Reflex. These reflexes were chosen due to possible correlations between retention of the primitive reflex(es) and sensory-integrative behaviors in school-aged children diagnosed with attention-deficit hyperactivity disorder [ADHD] (Berne, 2006; Konicarova & Bob, 2012; Konicarova & Bob, 2013; Taylor, Houghton, & Chapman, 2004).

The Moro Reflex is referred to by Taylor et al. (2004) as the developmental gateway to other primitive reflexes. This reflex occurs when the body reacts to a sudden

or potentially dangerous stressor. The brain initiates a reflexive response that causes the infant's upper limbs to stretch upwards and backwards, away from the body (Berne, 2006). McCormack and Perrin (1997) stated that this movement is followed by a return of the hands towards the trunk with a clasping position. This reflex typically emerges at nine weeks in utero and integrates by four months of age (Brown, Revels, & Smith, 2005).

A typical Tonic Labyrinthine Reflex (TLR) emerges at approximately sixteen weeks in utero and integrates by the time an infant is four months old. This reflex is stimulated by the vestibular system and can therefore be elicited by moving the head of an infant from a neutral position into flexion or extension (Berne, 2006). If the infant's head and neck are flexed, the limbs flex and the body assumes a fetal position. If the head is extended, the infant's limbs also extend (McCormack & Perrin, 1997). If an infant has automatic head responses, it is likely that the reflex is beginning to integrate due to the ability to respond to gravitational forces. This is crucial for making advancements in postural reflexes and stability (Berne, 2006; Goddard, 2002).

At 18 weeks in utero, the Asymmetrical Tonic Neck Reflex (ATNR) is present and used to move the fetus' head side to side while swinging the arms and legs. The motor pattern elicited by the reflex is extension of the same-sided extremities and flexion of the contralateral extremities (Brown et al., 2005). This motion assists in developing the fetus' vestibular system and muscle tone by facilitating the use of the extremities. The motor skills assisted by this reflex motor pattern after birth include bilateral coordination, eye-hand coordination, and movements for creeping and crawling (Berne, 2006;

Goddard, 2002). The ATNR can be elicited by rotating the head of the infant to one side for 15 seconds and observing the reaction. If the reflex is retained, the observer will see extension of the extremities on the side where the infant is looking, and flexion of those on the contralateral side (Zafeiriou, 2004).

In order for an infant to experience the gravitational forces necessary for regulation of the vestibular system, the Symmetrical Tonic Neck Reflex (STNR) is present. This reflex appears when an infant is approximately six to nine months old and integrates around nine to 11 months of life (Berne, 2006). The STNR can be elicited by placing an infant on his or her four extremities and extending the head, observing the motor patterns elicited. The reflex is present if the upper extremities extend and the lower extremities flex. When flexing the infant's head, the reflex is present if the upper extremities flex and the lower extremities extend (McCormack & Perrin, 1997). The STNR helps a child develop the motion necessary for creeping and crawling (Berne, 2006; Goddard, 2002).

The Spinal Galant Reflex can be first seen at approximately 20 weeks in utero and typically integrates by the time the infant is nine months old (Berne, 2006). To test this reflex, the infant is placed in the prone position and a finger is used to lightly stimulate the infant's back, along one side of the spine from the shoulder downwards. The reflex is present if the hip on the side of the stimulus upwardly rotates and there is an incurvation of the trunk with concavity towards the side of the stimulus (Zafeiriou, 2004). The Spinal Galant has an active role in the birthing process, as the hip rotation assists the infant move through the birth canal. The Spinal Galant is also important in preparing the child

for achieving developmental mobility milestones, such as crawling and walking (De Jager, 2009).

By the time the infant is 24 months old, the aforementioned primitive reflexes should be integrated. The integration of the reflex motor patterns will promote voluntary movements for the infant in his or her environment. This will promote typical development of the infant in subsequent months (Parham & Mailloux, 2010).

Twelve to twenty-four months typical development. As the infant enters his or her second year of life, precision of the sensory systems continues to enhance. The visual, proprioceptive, and vestibular systems combine to produce postural control and balance, especially noted with dynamic movement patterns. Refinement of the proprioceptive system allows the infant to learn motor patterns through imitation of others. Interplay between proprioception and the vestibular system allows for weight bearing through the stabilizing joints, which is necessary prior to controlled mobility. These sensory systems also prepare the infant for mature and controlled voluntary movement, including weight shifting and weight distribution when learning to walk. Body schemes and motor praxis, or the infant's ability to carry out planned motor actions, continue to develop throughout this stage and contribute to purposeful movement (Parham & Mailloux, 2010).

The infant will also have improved balance with postural reactions within this stage of development. This explains why an infant feels safe walking, resulting in a preference for walking rather than crawling or scooting. Other gross motor skills also significantly improve when an infant is 12 to 24 months old. The infant should be learning to kick a ball, jump with both feet, squat to play, and will begin to explore

playground equipment. However, the child may still experience frequent falls, as the sensory systems have not yet fully developed. Fine motor skills also continue to enhance, including the ability to complete tasks with bilateral hand use, hold a writing utensil with fingertips, and complete a four or five piece puzzle (Case-Smith, 2010).

