Fall 12-2021

Addressing Ocular Motor Dysfunction in Children with Autism within Occupational Therapy Practice

Emily Kingrey Francisco, MOT, OTR/L
Shawnee State University, ekingrey16@gmail.com

Addressing Ocular Motor Dysfunction in Children with Autism within Occupational Therapy Practice

Emily Kingrey Francisco, MOT, OTR/L

Department of Occupational Therapy, Shawnee State University

Author Note

Emily Kingrey Francisco, Shawnee State University, contact information: ekingrey16@gmail.com

Abstract

Autism affects 1 in every 54 children and has been present in all racial, ethnic, and socioeconomic groups (Center for Disease Control and Prevention [CDC], 2020b). Every individual diagnosed with autism can have varying skills and abilities, when dysfunction occurs impacting engagement in everyday occupation, occupational therapy services may be recommended. One important area to consider during occupational therapy evaluation, in order to explain dysfunction, is the visual system (Zoltan, 2007). Efficiently comprehending information retrieved through the visual system is crucial for successful engagement in daily occupations. Ocular motor function is a fundamental skill as explained in Warren's hierarchy of visual development and is required for developing comprehensive visual adaptation. Throughout the literature is has been made clear that there is a high prevalence of visual dysfunction among those with autism (Bakroon & Lakshminarayanan, 2016; Davis et al., 2006; Schmitt et al., 2014). Results from the conducted needs assessment indicate that occupational therapists have a general knowledge of ocular motor function, but do not feel equipped to address it in everyday practice. There is a great need for expanded knowledge and resources in occupational therapy practice in order to address ocular motor skill. To address the discovered area of limitation, ocular motor dysfunction in children with autism, a three-module education course was created for occupational therapy professionals. The education course developed meets a great need within the professional occupational therapy community and will serve as a resource for many therapists.

Keywords: oculomotor dysfunction, vision occupational engagement, visual dysfunction, visual education course, oculomotor treatment

Table of Contents

Introduction

Autism affects 1 in every 54 children and has been present in all racial, ethnic, and socioeconomic groups (Center for Disease Control and Prevention [CDC], 2020b). The prevalence of autism has greatly increased since 2000 and is more commonly noted in males than females (CDC, 2020a). Every individual diagnosed with autism can have varying skills and abilities, when dysfunction occurs impacting engagement in everyday occupation, occupational therapy services may be recommended. Occupational therapists evaluate, intervention plan, and achieve desired outcomes through client input and synthesis of dysfunction impacting occupational engagement and independence (American Occupational Therapy Association [AOTA], 2020). One important area to consider during evaluation in order to explain dysfunction is the visual system (Zoltan, 2007). Vision is the primary source sending information to the brain, and efficiently comprehending visual information is an important factor for successful engagement in daily occupations (Coetzee & Pienaar, 2011; Warren, 2013).

Problem Statement

Children with autism are more likely to demonstrate visual dysfunction versus typical developing children (Davis et al., 2006). Ocular motor skills are a fundamental skill of greater visual perceptual development, and occupational therapists have a responsibility to evaluate the visual system to fully understand limitations in occupational engagement (Zoltan, 2007). Due to the challenge of screening and treating ocular motor skills in children with autism it is frequently overlooked by practitioners. There are limited resources for occupational therapists to successfully and confidently screen, evaluate, and treat ocular motor dysfunction in children with autism.

Purpose Statement

Due to limited resources in occupational therapy literature, the purpose of this capstone project was to create an education course to provide fundamental knowledge, screening, and

treatment strategies on ocular motor skills to occupational therapy practitioners and emphasize the importance of addressing these skills as it relates to occupational engagement. After completion of the modules, an occupational therapist should feel more confident on the basics of ocular motor skills, be able to identify the impact ocular motor dysfunction has on occupational engagement, select and carryout screening techniques or assessments, fully understand occupational therapy's scope of practice in addressing ocular motor skills, and implement treatment strategies with various clients of different skill levels.

Theory and Framework

Universal Design Learning (UDL) provides a framework for developing educational content (Cast, 2018). The UDL guidelines suggest that learning content should have various means of engagement; this is ideal because all individuals are motivated to engage in learning through different means. The second guideline in the UDL is provide multiple means of representation.

