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Blended Approach to Occupational Performance (BAOP): Guidelines Enabling Children with Autism

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Abstract

The performance of daily activities is impacted by motor impairments in children with autism spectrum disorders (ASD). Research has recently demonstrated the prevalence and specificity of motor impairments in people with ASD. The motor learning of individuals with ASD is partially intact, and evidence suggests that a method to alter skill learning and repeated practice of motor sequences might be beneficial. Aiming to use this knowledge to guide occupational therapy interventions, initial guidelines for children with ASD blended Cognitive Orientation to daily Occupational Performance (CO-OP) with virtual reality (VR) were created. An expert panel reviewed the initial guidelines. The results from the semi-structured expert panel discussion were to (a) increase the number of sessions, (b) provide more visuals to children, and (c) use VR as a reinforcer. Guidelines were revised accordingly. The revised guidelines, called Blended Approach to Occupational Performance (BAOP), are ready for further testing.

Keywords

autism, motor performance, motor control, motor learning, cognition, motor impairments, CO-OP, virtual reality

Cover Page Footnote

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A child's performance of writing, tying shoelaces, riding a bicycle, or throwing a ball to a friend is, in part, influenced by his or her motor abilities and skills. For children with autism spectrum disorder (ASD), the performance of daily living skills is correlated with motor ability (Gowen & Hamilton, 2013; Hilton, Zhang, Whilte, Klohr, & Constantino, 2011). Hilton, Crouch, and Israel (2008) showed that children with ASD, as a result of motor impairments, participate in fewer physical activities than their typically developing peers.

Children with ASD exhibit a high prevalence (80% to 90%) of motor impairments (Hilton et al., 2011). There have been recent advancements in understanding the specific motor impairments present. In the neuroscience literature, the impairments are described as impairments in both performance and understanding of skilled actions or developmental dyspraxia (MacNeil & Mostofsky, 2012). Children with ASD demonstrate a bias toward proprioceptive feedback and poor organization of motor knowledge (Gowen & Hamilton, 2013; MacNeil & Mostofsky, 2012).

Although motor impairments are present, there is strong evidence that individuals with ASD are able to adapt their systems and benefit from the repeated practice of motor sequences (Radomski & Latham, 2008). When individuals with ASD practice a motor task, variability in movement decreases, and reaction times become similar to those of peers without ASD (Brown, Aczel, Jiménez, Kaufman, & Grant, 2010). Gowen and Hamilton (2013) suggest that with increased practice, individuals with ASD are able to overcome some of their motor impairments.

This work aims to incorporate such scientific knowledge about the specificity of motor impairments along with expert knowledge to develop and refine occupational therapy guidelines that address the performance of children with ASD. In the Human Performance Laboratory at Washington University in St. Louis, we significantly increased the amount of repetitions completed during therapy with the use of low cost, personalized virtual reality (VR) among children with cerebral palsy and adults with stroke (Burdea, et al., 2013; Lauterbach, Foreman, & Engsberg, 2013). A similar approach could be used with children with ASD. Generalization of skills is challenging for children with ASD, so increased practice in an artificial, virtual environment may not translate to performance in the natural environment (Case-Smith, 1995). One occupational therapy intervention that has been implemented to encourage children with ASD to use newly acquired skills and strategies in everyday life is the Cognitive Orientation to daily Occupational Performance (CO-OP). Blending our VR protocol with the CO-OP may meet the needs of children with ASD. In this article, after describing the CO-OP and VR, the blended approach and its development will be presented. The long-term goal of this work is to test the feasibility and efficacy of the guidelines.

The CO-OP approach is a "client-centered, performance-based, problem-solving approach that enables skill acquisition through a process of strategy use and guided discovery" (Polatajko & Mandich, 2004, p. 2). The CO-OP focuses on improving performance through the use of cognition, in particular cognitive strategies. Preliminary research shows that children with Asperger's Syndrome (now collapsed into the diagnosis of ASD) were able to engage in the CO-OP to improve their performance in client-chosen activities (Rodger & Brandenburg, 2008; Rodger, Ireland, & Vun, 2008; Rodger & Vishram, 2010). In one study, two children with ASD transferred acquired strategies to other contexts and situations, despite demonstrating rigid and inflexible thinking (Rodger, Springfield, & Polatajko, 2007).