Twelve to twenty-four months atypical behavior. Researchers have studied the effects of the retention of primitive reflexes with possible atypical development and behaviors. Each primitive reflex seems to have a specific behavioral outcome if it persists longer than it should (Bejerot, 2011; Berne, 2006; Brown et al., 2005; Futagi, Toribe, & Suzuki, 2012; Goddard, 2002; Konicarova & Bob, 2012; Konicarova & Bob, 2013; McPhillips, Hepper, & Mulhem, 2000; Taylor et al., 2004). Examples of atypical behaviors due to primitive reflex retention are discussed below.

A retained Moro Reflex may cause the infant to continually perceive his or her environment as a threat. The Moro Reflex has been compared (or often referred to) as the ‘startle reflex’ (Futagi et al., 2012). Although the relationship between these reflexes is controversial, the Moro Reflex has been considered to be the body’s internal protective system. An infant with a retained Moro Reflex may present with balance and coordination deficits if the infant is continually being startled. A child with a retained Moro Reflex may experience hypersensitivity to light and sound due to dysfunction of the vestibular system (Berne, 2006). Sensory overload may lead to difficulty with emotional regulation, anxiety, and social immaturity (Goddard, 2002). Retention of the Moro Reflex may also disrupt information processing due to poor visual control of eye movements and decreased visual attention (Berne, 2006; Brown et al., 2005). However,

there are controversies regarding a direct connection between these atypical behaviors and the retention of the Moro Reflex.

If the Tonic Labyrinthine Reflex (TLR) is not integrated appropriately, the child may experience difficulties with movement, dependent on if the reflex is retained in flexion or extension. If the reflex is retained in the flexed position, the child may present with hypotonicity, or weak muscle tone. If the TLR is retained in extension, the child may have hypertonicity, or stiff motor patterns caused by increased exertion of extensor muscles. Whether the TLR is retained in flexion or extension, poor posturing may be a result. Vestibular issues may also arise, presented by poor balance and motion sickness (Goddard, 2002). The retention of the TLR may also cause visual perceptual difficulties and poor oculomotor control, which may lead to difficulties processing information (Berne, 2006).

Retention of the Asymmetrical Tonic Neck Reflex (ATNR) can pose several issues in an infant's motor performance. Creeping and crawling may be impeded by retention of the ATNR, which can lead to eye-hand coordination difficulties. An infant may also have difficulty visually crossing midline, impaired balance with head movement side to side, poor visual perceptual skills (specifically with symmetrical shapes), and may present with ipsilateral movements of the extremities rather than normal cross-patterned movements. Ipsilateral movements may create difficulties with other developmental milestones such as walking, due to the need to move same-sided extremities together (Goddard, 2002).

If the Symmetrical Tonic Neck Reflex (STNR) persists into this developmental stage, the infant may experience complications with integration of his or her vestibular system, including difficulty creeping and crawling. This is caused by extension of the upper extremities and flexion of the lower extremities when the infant extends his or her head (Berne, 2006). Retention of this reflex may lead to poor posture, decreased eye-hand coordination, and difficulty focusing (Taylor et al., 2004).

Many issues can arise if the Spinal Galant Reflex is not integrated at an appropriate time. If the reflex is retained on a single side, impairments in posture, gait, and other movements of the trunk may occur. Scoliosis is a severe, long-term condition that can be caused by this reflex retention. Most of the developmental issues from retention of the Spinal Galant Reflex do not present until the child is in later stages of development, as discussed further in subsequent sections (Goddard, 2002).

As discussed above, in the typical development of birth to 24 months, primitive reflexes presented at birth integrate fully by age 12 months in typically developing children. Many of the behaviors identified by Ayers as atypical are present in children who retain primitive reflexes beyond 12 months. In children between 12 and 24 months, retained primitive reflexes are seen to further disrupt the interplay between the sensory systems. The following section will examine typical and atypical development with regard to cognitive, motor and sensory functions.

Preoperational (Toddler) Stage

The next stage of lifespan development is referred to by Jean Piaget as the preoperational stage. This period spans the child's physical age of two to seven years

(Piaget, 1962/2006). Due to the vast amount of physical and cognitive development throughout these years, the authors have chosen to divide this stage into two groups; ages two to five and five to seven years will be examined for typical and atypical development.

Two to five years typical development. Intellectual growth is significant for toddlers in this stage. The toddler is able to recognize symbols, as well as use more abstract memory and imagination skills. Thinking is illogical and irreversible, however, meaning the child believes there is only one solution to a problem (Cole & Tufano, 2008). In the preoperational stage, organization of the sensory systems continues to develop leading to appropriate sensory integration. Proprioceptive feedback from motor patterns adds to the child's ability to understand purposeful actions, thus building a sense of self-concept. This encourages toddlers to begin to challenge the sensory systems by participating in novel activities (Parham & Mailloux, 2010).