Every individual comprehends and processes information differently and providing multiple avenues of content representation is ideal to assist more learners. The last UDL guideline is to provide multiple means of action and expression. Providing opportunities to express comprehension and learning through various avenues, such as verbal explanation or written expression provides greater learning. The three-module education course follows the UDL framework for optimal learning and access to content for all different learning styles. Various forms of content delivery were utilized through visuals, demonstrations, and auditory engagement. The content also engaged the learner to think through various scenarios and

challenges that may be experienced in practice, but also provided worksheets as a different mode for content comprehension. Finally, therapists are provided with a call to action to utilize content learned within everyday practice, assisting in motivating for continued engagement in content.

The Adult Learning Theory was also considered during module development. Adult learning can be unique and multidimensional requiring careful consideration (Merriam, 2008). Adult learning is not only a cognitive process but a multi-sensory process tying in body, emotions, the spirit, and mind. When learning occurs through this multidimensional method, memory can be reconstructed. The modules created considered a multidimensional approach and provide multiple sensory experiences through visuals, auditory content, and written text. Content aims to connect real life practice experience for greater motivation and recall.

Significance

It is important that practicing occupational therapists are aware that children with autism are more likely to experience visual dysfunction (Davis et al., 2006) and understand the process of visual perceptual development. This is a significant area to address within occupational therapy practice because visual dysfunction can impact skill development and engagement in daily occupations.

Literature Review

Warren's hierarchy of visual perceptual development explained that the fundamental base for achieving higher visual perception first relies on the development of strong ocular motor skills, acuity, and ability to see in all visual fields (Zoltan, 2007). Warren has explained that visual development occurs in stages and each stage is dependent upon the previous stage. Impairment in one stage greatly impacts remaining development. The base tier in Warren's hierarchy of visual

development, as mentioned, is ocular motor function, visual fields, and acuity. Following those baseline skills is the second tier including attention, third is scanning, fourth includes pattern recognition, fifth is visual memory, sixth includes visuocognition, and finally the last stage is adaptation through vision (Warren, 1992). Warren's model of visual development should be considered during evaluation and intervention planning within occupational therapy practice in order to achieve optimal success with a client's occupational independence.

Ocular motor function is a fundamental skill as seen in Warren's hierarchy of visual perceptual development and is required for developing comprehensive visual adaptation. Ocular motor skills include saccades, smooth pursuits, optokinetic movement, vestibulo-oculomotor, and vergence skill (Zoltan, 2007). Without these basic eye movement skills, achieving visual perception can be challenging. Occupational therapists should be aware of visual development due to the impact visual dysfunction has on everyday occupational engagement. Occupational therapy's scope of practice, as described in *Occupational therapy practice framework: Domain and process fourth edition* (OTPF-4) (AOTA, 2020), discussed the responsibility of therapists to remediate and accommodate through intervention. Visual dysfunction can greatly impact a client's independence and can require remediation or accommodation to achieve greater client independence (Berger et al., 2016). Occupational therapists should evaluate visual dysfunction to explain occupation limitation (Zoltan, 2007). This is highly important in the pediatric population because without early detection/intervention, visual impairment can greatly and negatively impact development and quality of life (Chadha & Subramanian, 2011).