VR is a technology that allows for a safe and interactive environment (Schultheis & Rizzo, 2001). VR is more motivating than traditional therapy methods (Buxbaum et al., 2008) and significantly increases the amount of practice completed during therapy (Alankus, Proffitt, Kelleher, & Engsberg, 2011; Lauterbach et al., 2013). In our Human Performance Laboratory, the therapist uses the Kinect motion sensor, a monitor, any free online games, and a computer with free, specialized middleware called the Flexible Action and Articulated Skeleton Toolkit (FAAST) to evaluate and treat children with cerebral palsy, individuals recovering from stroke, and individuals with other diagnoses (Lauterbach et al., 2013). No controller is necessary to interact with the VR environment because the equipment tracks and records the client's body movements in real time. Prior to the evaluation and treatment, the occupational therapist (OT) selects the activities and uses the software to correspond the movements of the client (e.g., jumping up more than 5 inches) with the virtual actions (e.g., jumping up of the avatar). VR has the potential to increase the practice of motor sequences and aid the OT in making deliberate treatment decisions based on the client-selected goals.

Blending the CO-OP and VR into one set of guidelines would be novel and may result in synergy. VR activities could be used to (a) increase consistent practice of motor sequences and (b) begin the process of applying cognitive strategies that modulate patterns of skill learning and motor performance in children with ASD. OTs are uniquely equipped to understand the client and context in order to present a "just right" VR activity that encourages the use of a cognitive strategy (American Occupational Therapy Association, 2014). When the client encounters a challenge, the OT helps the client identify the goal and plan to overcome the obstacle by using the desired cognitive strategy. Guided generalization of skills from VR activities to performance in the natural environment also will be an essential part of the guidelines.

Background

The Motor Impairments of ASD

ASD is an inclusive term for a group of neurodevelopmental disorders sharing similar impairments in social communication and restricted, repetitive behavior. Research indicates that some motor processes and abilities are atypical in individuals with ASD (Dziuk et al., 2007; Gowen &

Hamilton, 2013; Haswell, Izawa, Dowell, Mostofsky, & Shadmehr, 2009; Larson, Bastian, Donchin, Shadmehr, & Mostofsky, 2008; MacNeil & Mostofsky, 2012). When learning to perform a movement, individuals with ASD build strong associations between intrinsic proprioceptive input and their motor commands. At the same time, external visual information is comparatively discounted. This overreliance on proprioception is correlated with impairments in social function and imitation (Dziuk et al., 2007; Haswell et al., 2009).

Beyond sensory input and integration, motor planning and motor execution seem to be more challenging for individuals with ASD than for those without ASD (Gowen & Hamilton, 2013). The goal of motor planning is to plan a sequence of actions that reaches a desired physical state and to regulate the execution of those actions (e.g., the plan to reach and grasp a cup of water). Part of motor planning is using previously acquired motor knowledge and chaining together multiple sequences; these skills are problematic for individuals with ASD (Gowen & Hamilton, 2013). When individuals with ASD carry out a motor plan, there is variability in execution, particularly in the spatial and temporal aspects of motor execution (Gowen & Hamilton, 2013).

Although individuals with ASD experience these sensorimotor challenges, there is consistent evidence that motor learning is intact and that flexibility exists. In this context, motor learning is "a set of processes associated with practice or experience leading to relatively permanent changes in the capability for producing skilled action" (Shumway-Cook & Woollacott (2007). The practice of motor sequences may positively impact the motor processes in children with ASD (Brown et al., 2010; Gowen & Hamilton, 2013). Brown and colleagues (2010) found that participants with ASD may benefit more from practice than participants without ASD; their overall reaction times become similar to those of the group without ASD following practice on repeated sequences. Gowen and Hamilton (2013) propose that with more experience and practice, individuals with ASD (particularly those who are high functioning and older) are able to overcome some of the atypical processes.