The gross motor component of development also makes significant changes in the preoperational stage, which is a result of increased development of the vestibular system. From 24 to 36 months of age, the toddler should be able to jump from a small height, hop on one foot, catch a ball against his or her chest, and ride a tricycle. These skills are refined from ages three to four when the toddler learns to skip and can alternate feet while walking upstairs. Fine motor performance skills also continue to refine during these years of life, which is a result of improved tactile sensations and proprioceptive skills. These enhanced activities may include the ability to color within lines and copy simple shapes while using a tripod grasp (Case-Smith, 2010; Parham & Mailloux, 2010).

Two to five years atypical behavior. Typical development in the preoperational stage may be impeded if the aforementioned primitive reflexes are retained. According to Keen (2008), hypersensitivity caused by the Moro Reflex may cause the child to experience emotional dysregulation, performance anxiety with novel activities, and potentially have social immaturity from distractible or impulsive behaviors. A retained Tonic Labyrinthine Reflex (TLR) may cause the child to continue to present with poor posturing and gait impairments. The child may also experience difficulty reading from left to right and may have poor performance during sporting activities. When the Asymmetrical Tonic Neck Reflex (ATNR) is retained, the child may have difficulty with both gross and fine motor tasks such as handwriting activities (i.e. may have an excessive pencil grip) or catching a ball (Keen, 2008). A child with a retained Symmetrical Tonic Neck Reflex (STNR) will have continued difficulty with eye-hand coordination, poor organizational skills, and may have an abnormal or “ape-like” gait (Keen, 2009). Keen (2008) also reported that Spinal Galant retention may cause the child to be overly clumsy or have difficulties sitting still when seated. Inability for a child to control his or her bladder may also be a presentation of this retained reflex that could be of a greater concern as the child begins formal schooling (Keen, 2008).

Five to seven years typical development. The second half of the preoperational stage of development occurs during the fifth and sixth years of the child’s life. During these years, the child transitions from preschool to elementary school. Parham and Mailloux (2010) explain that improvements within a child’s sensory organization allow him or her to participate in complex behavior sequences with autonomy. Examples of

these behaviors include self-feeding, dressing, completing homework, and performing household chores. Children in this stage of development begin to participate in occupations that challenge their sensorimotor abilities. Participating in sports with peers challenges the child's sensory systems, as peer movements are often spontaneous and the child is required to plan his or her motor movements in relation to the constantly changing environment (Parham & Mailloux, 2010).

A variety of performance skills, including fine motor and manipulation, as well as gross motor and mobility skills, are developed and advanced throughout this stage. The enhanced fine motor and manipulation skills include the ability to copy names and shapes, use both hands in complementary movements, and manipulate small objects. Gross motor and mobility skills include being able to hop long distances, skip with good balance, use two hands to catch a ball, and stand on one foot for eight to ten seconds (Case-Smith, 2010).

Five to seven years atypical behavior. Children in the preoperational stage are transitioning into kindergarten and educational performance will be impacted if the child experiences atypical development. According to Ayres (1979), this time period is critical for sensory integration development. The child's brain is the most receptive and able to organize sensory input. Dysfunction in this process may lead to hyperactivity and distractibility, behavior challenges, speech delays, and/or muscle tone and coordination deficits. These sensory-integrative challenges can directly impact the child's ability to participate in reading, writing, and arithmetic activities at school (Ayres, 1979).

Educational deficits may result if atypical behaviors present through the retention of primitive reflexes. The hypersensitivity experienced by a child with retained Moro Reflex may be especially apparent in classrooms with fluorescent lighting and/or loud noises (Goddard, 2002). Sensory overload may occur if a child is not placed in a quiet learning environment. Children with a retained Tonic Labyrinthine Reflex (TLR) present with a poor sense of time and frequent careless mistakes in the classroom due to poor sequencing and organizational skills (Goddard, 2002; Taylor et al., 2004).

Persistence of the Asymmetrical Tonic Neck Reflex (ATNR) has been shown to lead to poor oculomotor control and disrupt classroom performance in writing and reading (Brown et al., 2005). This is a result of the impaired visual perceptual skills caused from the retained ATNR (Goddard, 2002). Educational activities that are affected by a retained Symmetrical Tonic Neck Reflex (STNR) include difficulty maintaining a seated position in a chair or engaging in activities that require coordinated movements (Taylor et al., 2004).

The continued presentation of the Spinal Galant Reflex may cause a child to continuously move his or her trunk when seated, which may appear like fidgeting or squirming (Berne, 2006). The retained reflex may also lead to poor short term memory, interfere with development of the child's orientation to time and space, as well as interrupt the ability to maintain attention during classroom tasks due to the incessant need to be in constant motion (Berne, 2006; Brown et al., 2005). Academic difficulties that present in this stage may continue to hinder a child's education in subsequent years if the

reflexes continue to be retained (McPhillips et al., 2000; McPhillips & Jordan-Black, 2007).

Attention-deficit hyperactivity disorder (ADHD) is a specific diagnosis linked to academic performance issues, and Mall and Holland (2013a; 2013b) were able to gather interviews with children who are experiencing this dysfunction. One child in particular stated he that “struggled with listening and concentrating in a big school...” (Mall & Holland, 2013b, p. 88). Another experience was described as a “feeling of entrapment...more than anything you know...like you’re... [an] animal in a corner” (Mall & Holland, 2013a, p. 40). The particular educational challenges experienced by school-aged children with ADHD will be described in detail in the following section.