Ocular Motor Skills in Autism

Throughout the literature it is clear that there is a high prevalence of visual dysfunction among those with autism (Bakroon & Lakshminarayanan, 2016; Davis et al., 2006; Schmitt et al., 2014). Davis and colleagues (2006) discovered that in comparison to typically developing children, those diagnosed with autism have increased difficulty with overall visual perceptual skills. As explained in Warren's model of visual perceptual development, overall visual perception begins with basic eye movement and function. Children with autism tend to have difficulty with these basic skills and have shown to demonstrate dysfunction with smooth pursuits (Bakroon & Lakshminarayanan, 2016), visual attention, saccades, central vision, motion discrimination (Davis et al., 2006), poor pattern detection, visual discrimination, poor pupil response (DiCriscio et al., 2019) and poor tracking skill (Johnson et al., 2016). Difficulties with underlying eye function make visual perception hard to achieve. Decreased eye movement control is proven to be present in those with autism which is thought to originate from abnormalities in the neural system (Johnson et al., 2012; Minshew et al., 1999; Schimitt et al., 2014; Shirama et al., 2016; Takarae et al., 2004; Takarae et al., 2007). There is thought that visual dysfunction in children with autism originates from the dorsal and ventral visual stream (Hay et al., 2019). Disruption in the ventral pathway impacts visual perception and disruption in the dorsal pathway impacts motor coordination (Hebart & Hesselmann, 2012). Overall, there may be a neurological base to increased prevalence of visual dysfunction in children with autism.

The visual system is one of the primary sources sending information to the brain to be perceived; when dysfunction occurs in this communication, execution in motor skills are negatively affected (Coetzee & Pienaar, 2011). Ocular motor skills are closely tied to the

development of skills like balance, spatial awareness, body awareness, coordination, reading, and writing. Poor ocular motor skills are also linked to concentration. Every individual with autism is different, however, common challenges among those with autism include poor attention (Anderson et al., 2017), poor motor coordination (Fournier et al., 2010), and difficulty with spatial relations (Cardillo et al., 2020). There is also a strong connection between eye movement difficulties and delay in fine motor skills (Hay et al., 2019). Motor coordination challenges, poor attention, and poor fine motor skills may all tie back to dysfunction in the visual system (Cotezee & Pienaar, 2011). There is also a strong correlation between poor visual perceptual skills and difficulty with self-care tasks in young children with autism (Chi & Lin, 2021). With the connection of those with autism demonstrating many motor challenges, and visual dysfunction being more prevalent in those with autism, occupational therapists have an important role to screen, evaluate, and treat ocular motor skills as they impact occupational engagement.

Vision Evaluation and Treatment

Although it has been made clear, visual dysfunction is common among those with autism, evaluation and treatment can be challenging. There is a lack of screening tools, assessments, and intervention strategies to remediate ocular motor skills or accommodate for visual dysfunction among those with autism who may demonstrate difficulty with direction following/comprehension, attention, reading, or are non-verbal. Assessments testing ocular motor skills include the King Devick Test and the Developmental Eye Movement test (Heick et al., 2018). Both assessments rely on the ability for clients to maintain attention, the ability to read, follow multi-step directions, and verbally communicate. Another ocular motor assessment includes the Groffman Visual Tracing Test. This assessment has no language requirement and can be utilized

for children starting in kindergarten through adulthood (Facchin et al., 2020). There are no reported psychometric properties on the Groffman Visual Tracing Test and it has shown to be challenging for children to complete. Other visual perceptual assessments include Beery Visual Motor Integration (VMI), Developmental Test of Visual Perception (DTVP), and the Motor Free Visual Perceptual test (MVPT), these assessments test visual perceptual skill; however, are not a measure of fundamental ocular motor skill. Lack of visual function research among those with lower functioning autism roots back to the difficulty in testing those with mild to severe intellectual disability, which is the leading cause to visual dysfunction going underestimated (Chokron et al., 2020).

Intervention that is shown to improve ocular motor components such as tracking and saccades, include scanning exercises (Berger et al., 2016). Optometrists or ophthalmologists can also prescribe prisms which may be required for some visual dysfunction. Color overlays also benefit visual function and may be a beneficial intervention to trial with those who have lower functioning autism (Guimarães et. al., 2020). Other interventions discussed in literature include computer based visual intervention (Atasavun & Duger, 2012). Few studies identified intervention for ocular motor remediation or protocols specifically for those with lower functioning autism.