Theoretical Framework

The Cognitive Orientation to daily Occupational Performance. The CO-OP (Polatajko & Mandich, 2004) was originally developed as an alternative to the relatively ineffective and time-consuming traditional approaches that focused on remediation of a child's motor impairments (Steultjens, Dekker, Bouter, Leemrijse, & van den Ende, 2005; Sugden, 2007). Based on their examination of the learning, cognitive behavior modification, and contemporary motor literature, Polatajko and colleagues applied a learning paradigm to the treatment of children with motor-based performance problems. With the CO-OP, the client is taught a global problem-solving framework (GOAL-PLAN-DO-CHECK) and guided to discover domain-specific strategies (DSSs) to enable mastery of the client-selected activity (Polatajko & Mandich, 2004; Rodger &

Brandenburg, 2009). DSSs are embedded in the global problem-solving framework and typically emerge when the client is planning how to accomplish the task. DSSs are intended to be used for a short time and are unique to a particular task or person.

The CO-OP is comprised of seven key components: client-centered goals, dynamic performance analysis, cognitive strategy use, guided discovery, enabling principles, parent/significant-other involvement, and intervention format. Each component is linked to one or more of the objectives—skill acquisition, strategy, and the generalization and transfer of the skills and strategies to everyday life (Polatajko & Mandich, 2004).

Virtual Reality. VR is an emerging technology that allows for the creation and control of interactive multidimensional environments, in which the response of the user can be measured and recorded. VR creates a safe environment for the user that can be adapted for therapeutic use (Schultheis & Rizzo, 2001). VR is more motivating than traditional therapy methods (Buxbaum et al., 2008) and significantly increases the amount of repetitions completed during therapy (Alankus et al., 2011; Lauterbach et al., 2013). Interventions using VR aid people with ASD in learning new daily living activities and cognitive concepts (den Brok & Sterkenburg, 2014).

VR has been used by traditional or bottom-up approaches (e.g., Lauterbach et al., 2013). Bottom-up approaches underline a microlevel of function analysis. These approaches assume that if foundational motor skills are developed, motor control will emerge and task performance will improve. Conversely, top-down approaches, like the CO-OP, accentuate a macrolevel analysis of function and are based on concepts (Christiansen, Baum, & Bass-Haugen, 2005). Top-down approaches begin by using assessments and observations to identify the personal or environmental constraints that are directly contributing to the loss of performance in client-selected activities. In the following guidelines, VR is used as part of a top-down approach.

Development of Guidelines

Initial guidelines. The initial guidelines were developed by blending the CO-OP with VR to meet the performance needs of children with ASD. The guidelines were originally intended to be 16 one-hr sessions over the course of 10 weeks. The intervention was broken into three phases: the clinic phase, the transference phase, and the natural environment phase. The therapist aided clients in developing motor skills and cognitive strategies in the controlled environment of a clinic-based VR and then assisted them in transferring those skills and strategies to the performance of the selected activity in the natural environment.

Method

Data Collection and Analysis

The lead author presented the initial guidelines to an expert panel of three experienced pediatric OTs. Data were collected through an in-depth, semi-structured discussion of the initial guidelines. The lead author led the discussion. The lead author and a graduate student on the research team transcribed the discussion via audio and video recordings. Data analysis was informed by thematic analysis (Boyatzis, 1998). The lead author and a second graduate student on the research team identified common codes and established intercoder agreement. The second author reviewed the common codes and confirmed intercoder agreement.

Results

The results indicate that, from the experience of the expert panel, children with ASD are challenged by transitions between activities. In order to ease the transitions and increase participation in the sessions, the OTs consider the whole session and how one therapeutic activity relates to the next activity. This was demonstrated by one panelist with the statement, “You’re not just talking about an activity in isolation. There’s a whole new dynamic.” The therapists also used structure and pleasure to facilitate the participation of children with ASD.

Structure is explicit rules, schedules, or visual representations of events. One panelist said, “We use a visual of what’s going to happen” to help ease transitions. Structure recommendations included a visual representation and checklist of the Blended Approach to Occupational Performance (BAOP) timeline that can be used to review the progression.

Pleasure may be inherent in an activity, such as “screen time.” However, pleasure can also be added by incorporating the child’s interests into an activity or arranging a desired activity after a nonpreferred activity. Other factors were family support, sensory modulation, and self-awareness. In terms of the guidelines, the therapists noted that the guidelines use inherently pleasurable and portable technology activities. The panel suggested ending the sessions carried out in the natural environment with the motivating VR activities.