Attention-Deficit Hyperactivity Disorder

ADHD impacts approximately 9.5 percent of Americans under the age of 17. Data was collected through the National Survey for Children’s Health (NSCH) to illustrate a 21.8 percent increase from 2003 to 2007 in parent-reported ADHD diagnosis in children between the ages of four and 17 (CDC, 2010, p.1439). This increase in prevalence has resulted in ADHD receiving a separate and distinct classification of diagnosis in the Diagnostic and Statistical Manual of Mental Disorders (DSM). The DSM-5 lists several definitive features of ADHD which include: a persistent pattern of inattention, hyperactivity, or impulsivity that is more frequent and severe than that of typical development, presentation of symptoms before the age of 12 and in at least two settings, symptoms interfering with social, academic, or occupational functioning, and symptoms that do not only occur during the course of any other mental diagnosis (APA, 2013).

The DSM-5 categorizes the diagnosis into three subtypes, which include ADHD predominantly inattentive type, ADHD predominantly hyperactive-impulsive type, and ADHD combined type. ADHD predominantly inattentive type must include six or more symptoms of inattention for at least six months. However, fewer than six hyperactivity-impulsivity symptoms must be present in order for the ADHD diagnosis to be considered predominantly inattentive type. On the other hand, ADHD predominantly hyperactive-impulsive type is used if six or more symptoms (but less than six of inattention) are presented for six months or more. The ADHD combined type is used for diagnosis if both inattentive and impulsive symptoms (six or more of each) have been present for at least 6 months (APA, 2013).

Inattention, hyperactivity and impulsivity are components of symptomology describing these ADHD subtypes. Examples of inattention have been listed by the DSM-5 and include: failure to give attention to details which causes careless mistakes, difficulty sustaining attention to tasks or play, failure to listen when spoken to directly, failure to follow through on instructions at school or home, difficulty organizing tasks, reluctance to change, and becoming easily distracted by external stimuli (APA, 2013). Hyperactivity can be explained as the individual fidgeting or squirming in seat, climbing or running in situations deemed as inappropriate, exhibiting difficulty with engaging in quiet leisure activities, and often talking excessively. Impulsivity is identified when the individual blurts out answers before a full question is asked, has difficulty waiting his or her turn to speak, and often interrupts and intrudes on others (APA, 2013; Hardy et al., 2004).

The severity of ADHD symptoms, as well as the degree of impact on the child's occupational performance, may vary considerably. The most obvious of these impairments are within the academic and social interaction contexts. "Executive functions," an umbrella term for cognitive processes, are known to be significantly impaired in a child with ADHD. Executive functions can be defined as memory, concentration, attention, problem solving, and multitasking (Lambek et al., 2011). According to Loe and Feldman (2007), executive function impairment can lead to low grades and standardized test scores, detention, grade retention, expulsion, and even low graduation rates. Children with ADHD are four to five times more likely to need special education classes, as well as tutoring and after-school programs (p. 644), which may occur throughout elementary and early adolescent stages.

Atypical behaviors that present in children with ADHD are similar to the atypical behaviors that present in children with retained primitive reflexes. Some of these behaviors include executive functioning disturbances such as decreased attention and difficulty concentrating, poor short-term memory, difficulty multitasking, and impaired academic performance. Other atypical behaviors that may occur with either ADHD or retained primitive reflex symptomology include fidgeting or continuous need for movement, emotional disturbances and hypersensitivity to lights and sounds (APA, 2013; Berne, 2006; Brown et al., 2005; Taylor et al., 2004). Many of these atypical behaviors presented in both ADHD and retained primitive reflex symptomology persist into subsequent lifespan development stages.

Concrete Operational (Elementary and Early Adolescence) Stage

Typical development. The concrete operational stage of development spans the ages seven to 12 years and mainly consists of continued development and refinement of skills from the preoperational stage (Piaget, 1962/2006). According to Williamson and Anzalone (as cited in Yack, Aquilla, & Sutton, 2002), at this point in a child's development, all sensory systems are integrated, allowing the child to respond to sensory input automatically. The child should be able to register sensory input, orient to the information received, interpret the meaning of the sensory information, organize a response, and execute a motor, cognitive, or emotional response effectively.

A child's dexterity, as well as motor planning and precision are refined to allow for better fine motor skills. Gross motor skills improve, including the speed of running, coordination during jumping activities, and ability to throw and catch a ball with increased accuracy. Typically developing children also have improved self-regulation skills during this stage and are typically less impulsive (Case-Smith, 2010).

Atypical behavior. A continuation of the aforementioned atypical behaviors is presented in this stage if the child has retention of a primitive reflex. In a recent study of children with retained Asymmetrical Tonic Neck Reflex (ATNR), McPhillips et al. (2000) found a strong positive correlation between a retained ATNR and low reading scores. With intervention directed toward integrating ATNR, children's scores significantly improved, supporting the researchers' hypothesis that retained reflexes significantly disrupt the development of reading skills. Bejerot (2011) found that interventions addressing motor skills also improved the mathematical abilities in children

with retained reflexes. If interventions are not provided, however, these reflexes are thought to impede academic performance throughout childhood (Goddard, 2002).