Summary

Ocular motor skill is inseparable from visual perception but overlooked in practice as well as research. Vision is the dominant sensory system and individuals rely heavily on it for its efficient accuracy to update mental and physical responses to the surrounding environment

(Coetzee & Pienaar, 2011). Further research is required on assessment tools and functional intervention to improve ocular motor skills in those with more severe autism (Johnson et al., 2016). There has been an increased interest regarding visual disturbances in those with autism, however, individuals on the lower end of the spectrum continue to be underrepresented in research (Chokron et al., 2020). Occupational therapy can play a large role in early detection of visual dysfunction and should greatly consider the visual system when evaluating a client's limitations. Overall, those with autism are more likely to demonstrate dysfunction with ocular motor skill, and there are limited assessments, and intervention strategies to remediate these skills in children with more severe autism. Further exploration of how to evaluate and remediate ocular motor skills in children with more severe autism is needed.

Needs Assessment

The three-module education course was developed after completion of an informal needs assessment. The conducted needs assessment gained professional opinions from colleagues regarding the subject area of addressing ocular motor skills in practice. Informal interviews were conducted through a virtual platform as well as an email exchange with fellow occupational therapists. The objective of the informal needs assessment was to identify if ocular motor skills are being addressed by occupational therapists and to identify if there was a gap in service delivery regarding visual dysfunction in those with more severe autism.

A problem area was identified through clinical observation and review of literature. The problem area identified was ocular motor dysfunction is present amongst children with autism, but screening, evaluation, and treatment was rarely occurring. The needs assessment was created to learn more regarding the identified problem. Multiple questions, a brief purpose

statement, and a definition of ocular motor skills were sent to fellow occupational therapists that work with children who have autism. There was a total of six questions sent asking if colleagues feel equipped to treat ocular motor skills, have ever addressed ocular motor skills in practice, and have access to assessments. The questions were sent to 11 occupational therapists and one occupational therapy assistant. Information was received back from four occupational therapists. Additional information was gathered for the needs assessment through virtual interview. One occupational therapist working in a school setting for children with autism was interviewed, and one occupational therapist with a vision rehabilitation certificate was interviewed.

Results from the findings indicate that occupational therapists have a general knowledge of ocular motor function, but do not feel equipped to address it in everyday practice. Many therapists discussed addressing visual perceptual skills and providing intervention in this area but were unable to identify that ocular motor skills are a key component in order to achieve the more advanced skill of visual perception. Workplaces either did not have specific ocular motor screenings/assessments or therapists were not aware of these assessments. Lack of knowledge on different intervention strategies to treat ocular motor dysfunction was also noted. Through the virtual interviews conducted it was discussed how challenging it may be to evaluate and treat ocular motor dysfunction in children with more severe autism. There is a general agreeance that children with autism probably have greater difficulty than people realize with ocular motor skills. This could be a key factor into limited development of many skills including physical coordination, fine motor skill, sensory processing, and participation in academics including reading and writing. These professionals identified that greater resources for addressing these skills in children who

have more severe autism is needed. Overall, results identify not enough knowledge, confidence, and resources for occupational therapists to address ocular motor function in clients.

Need Assessment Discussion

There is a great need for expanded knowledge and resources in occupational therapy practice in order to address ocular motor skills. Ocular motor dysfunction can greatly impact occupational engagement as every task throughout the day requires eye movements such as saccades, tracking, vergence and visual fixation. Without this fundamental eye movement skill, visual perception would be hard to achieve. Many occupational therapists appear to address visual perceptual skills such as figure ground, form constancy, and visual discrimination, however, have never looked at ocular motor performance. Goals for handwriting, spatial awareness, navigating environments safely, attention, bilateral coordination, motor coordination, letter identification, and so many more are being written without even a thought that difficulty with these skills may root in the inability of a client to efficiently move the eyes. These client goals are being addressed for years at times, with little progress, and this may be due to the fact that fundamental eye movement skills to succeed in these tasks are not being addressed. What has been discovered through this needs assessment, is that there are limited interventions, protocols, and assessments to evaluate and treat ocular motor dysfunction and utilize with children who have more severe autism. Ocular motor skills can be challenging to assess and treat in clients who cannot follow one or two step directions, may be non-verbal, and may have difficulty comprehending what is being asked. Poor ocular motor skills can impact many aspects of occupational engagement, for example, writing in school, safety when walking through a parking lot for grocery shopping, catching a ball when playing with a friend, finding a needed ingredient in

the fridge when cooking, and balancing on one foot to put pants on in the morning. Greater educational resources are needed for occupational therapists in order to establish confidence and knowledge in screening and treating ocular motor eye function.