The panel identified three potentially challenging transitions in the initial guidelines, including the transition from clinic-based VR activities to performance in the natural environment. The panel recommended lengthening guidelines by a few sessions in order to allow for a more gradual transition as well as to introduce elements of the physical and social environment.

Refinement of Guidelines

The lead author used the results from the qualitative work to modify the initial guidelines and create the revised guidelines, the BAOP. The lead author added three sessions to the intervention, bringing the revised protocol to 19 one-hr sessions over the course of 11 weeks. To provide visual structure for the client, the BAOP guidelines were updated to include a binder that contains the client’s performance goals, a timeline of the complete intervention, schedules of each session, a visual of the global strategy, and a visual of the strategies as discovered.

The guidelines also include a reconceptualization of the intervention phases. The initial guidelines had three phases; the BAOP has seven phases. With the aim of improving the clients' understanding of the intervention, these phases have basic names (e.g., building, launching) and the goals are more explicit. In the BAOP phases, greater emphasis is placed on building discrete skills and on generalizing strategies across contexts. In accordance with the suggestions from the panel, the VR activities in the BAOP are used as a reinforcer for participation at the end of sessions, when appropriate.

The BAOP Guidelines Overview

The BAOP is divided into seven phases: preparation, evaluation, building, launching, honing, reevaluation, and long-term reevaluation. As the client progresses through the phases, the sessions transition from doing motor sequences in a controlled environment, such as the clinic, to performing the selected activity in the real world or natural environment (i.e., home, school, or community) (see Table 1). The therapist and the client meet for 19 sessions over the course of 9 weeks. The last session (session 20) evaluates the long-term results of the BAOP and occurs a month after session 19.

Table 1

The Timetable of the BAOP Phases

Phase	Week	Session	Location
Preparation	A	--	--
Evaluation	B	1	the natural environment of the selected activity (home, school, or community)
Building	B, C, D, E	2, 3, 4, 5, 6, 7, 8	clinic
Launching	F, G, H	9, 10, 11, 12, 13, 14	clinic the natural environment
Honing	I, J	15, 16, 17, 18	the natural environment
Reevaluation	K	19	the natural environment
Long Term ReEvaluation	--	20	the natural environment

Preparation phase. A week prior to the evaluation, the therapist contacts the client to orient him or her to the BAOP, ensure the client's commitment (including the caregiver), and provide a week-long daily activity log. The client and the OT discuss possible goal areas and schedule a relevant observation for the evaluation. If permission to observe the client at a school or in the community during the evaluation is required, the therapist obtains permission during this phase.

Evaluation phase. After personal introductions, the OT interviews the child about his or her interests and administers an occupational profile assessment, such as the Pediatric Activity Card Sort (Mandich, Polatajko, Miller, & Baum, 2004). The OT reviews the activity log to better understand the frequency and schedule of daily activities as well as to compare it to the occupational profile. The OT observes the client performing the identified activities in the home, school, or community. The OT identifies possible factors contributing to the breakdown of performance. If the client meets the inclusion criteria for the BAOP, the OT and client identify up to three performance goals. The goals are written in occupation-based and observable terms. The goals are also realistic for the client to achieve by the end of the intervention and are written in plain language.

Building phase. In order to prepare the client, the therapist deliberately uses personalized VR activities to (a) provide consistent practice of goal-related movements and (b) reinforce the use of the global strategy by varying the training tasks and environments. In this phase, the OT plans for adequate rest breaks, provides verbal and visual feedback, and encourages caregivers to observe.

Before the building phase begins, the OT selects a variety of free, online games based on the client's interests. The OT then modifies the games according to the client's goals and abilities using the FAAST middleware. The FAAST allows the OT to modify the conditions for a virtual response (e.g., modifying an input from a mouse click to 20 degrees of right shoulder abduction) without writing computer code. Conditions can be saved for later use and also combined with other conditions.