As with retention of primitive reflexes, attention-deficit hyperactivity disorder (ADHD) symptoms continue to disrupt academic performance if intervention is not implemented. Significant attention has been paid to classifying themes in the appearance of ADHD in attempt to identify optimal intervention strategies (Hardy et al., 2004). However, a single, universal intervention has not been identified to treat children diagnosed with ADHD. Given the parallel presentation of ADHD and primitive reflexes, recent research has been conducted to determine if there is a correlation between the two (Konicarova & Bob, 2012; Konicarova & Bob, 2013; Taylor et al., 2004).

Many characteristics of retained primitive reflexes and ADHD symptomology are very similar in presentation. Hyperactive behaviors present in children with ADHD include fidgeting and continuous need for movement, which are key symptoms of a retained Symmetrical Tonic Neck Reflex (STNR) or Spinal Galant Reflex (APA, 2013; Berne, 2006; Brown et al., 2005; Taylor et al., 2004). The executive functions impacted by ADHD include memory, concentration, attention, problem solving, and multitasking (Lambek et al., 2011). Children with a retained Spinal Galant Reflex may have poor short term memory and difficulty concentrating (Berne, 2006; Brown et al., 2005). If the STNR is retained, a child may present with difficulty focusing and multitasking, specifically when required to coordinate multiple movements (Taylor et al., 2004). Hypersensitivity and emotional distress are key features of a retained Moro Reflex, which impacts the child's ability to attend to tasks and maintain concentration, both features of ADHD

(Berne, 2006; Brown et al., 2005). Retention of a ATNR may cause difficulties with reading, writing, and telling time (Brown et al., 2005; Taylor et al., 2004). Similarly, these components of academic performance are often impaired in children with an ADHD diagnosis (Loe & Feldman, 2007). Many atypical behaviors of retained primitive reflex and ADHD symptomology have common presentations; however, there is limited research directly connecting the two.

Konicarova and Bob (2012) conducted a study to explore primitive reflexes in relation to ADHD based on prior research conducted connecting primitive reflexes with other neuropsychiatric disorders. The researchers found that children with an ADHD diagnosis had a higher occurrence of retained Moro and Spinal Galant Reflexes. A second study was conducted by Konicarova and Bob (2013) connecting ADHD and ATNR. The ATNR was found to be significantly more prevalent in children with an ADHD diagnosis.

Retention of the Tonic Labyrinthine Reflex (TLR), ATNR, STNR, and Moro Reflex were also explored by Taylor et al. (2004) in relation to the ADHD diagnosis. Children with an ADHD diagnosis were found to have a significantly higher rate of primitive reflex retention in comparison to those without ADHD. However, the researchers did not find a direct correlation between retained Moro Reflex and ADHD symptoms. The effects of the Moro Reflex retention were dependent on the retention of the other reflexes. This supports the argument that the Moro Reflex acts as a gateway to other primitive reflexes (Berne, 2006; Taylor et al., 2004).

Although there have been research studies conducted on a possible correlation between ADHD and the retention of primitive reflexes, there continues to be a limited amount of definitive research. Furthermore, the same two research teams, Konicarova and Bob (2012; 2013) and Taylor et al. (2004), have conducted studies linking retained primitive reflexes and ADHD. The lack of research, as well as the limited number of researchers conducting studies on this subject leads to justification for continued research.

Formal Operational (Adolescence and Adulthood) Stage

Piaget defines the fourth and final developmental stage, formal operational, as an enhancement of logical and abstract thinking (Cole & Tufano, 2008). This developmental stage spans from age 12 through adulthood (Piaget, 1962/2006). The individual should now be able to reason upon hypotheses and generalize operational skills (Piaget, 1964/2003). Atypical behaviors in this stage may be presented through various physical and cognitive conditions and illnesses, such as neuropsychiatric disorders.

Research has been directed towards primitive reflex retention and various neuropsychiatric disorders. Researchers have found a positive correlation among diagnoses such as traumatic brain injury, schizophrenia, bipolar disorder, dementia, Parkinson's disease, and cerebral palsy (Futagi et al., 2012; Links, Merims, Binns, Freedman, & Chow, 2010; Sanders & Gillig, 2011; Walterfang & Velakoulis, 2005; Wortzel, Frey, Anderson, & Arciniegas, 2009; Zafeiriou, 2004). Due to the connection between these diagnoses and primitive reflexes, researchers recommend further attention

be directed toward identifying a more definitive correlation between the topics (Brown et al., 2005).

ADHD is another neuropsychiatric disorder that is associated with impaired functioning in adults (Faraone & Biederman, 2005). Kessler et al. (2006) conducted a study that examined the prevalence and correlations of adult ADHD and found that an estimated 4.4 percent of adults have ADHD. Correlations identified by the researchers included adult ADHD being comorbid with other diagnoses such as mood, anxiety, substance use, and impulse control disorders. The researchers also found that adult ADHD correlated to role impairment in the areas of self-care, mobility, and cognition, as well as dimensions of instrumental functioning (Kessler et al., 2006).