Knowledge on the development of the visual system, such as ocular motor skills, is needed so the just right challenge can be applied for greater client success. Without these fundamental skills, higher level visual perception cannot be mastered. These are challenging performance skills to address with those who have more severe autism; however, occupational therapists have a role in identifying ocular motor dysfunction and how it may be impacting occupational engagement. Without assessing this area of need, a skill that impacts many body functions could go unaddressed, greatly impacting a client's ability to achieve goals.

To address the discovered area of limitation, ocular motor dysfunction in children with autism, a three-module education course was created for occupational therapy professionals. This resource will cover the gaps found in the needs assessment providing education on ocular motor skills, as well as provide tools to treat this area of need specifically for the population of those with autism that may not be able to complete standard eye exercises. The courses created will open doors for occupational therapists to feel confident addressing ocular motor skills with clients.

Overview of Ocular Motor Education Modules

Introduction

Based on the conducted literature review and needs assessment, a three-module education course was created for occupational therapy professionals. It has been made clear that occupational therapists do not feel equipped to address ocular motor skills within practice and

are unaware these skills are needed to achieve visual perception. The courses developed educate occupational therapy practitioners on the basics of ocular motor skills and how to address them in practice. Another discovered challenge is specifically addressing ocular motor dysfunction among those with autism who are non-verbal, have difficulty with multi-step directions, and are unable to read. As stated by Chokron and colleagues (2020), there is high interest in visual disturbance among those with autism, but those with autism on the lower end of the spectrum are not represented in research. The modules provided strategies to screen and treat ocular motor dysfunction even for children who are unable to complete traditional assessments or interventions. The three modules are each approximately 45-80 minutes long with content delivered through visuals, text, and auditory presentation. Courses were developed using the Canva platform and can be accessed through embedded links within a Google sites page, which contains all required resources for module completion. As indicated in the literature review, those with autism have a higher prevalence of ocular motor dysfunction (Bakroon & Lakshminarayanan, 2016; Davis et al., 2006; Schmitt et al., 2014). Difficulty with these skills impacts everyday occupational engagement (Petrosyan, 2021) and it is important for occupational therapy practitioners to screen these skills as a means to explain dysfunction (Zoltan, 2007). After each module a survey will be provided to learners giving an opportunity to express feedback, questions, or concerns, as well as a content quiz to assess learning.

Module 1: Occupational Therapy Addressing Ocular Motor Dysfunction in Children with Autism

Objective 1. The practitioner will be able to identify what ocular motor dysfunction is and three primary eye movements.

Objective 2. The practitioner will identify the impact ocular motor skills may have on occupational engagement.

Module one provided a visual presentation paired with auditory teaching following the above objectives. The presentation provided information from the conducted needs assessment, review of literature, anatomy of the eye, as well as reviewed the different ocular motor skills. Module one also identified the impact visual dysfunction has on occupational engagement. Throughout the presentation, learners are challenged to review the material, test content recall, and apply it to practice. A preview of module two was also provided so learners are aware of what is to come. Module one content quiz was created to evaluate learning.

Module Two: Ocular Motor Screening and Evaluation for Children with Autism in Occupational Therapy Practice

Objective 1. Select appropriate screening methods and assessment tools when evaluating a client's ocular motor skills.

Objective 2. Understand occupational therapy's scope in addressing ocular motor skills.

Module two provided a visual presentation paired with auditory teaching following the above objectives. The presentation provided a review from module one, the scope of occupational therapy addressing ocular motor skills, screening/evaluation techniques and assessments, as well as when to refer to an optometrist. Throughout the presentation, learners are challenged to review the material, test content recall, and apply it to practice. A preview of module three was provided at the end of educational presentation. Module two content quiz was created to evaluate learning.

Module Three: Treatment Strategies for Ocular Motor Dysfunction among those with Autism in Occupational Therapy Practice

Objective 1. Select appropriate intervention for strengthening of ocular motor skills.

Objective 2. Grade activities appropriately for the just right challenge for each client.