During Session 2, the OT instructs the client on the global strategy: GOAL-PLAN-DO-CHECK. The OT discusses applying the global strategy in basic daily activities. The client demonstrates understanding by returning the instructions, and then he or she begins the VR activities. For Sessions 3 through 6, the client participates in personalized VR activities for 45 min each session. The global strategy is reinforced when the client uses it to overcome a motor challenge presented by a VR activity. When the client encounters a challenge, the OT helps the client identify the goal and plan to overcome the obstacle. If the client does not have enough knowledge to make a plan, the OT instructs the client on how to complete the task. The activity is restarted and the client plays again. If the goal is not achieved, the client and the OT create a new plan and play again. The global strategy is also reinforced when the client applies it across different, novel VR activities. The OT facilitates generalization by discussing with the client how he or she could use the global strategy in daily activities.

It is important to balance the priority of using the global strategy with the priority of goal-related blocked practice (drills that require clients to perform many repetitions of the same task in the same way [Schmidt, 1991]). The OT uses a VR activity with consistent conditions to increase repetitions and help the client build a repertoire of movements. As the phase continues, the conditions of VR activities can be combined to form more complex, serial tasks with connected discrete movements (Radomski & Latham, 2008). Objects related to the goal, such as a basketball and certain clothing, are gradually included. Elements of the real-world environment, such as the soundscape of the natural environment, the volume of the soundscape, other people, and people doing the same activity or a different activity, are gradually included. The OT fades the use of the VR to practice movement sequences.

Launching phase. The launching phase gradually transitions the client from goal-related movement sequences in a controlled environment to practice of a whole task in the real-world environment. The OT gradually provides fewer verbal and visual cues than he or she provided in the building phase. The VR activities are used for short periods of positive reinforcement at the end of the sessions. The parents or caregivers are encouraged to observe and promote the generalization of strategies and motor skills outside of the therapy sessions.

To help the client transition and transfer skills to the real-world environment, the sessions in the launching phase alternate between the clinic and the real-world environment. The client begins to use the global strategy to overcome real-world motor challenges by, for example, retrying challenging activities with a plan. The OT helps the client think about possible solutions or plans; through that collaborative process, the client discovers DSSs, such as becoming aware of "body position." Real-world activities are repeated several times to improve motor learning, as well as being graded and varied to promote the generalization of the global strategy. The client and OT discuss how the global strategy and DSSs can be used in other real-life situations. As the phase progresses, the OT gradually reduces direct verbal and visual feedback.

Honing phase. This is the phase in which the client improves performance accuracy and consistency. The client continues to perform in the real-world environment; depending on the goal, the real-world environment could include a combination of variable factors, including the time of day, people, built environment, tools of the occupation, and clothing. If the client attempts a plan and is unsuccessful, the OT or caregiver provides the least amount of verbal and visual assistance necessary (e.g., a gesture to the BAOP binder). The child discusses with the OT and the caregiver what steps are needed to meet the goals and how the strategies can be used in other activities.

Reevaluation phases. For the purpose of accurately capturing outcomes, the client is reevaluated at the end of the intervention and a month later. The second reevaluation is necessary to demonstrate learning and relatively permanent changes in motor performance. During both reevaluations, the same occupational profile assessment used during the evaluation is administered. The OT observes and documents the performance of goal activities. The OT facilitates the client in checking if the goals were achieved and probes the client for evidence of generalization and transfer to other activities. The client is encouraged to continue honing his or her performance and using the strategies to improve performance.

The BAOP in Action: Case Example

The OT receives a therapy order for a boy named Harry. When the OT calls, Harry and his mother ask if the OT could help him play basketball with his classmates. The OT observes him play basketball and notices that 60% of Harry's shots do not make it to the hoop. Harry does not jump as high as his classmates, and his shots veer to one side or the other. Harry does not know why he is missing the hoop. The OT and client agree on this goal: In Vance Elementary's gymnasium, Harry will demonstrate good body mechanics by performing a jump shot attempt by the end of the 18th treatment session. The OT and client discuss the other goals about transfer and generalization. A copy of the goals is put in Harry's BAOP binder for reference.

The OT instructs Harry and his parents on GOAL-PLAN-DO-CHECK and uses brushing teeth and taking a pill as examples. When Harry tries to explain the global strategy to his father, he can only remember GOAL-PLAN-DO. His OT cues him to the visual in his BAOP binder, and then Harry is able to explain each part. He also tells his father how he could use global strategy to don his baseball cap.