Adults with persisting childhood ADHD symptomology have been found to have decreased quality of life compared to adults without previous ADHD symptoms. The most severe impairments in adult life quality were found to be with life productivity, psychological health, and relationships (Yang, Tai, Yang, & Gau, 2013). The prevalence of ADHD in adulthood and the frequency of comorbidities with ADHD make it necessary for adults to be screened and evaluated for an ADHD diagnosis (Faraone & Biederman, 2005).

Although there is limited research ADHD in adulthood, there is even less research on the primitive reflexes that have been retained into this stage. Due to the research connecting these neuropsychiatric disorders to primitive reflexes, it may be possible that there is also a connection between ADHD and the retention of primitive reflexes (Konicarova & Bob, 2012; Konicarova & Bob, 2013; Taylor et al., 2004).

Chapter III Methodology

The authors were first introduced to primitive reflexes, attention-deficit hyperactivity disorder (ADHD), and sensory integration in an introductory pediatric course through the University of North Dakota Master's of Occupational Therapy Program. Additionally, education via fieldwork experiences inspired the authors to further explore these topics. A fieldwork educator acknowledged a possible correlation between the retention of primitive reflexes and ADHD symptoms. The authors then began collaborating with University of North Dakota faculty to initiate the process of completing a scholarly project focused on a correlation between the two topics. This scholarly project could be used to provide more effective interventions for children with retained primitive reflexes and an ADHD diagnosis.

The authors conducted a literature review on the presence of primitive reflexes in children with ADHD and the role retained primitive reflexes have on children's educational performance. It was anticipated that the information gathered would be used to guide the development of a classroom personnel handbook to be utilized in schools for implementation of an all-inclusive classroom. The handbook was designed to be a resource to assist classroom personnel in the identification of retained primitive reflexes in a child, how to refer the child to therapy services, and how to collaborate with

occupational therapists to modify classrooms in order to promote a more conducive learning environment.

The extensive literature review was completed by the authors using a variety of databases, such as Cinahl, ERIC, PubMed, and PsychINFO. The *American Journal of Occupational Therapy* (AJOT) was used as a resource in conjunction with the databases. Upon completion of reviewing the existing literature, the authors acknowledged a lack of comprehensive research evidence on the correlation between ADHD and retention of primitive reflexes, especially in relation to how the correlation impacts academic performance. The authors determined that an alternate direction for the scholarly project was needed.

The gap in research regarding a correlation between retained primitive reflexes and ADHD provided the authors with the justification to refocus and redesign the scholarly project. When the authors examined the possible correlation between retained primitive reflexes and ADHD, the conclusion of the analyzed research was that there is limited research approving or disproving the correlation between retained primitive reflexes and ADHD. The majority of articles published on the topic were written by two authors (Konicarova & Bob, 2012; Konicarova & Bob, 2013). These findings provided the authors with justification to produce a scholarly project researching a possible correlation and advocating the need for additional research to be conducted on this topic.

The authors reviewed additional literature regarding typical and atypical development throughout the lifespan. Aspects of development that were explored include motor skills, sensory integration, behaviors (both typical and atypical), as well as the role

of primitive reflexes in the developmental process. The authors chose to structure the literature review according to the theories that were used as a foundation for the scholarly project: Jean Piaget's theory of development and Dr. Jean Ayres' Sensory Integration Theory. The two theorists were used to illustrate the parallels between typical and atypical development throughout the lifespan. The focus of atypical development was on the sensory-integrative behaviors associated with the retention of primitive reflexes and ADHD symptomology was researched in order to examine a possible correlation.

The authors utilized the information provided through the literature review to develop a scholarly article outlining current research, and advocating the need for further research on the topic. It is anticipated that the article will be submitted for publication in *OT Practice*. The article may be placed for publication in other journals and magazines if it is not accepted for publication in *OT Practice*. The article will be modified in length and content depending on placement of submission for publication, and may be revised prior to publication.

Chapter IV Product

The product developed for this project is a scholarly article written to explore a possible correlation of retained primitive reflexes and sensory integrative behaviors in school-aged children diagnosed with attention-deficit hyperactivity disorder (ADHD). Included in the article is a background of the existing literature on the overlapping behaviors between the selected retained primitive reflexes and ADHD. This scholarly article will be used to demonstrate the need for further research on the retention of primitive reflexes and the symptomology of ADHD, as well as the possible correlation between the two topics. The scholarly article in its entirety can be found in the Appendix.