Module three provided a visual presentation paired with auditory teaching following the above objectives. The presentation provided a review of the two previous modules, the importance of addressing ocular motor skills in practice, treatment strategies, and how to grade interventions to address eye function. Learners are provided opportunities to engage with content, test learning, and apply personal experiences to learned material. Module three content quiz was created to evaluate learning.

Discussion

Overall, the literature review and needs assessment indicated the need for greater resources addressing ocular motor skills among those with autism in occupational therapy practice. Based on the findings, the three-module education course was developed. The content delivered throughout the educational modules addressed the gap in occupational therapy practice. The modules directly educated on what, how, and why ocular motor skills are important to address in occupational therapy. These findings and developed programming benefit the field of occupational therapy and will aid therapists in feeling greater confidence when addressing ocular motor skills.

Strengths

The strengths within the three-module education course include the accessibility for therapists living in all different states. Through the created webpage the courses will be

embedded, and learners are able to stream the recorded modules. This allows the content to be shared widely and reach more practicing therapists. Another strength includes the three-module format, each module is approximately 45-80 minutes; however, a therapist does not have to watch all three modules if already confident in one area verses another. The modules are self-paced and can be paused, watched again, and resumed when convenient for each therapist.

Finally, the created content is filling an area of need within occupational therapy practice and is addressing a gap in literature in order to better serve clients where they are and helping them achieve goals.

Limitations

There is limited research addressing ocular motor dysfunction in populations with more severe autism (Chokron et al., 2020). Limited research negatively impacts the strength of the content delivered and continued research is needed for this niche within occupational therapy. Another limitation was that content within the modules is focused on children with autism, specifically those with more severe autism. The literature reviewed and content delivered is geared toward this population and may not apply to all therapists cliental. Finally, another limitation included the length of the subject matter. Although it can be divided and not all modules have to be watched, three hours of content is not always feasible for working therapists.

Implications for practice

The provided content was created to prepare occupational therapists to feel confident addressing and screening ocular motor skills with clients. Reaching more therapists about how visual perception is developed and how to address fundamental skills, such as ocular motor skills, prior to more challenging performance skills, will benefit clients in goal progression. With this

knowledge therapists can be more aware of what may be causing dysfunction and it could be the key element to reaching goals. Many children with autism are addressing visual perceptual and visual motor goals possibly for years, with minimal progress, and this may be due to missing the underlying deficit which could be ocular motor skills. The educational modules will give therapists the skills to screen ocular motor skills, rule them out as no concern, address them in practice, and when appropriate refer to an optometrist.

Future directions

Addressing ocular motor skills in occupational therapy practice is an emerging niche and its importance has been made clear for successful occupational engagement. Research in the area of addressing ocular motor skills with individuals who have mild to profound disability is needed. Also needed is further research on treatment strategies that are the most successful for improved ocular motor skills and the correlation with occupational engagement. It would be beneficial to also have a resource, such as manual, for occupational therapists to refer to when in a situation needing to address ocular motor skills. Finally, data collection on the skills learned by occupational therapists after taking the education modules would be beneficial for the future of the education programing. Future directions are broad for this emerging niche in occupational therapy.

Conclusion

As seen through the literature review, those with autism have a higher prevalence of ocular motor dysfunction (Bakroon & Lakshminarayanan, 2016; Davis et al., 2006; Schmitt et al., 2014), difficulty with these skills impacts everyday occupational engagement (Petrosyan, 2021) and it is important for occupational therapy practitioners to screen these skills as a means to

explain dysfunction (Zoltan, 2007). The needs assessment made it clear that occupational therapists are not equipped to address these skills in practice and are unaware of how important ocular motor skills are to greater visual perceptional development and occupational engagement. To meet the need, a three-module educational course was created for practicing occupational therapists. The courses cover the basics on ocular motor skills, screening/assessment strategies, and intervention techniques. The completed project will provide the occupational therapy community with a resource to confidently address ocular motor skills in practice.