The OT starts the Kinect motion sensor, monitor, and computer. Prior to the session, the OT found a free, online basketball game using a web browser, created the condition of jumping up at least two inches in the FAAST, and then saved the condition. Harry plays the basketball game and fails to jump high enough to trigger the avatar. The OT demonstrates playing the game and instructs Harry that he needs to bend down farther before jumping. Harry says he will try to bend down until his hands touch the back of his calves. Harry plays and says it works. The OT congratulates him on using the global strategy; he identified the GOAL of jumping high, the PLAN (and the DSS in this case) to bend down until his hands touch the back of his calves, engaged in the VR activity again, and completed a CHECK to see if the goal was accomplished. Harry plays for 10 min before the session ends. The OT saves the data from the FAAST about the client's movements. During the next session, the OT changes the conditions of the game to jumping up at least five inches. The client adjusts his plan and meets the conditions for the avatar to shoot the basketball. As the sessions continue, the OT changes the conditions to a combination of jumping up and upward bilateral arm movement. The OT incorporates a real basketball and then a target as high as a basketball hoop.

In the Vance Elementary gymnasium, the client modifies his goal to hitting the backboard of the hoop with the basketball. Harry modifies a plan he used in the clinic and is able to get the ball to reach his goal. He practices to improve his consistency. The OT challenges him to shoot the ball from different angles and from different distances from the hoop. At the end of the session, Harry discusses how he could use the global strategy and similar DSSs to improve his volleyball performance.

Harry decides his next goal should be to hit the rim of the hoop by bouncing the basketball off of the backboard. He makes a plan and achieves his goal once. Harry inconsistently achieves his goal initially but improves after practice. Harry also practices hitting the rim of his basketball hoop at home with his father. Harry continues to hone his body mechanics and accuracy after school in the gymnasium with occasional support from his OT. The OT observes Harry playing basketball with his classmates during the reevaluation. Harry jumps as high as his classmates and his throws are hitting the rim with increased consistency. A month later, Harry says he loves to play basketball with his classmates and that now he also can jump up high enough to reach the monkey bars on the playground. The OT observes his improved motor performance during basketball with his classmates.

Discussion

The developing BAOP guidelines blend the CO-OP with VR and are now ready for feasibility testing. The BAOP focuses on client-centered motor performance issues and engages the child as an active participant in the therapy process. Skill development starts with graded VR activities in a controlled environment and graduates to performance of a selected activity in the natural environment.

The initial guidelines were revised based on data collected from an in-depth, semi-structured discussion of the initial guidelines with an expert panel of three pediatric OTs. The panel reported that children with ASD struggle with transitions between activities, and that 10 weeks would not be long enough to allow for gradual transitions. The panel also reported that more visuals and using VR as a reinforcement would help children with ASD to participate. The phases of the revised guidelines, now called the BAOP, were restructured to include more sessions and to improve clarity. The revised guidelines recommend that VR be used as a reinforcer during the launching and honing phases and that a binder of visual aids be created in collaboration with the participant.

The BAOP is novel because it is informed by knowledge about the specific motor impairments of people with ASD, and also because it takes a blended approach. To our knowledge, the CO-OP and VR have not been blended before. Given the prevalence and impact of motor impairments in ASD, further investigation into the BAOP guidelines is warranted.

Limitations

As of this writing, the guidelines are still in development and have limited clinical significance without more investigation. The benefits of the guidelines cannot be substantiated until participant data are collected and analyzed.

The primary focus of the BAOP is motor performance, and it is intended to complement a full plan of care for children with ASD. The child may identify several goals, including ones unrelated to motor performance; however, unlike the CO-OP, not all goals may be appropriate to address with the BAOP.

Future Work

Moving forward, investigation into the feasibility and efficacy of the BAOP is essential. Descriptive case studies are first necessary to determine feasibility and to direct additional refinements of the guidelines. Subsequent case

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studies will investigate the response of individual children with ASD to the BAOP by comparing pre and postintervention measures, such as the Canadian Occupational Performance Model. Given that there is evidence correlating motor performance with the social, communicative, and behavioral impairments that are characteristic of ASD, any large-scale study investigating the efficacy of the BAOP ought also to measure changes in those correlated impairments.

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