Jean Piaget's theory of development and Dr. Jean Ayres' Sensory Integration Theory guided the content of the article. Piaget's theory of development was chosen based on the hypothesis that schemes organize human behavior, including childhood development (Cole & Tufano, 2008). Although Piaget's theory is often referred to as a cognitive theory, this theory encompasses core aspects of the lifespan stages related to typical development of sensory and motor systems. The stages outlined within this theory are in alignment with this scholarly project, as the project has identified typical and atypical sensory and motor development throughout the stages outlined by Piaget (APA, 2013; Cole & Tufano, 2008). Piaget's development theory stages include sensorimotor (infancy), preoperational (toddler), concrete operational (early adolescence), and formal

operational (adolescence and adulthood). To better align typical development with these stages, the sensorimotor stage was modified into two substages: zero to 12 months and 12 to 24 months. The preoperational stage was also modified into two substages: two to five years and five to seven years (Cole & Tufano, 2008; Piaget, 2003; Piaget, 2006). The concrete operational and formal operational stages were not modified in this scholarly project.

The focus of Ayres' Sensory Integration Theory can be used to explain the symptomology typically presented in school-aged children diagnosed with ADHD. The Sensory Integration Theory was chosen for this project based on the premise that the sensory systems have a typical pattern of development; disruptions in this pattern may therefore occur, resulting in atypical behaviors. Ayres' theory also emphasizes the importance of the role of primitive reflexes in the typical development of sensory systems. Sensory systems that may be specifically impacted by the primitive reflexes include the vestibular, proprioceptive, tactile, and visual systems (Parham & Mailloux, 2010). This theory also describes development in a chronological order with an emphasis on development that occurs from birth to 12 years.

Connections can be made between Piaget's theory of development and Ayres' Sensory Integration Theory that further justify the inclusion of these theories in this scholarly project. A primary connection between the two theories is the use of chronological sequence to describe typical and atypical development. Pediatric and adolescent development are also emphasized through both theories, which is pertinent to the school-aged population that serves as the focus for this project. The Sensory

Integration Theory and Piaget's theory of development include the repercussions that occur throughout the lifespan if typical development is impeded. Retained primitive reflexes and ADHD are two factors that impede typical development; therefore, these theories can be directly applied to these populations.

Chapter V Summary

The purpose of this scholarly project was to research existing literature on a possible correlation between retained primitive reflexes and sensory-integrative behaviors in school-aged children diagnosed with attention-deficit hyperactivity disorder (ADHD). From the information gathered through the literature review, the authors developed a scholarly article presenting the research regarding these topics and the possibility of a correlation between the two. It is anticipated that the authors will submit the article and gain approval for publishing into *OT Practice* magazine. Piaget's developmental theory and Ayres' Sensory Integration Theory guided the development of the literature review and article. The authors hypothesize that this product will be used to support evidenced-based practice in occupational therapy.

Limitations

There is a lack of concrete research regarding the existence of a possible correlation existing between the retention of primitive reflexes and school-aged children diagnosed with ADHD. Research refuting a correlation between the topics is also very limited. The majority of the research that has been conducted on the correlation between retained primitive reflexes and ADHD was completed by two authors (Konicarova & Bob, 2012; Konicarova & Bob, 2013). This lack of research creates a continued gap between ADHD and other behavioral symptomology that may be connected.

Another limitation of this study is that the authors hand-selected five primitive reflexes to research. Due to the lack of research on this topic, it is possible that these five primitive reflexes do not correlate with ADHD. On the other hand, there may be a correlation between ADHD and primitive reflexes that were not examined in this scholarly project. It may also be difficult to directly apply this scholarly project in practice settings. This is due to the need for further research to be conducted prior to direct clinical application. The audience of this article may not be interested in further investigation of this topic, nor have the means available for investigation, making the article less useful.

Implementation

This article can be implemented simply by being accessible in an American Occupational Therapy Association (AOTA) publication for occupational therapy professionals and/or other disciplines to read. Upon reading the article, these professionals will be able to critically evaluate the literature and determine the possibility of a correlation between retained primitive reflexes and ADHD. The article may also increase collaboration between occupational therapists, educational personnel, and other healthcare professionals when critically evaluating interventions/treatments for individuals within this population.

Conclusions

The developed article can provide useful research and information for occupational therapists and other health and education professionals. As there is not a single optimal approach for treatment with school-aged children diagnosed with ADHD,

the article can lead professionals to explore possible unconventional intervention strategies. Implementation of these interventions can lead to better occupational performance in meaningful childhood occupations, including education, leisure, play, and social participation. Increased collaboration between occupational therapists, educational personnel, and other health professionals may become more effective if intervention strategies are better defined with this population. This includes the implementation of an increased number of direct, physical interventions for individuals with retained primitive reflexes and/or an ADHD diagnosis. However, a significant amount of research needs to be conducted to confirm or disprove a correlation between retained primitive reflexes and ADHD in order to implement appropriate intervention strategies with this population.

Recommendations

There are many ways that this research can be further integrated into the occupational therapy profession, as well as other health and education professions. Further research needs to be conducted to determine if there is a possible correlation between retained primitive reflexes and ADHD, including how this correlation influences occupational therapy interventions with school-aged children. Once interventions have been identified, research needs to be conducted on the efficacy of these interventions in promoting increased occupational performance.