References

American Occupational Therapy Association. (2020). Occupational therapy practice framework: Domain and process (4th ed.). *American Journal of Occupational Therapy*, *74*(Suppl. 2), 7412410010. https://doi. org/10.5014/ajot.2020.74S2001

Andersen, P. N., Hovik, K. T., Skogli, E. W., & Øie, M. G. (2017). Severity of autism symptoms and degree of attentional difficulties predicts emotional and behavioral problems in children with high-functioning autism; a two-year follow-up study. *Frontiers in Psychology*, *8*. https://doi-org./10.3389/fpsyg.2017.02004

Atasavun Uysal, S., & Düger, T. (2012). Visual perception training on social skills and activity performance in low-vision children. *Scandinavian Journal of Occupational Therapy*, *19*(1), 33–41. https://doi-org./10.3109/11038128.2011.582512

Bakroon, A., & Lakshminarayanan, V. (2016). Visual function in autism spectrum disorders: a critical review. *Clinical & Experimental Optometry*, *99*(4), 297–308. https://doi-org./10.1111/cxo.12383

Berger, S., Kaldenberg, J., Selmane, R., & Carlo, S. (2016). Effectiveness of interventions to address visual and visual-perceptual impairments to improve occupational performance in adults with traumatic brain injury: A systematic review. *American Journal of Occupational Therapy, 70*(3), p1–p7. https://doi org./10.5014/ajot.2016.020875

Cardillo, R., Erbì, C., & Mammarella, I. C. (2020). Spatial perspective-taking in children with autism spectrum disorders: The predictive role of visuospatial and motor abilities. *Frontiers in Human Neuroscience*, *14*. https://doi-org./10.3389/fnhum.2020.00208

Cast. (2018). *Universal Design for Learning Guidelines version 2.2.* Retrieved from http://udlguidelines.cast.org

Chadha, R. K., Subramanian, A., (2011). The effect of visual impairment on quality of life of children aged 3-16. *British Journal Ophthalmol*. *95*(5), 642-645.

Chi, I.-J., & Lin, L.-Y. (2021). Relationship between the performance of self-care and visual perception among young children with autism spectrum disorder and typical developing children. *Autism Research: Official Journal of the International Society for Autism Research*, *14*(2), 315–323. https://doi-org./10.1002/aur.2367

Center for Disease Control and Prevention. (2020a, March 25). *Autism data visualization tool.* https://www.cdc.gov/ncbddd/autism/data/index.html

Center for Disease Control and Prevention. (2020b, September 25). *Data and statistics on autism spectrum disorder*. https://www.cdc.gov/ncbddd/autism/data.html

Chokron, S., Kovarski, K., Zalla, T., & Dutton, G. (2020). The inter-relationships between cerebral visual impairment, autism and intellectual disability. *Neuroscience & Biobehavioral Reviews, 114*, 201-210. doi:10.1016/j.neubiorev.2020.04.008

Coetzee, D., & Pienaar, A. E. (2011). The nature and scope of ocular muscle control deviations among 7 to 8 year-old children diagnosed with Developmental Coordination Disorder (DCD). *African Journal for Physical, Health Education, Recreation & Dance*, 887–901.

Davis R. O., Bockbrader M. A., Murphy R. R., Hetrick W. P., & O'Donnell B. F. (2006). Subjective perceptual distortions and visual dysfunction in children with autism. *Journal of Autism & Developmental Disorders*, *36*(2), 199–210. https://doi-org./10.1007/s10803-005-0055-0

DiCriscio, A. S., Hu, Y., & Troiani, V. (2019). Brief report: Visual perception, task-induced pupil response trajectories and ASD features in children. *Journal of Autism & Developmental Disorders*, *49*(7), 3016–3030. https://doi-org./10.1007/s10803-019-04028-7

Fournier, K. A., Hass, C. J., Naik, S. K., Lodha, N., & Cauraugh, J. H. (2010). Motor coordination in autism spectrum disorders: A synthesis and meta-analysis. *Journal of Autism & Developmental Disorders*, *40*(10), 1227–1240. https://doi-org./10.1007/s10803-010-09813

Facchin, A., Giordano, L., Brebbia, G., & Maffioletti, S. (2020). Application, limits, scoring and improvements of Groffman visual tracing test. *Scandinavian Journal of Optometry of Visual Science, 13*(1), 2-9. https://doi.org/10.5384/SJOVS.vol13i1p2

Guimarães, M. R., Vilhena, D. de A., Loew, S. J., & Guimarães, R. Q. (2020). Spectral overlays for reading difficulties: Oculomotor function and reading efficiency among children and adolescents with visual stress. *Perceptual & Motor Skills*, *127*(2), 490–509.