Research also needs to be conducted in a variety of age groups to further explore the retention of primitive reflexes and ADHD behaviors throughout the lifespan. This research can include possible correlations between the retention of primitive reflexes and a variety of other diagnoses. Other explanations for the behavioral symptomology of

ADHD should continue to be researched as well. In addition, it is recommended that further research be conducted on which specific reflexes are possibly correlated to an ADHD diagnosis. Further research conducted would increase the evidence-base regarding retention of primitive reflexes, sensory-integration behaviors, and any possible correlation between the two.

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Appendix

Retained Primitive Reflexes and ADHD?

Examining Atypical Symptomology in the School-Aged Population

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Recent research has been dedicated to identification of a positive correlation between the behaviors presented with ADHD and retained primitive reflexes. Konicarova and Bob (2012) conducted a study to explore primitive reflexes in relation to ADHD based on prior research connecting primitive reflexes with other neuropsychiatric disorders. The researchers found that children with an ADHD diagnosis had a higher occurrence of retained Moro and Spinal Galant Reflexes. A second study was conducted by Konicarova and Bob (2013) connecting ADHD and ATNR. The ATNR was found to be significantly more prevalent in children with an ADHD diagnosis.

Retention of the TLR, ATNR, STNR, and Moro Reflex were also explored by Taylor et al. (2004) in relation to the ADHD diagnosis. Children with an ADHD diagnosis were found to have a significantly higher rate of primitive reflex retention in comparison to those without ADHD. However, the researchers did not find a direct correlation between retained Moro Reflex and ADHD symptoms. The effects of the Moro Reflex retention were dependent on the retention of the other reflexes. This supports the argument that the Moro Reflex acts as a gateway to the other primitive reflexes (Berne, 2006; Taylor et al., 2004).

Through an extensive review of literature, the authors identified additional similarities between the atypical behaviors of school-aged children diagnosed with ADHD and those presented in retained primitive reflexes. A child with a retained Moro Reflex presents with hypersensitivity to light and sound (Berne, 2006). The overstimulation of the sensory systems may result in emotional distress, anxiety, and social immaturity, which may affect the child's ability to attend to tasks and maintain

concentration. Retention of the Moro Reflex may also impair the ability to process information due to poor visual control of eye movements and decreased visual attention (Berne, 2006; Brown et al., 2005; Goddard, 2002). These atypical behaviors that accompany a retained Moro Reflex are also commonly presented in school-aged children diagnosed with ADHD (APA, 2013).

A child that experiences retention of the TLR may also present with atypical behaviors that are similar to those presented with an ADHD diagnosis. The child may have difficulties processing information due to visual perceptual deficits and poor oculomotor control (Berne, 2006). Poor sequencing and organizational skills may cause the child to be unable to orient to time and make frequent careless mistakes in the classroom (Goddard, 2002; Taylor et al., 2004). Many of these atypical behaviors are also common in school-aged children who are diagnosed with ADHD (APA, 2013).

School-aged children that present with a retained ATNR often times have difficulty writing and reading, which impacts occupational performance in the classroom context. A child with this retained reflex may also experience impaired visual perceptual skills and poor ocular movement (Brown et al., 2005; Goddard, 2002). Eye-hand coordination skills may also be impaired due to the ipsilateral movement patterns that a retained ATNR presents (Goddard, 2002). These atypical behaviors are oftentimes also seen in school-aged children diagnosed with ADHD.

Atypical behaviors that may present in a child with a retained STNR are also common features in school-aged children diagnosed with ADHD. Difficulty focusing and sitting still in a chair, as well as difficulty engaging in activities that require coordinated

movements are all atypical behaviors that a child with a retained STNR may experience. A child may also have decreased eye-hand coordination, which can affect participation in educational activities (Taylor et al., 2004). These behaviors, especially difficulty focusing and sitting still, are common features that present in school-aged children diagnosed with ADHD (APA, 2013).

The retention of the Spinal Galant Reflex may also cause a child to have difficulties sitting still. He or she may continuously move the trunk when seated, which could appear like fidgeting or squirming (Berne, 2006). The retained reflex may also lead to poor short-term memory, interfere with development of the child's orientation to time and space, as well as interrupt the ability to maintain attention during classroom tasks due to the incessant need to be in constant motion (Brown et al., 2005; Berne, 2006). Again, these atypical behaviors are very similar in presentation to those experienced by a child diagnosed with ADHD (APA, 2013).

There are many ways that this research can be further integrated into the occupational therapy profession, as well as other health and education professions. Further research needs to be conducted to determine if there is a possible correlation between retained primitive reflexes and ADHD, including how this influences occupational therapy interventions with school-aged children. Once interventions have been identified, research needs to be conducted on the efficacy of these interventions in promoting increased occupational performance.

Research also needs to be conducted in a variety of age groups to further explore the retention of primitive reflexes, as well as ADHD behaviors throughout the lifespan.

This research can include possible correlations between the retention of primitive reflexes and a variety of other diagnoses. Other explanations for the behavioral symptomology of ADHD should continue to be researched as well. It is recommended that further research be conducted on which specific reflexes are possibly correlated to an ADHD diagnosis. Further research would strengthen the evidence-base regarding primitive reflexes, sensory-integrative processes, as well as a possible correlation between the two.

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