Hay, I., Dutton, G. N., Biggar, S., Ibrahim, H., & Assheton, D. (2019). Exploratory study of dorsal visual stream dysfunction in autism: A case series. *Research in Autism Spectrum Disorders*, *69*. https://doi-org./10.1016/j.rasd.2019.101456

Heick, J. D., Bay, C., & Valovich McLeod, T. C. (2018). Evaluation of vertical and horizontal saccades using the developmental eye movement test compared to the King-Devick Test. *International Journal of Sports Physical Therapy*, *13*(5), 808–818.

Hebart, M. N., & Hesselmann, G. (2012). What visual information is processed in the human dorsal stream? *Journal of Neuroscience, 32*(24), 8107-8109. doi:10.1523/jneurosci.1462-12.2012

Johnson, B. P., Lum, J. A. G., Rinehart, N. J., & Fielding, J. (2016). Ocular motor disturbances in autism spectrum disorders: Systematic review and comprehensive meta-analysis. *Neuroscience and Biobehavioral Reviews*, *69*, 260–279. https://doi-org./10.1016/j.neubiorev.2016.08.007

Johnson, B. P., Rinehart, N. J., Papadopoulos, N., Tonge, B., Millist, L., White, O., & Fielding, J. (2012). A closer look at visually guided saccades in autism and asperger's disorder. *Frontiers in Integrative Neuroscience, 6*. doi:10.3389/fnint.2012.00099

Minshew, N. J., Luna, B., & Sweeney, J. A. (1999). Oculomotor evidence for neocortical systems but not cerebellar dysfunction in autism. *Neurology, 52*(5), 917.

Merriam, S. B. (2008). Adult learning theory for the twenty-first century. *New Directions for Adult & Continuing Education, 119*, 93-98. http://doi.org/10.1002/ace.309

Petrosyan, T. (2021). The dos and don'ts of binocular vision testing. *Review of Optometry, 158(*1), 44-49.

Schmitt, L. M., Cook, E. H., Sweeney, J. A., & Mosconi, M. W. (2014). Saccadic eye movement abnormalities in autism spectrum disorder indicate dysfunctions in cerebellum and brainstem. *Molecular Autism*, *5(*1), 47.

Shirama, A., Kanai, C., Kato, N., & Kashino, M. (2016). Ocular fixation abnormality in patients with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *46*(5), 1613–1622. https://doi-org./10.1007/s10803-015-2688-y

Takarae, Y., Minshew, N. J., Luna, B., & Sweeney, J. A. (2004). Oculomotor abnormalities parallel cerebellar histopathology in autism. *Journal of Neurology, Neurosurgery and Psychiatry, 75*(9), 1359–1361.

Takarae, Y., Minshew, N. J., Luna, B., & Sweeney, J. A. (2007). Atypical involvement of frontostriatal systems during sensorimotor control in autism. *Psychiatry Research: Neuroimaging, 156*(2), 117–127.

Warren, M., (1993). A hierarchial model for evaluation and treatment of visual perceptual dysfunction in adult acquired brain injury, part 1. *The American Journal of Occupational Therapy, 47*(1), 42-54. https://doi.org/10.5014/ajot.47.1.42

Warren, M. (2013). Evaluation and treatment of visual deficits following brain injury. In Pedretti, H. M. Pendleton, W. Schultz-Krohn (Eds.), *Occupational Therapy Practice Skills for Physical Dysfunction (7th ed., pp. 590-630).* Elsevier.

Zoltan, B. (2007). *Vision, perception, and cognition: A manual for the evaluation and treatment of the adult with acquired brain injury - 4th. ed.* Thorofare, NJ: SLACK.