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Play in natural environments: A pilot study quantifying the behavior of children on playground equipment

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ABSTRACT

Playground design is critical to school-based practice, insuring access and use for all children. The play behavior of children with special needs is qualitatively and quantitatively different than their typically developing peers. However, empirical data is needed to support the therapeutic value of playground equipment used with school-aged children. Thirty-two hours of videotape was collected from 140 children who were typically developing (male = 56%) and 41 children with a variety of developmental disabilities including autism, ADHD, sensory and regulatory disorders (male = 76%), ages 3 to 15 years. Six pieces of playground equipment were analyzed using a behavioral coding system for sensory features, social interaction, self-regulation, motor skills, and play levels. Content validity of the behavioral coding scheme was obtained through a case study. Proprioception was enhanced through active use of the playground equipment. Increased verbalizations and positive affect were observed across all pieces of equipment. Symbolic play, novel use and motor planning were fostered. Regaining regulation and expressions of self-esteem were quantifiable. Correlations support relations between proprioception and social interaction; positive affect and social interaction; motor planning and self-esteem; and play levels with positive affect and social interaction. Improvements in regaining regulation, self-esteem, and postive affect were demonstrated through the case study analyses. Playground behaviors could be described using a behavioral coding scheme that includes sensory features, social interaction, self-regulation, motor skills, and play levels. This behavioral coding system validated the features of an inclusive playground and quantified the effectiveness of intervention.

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Play is foundational to the development of children (Pellegrini & Smith, 1998) and has the potential to modify functioning in many domains. The evidence that play is an effective change agent is plentiful, including social transformations (Hurwitz, 2003; Koegel & Kern-Koegel, 2006; Vickerius & Sandberg, 2006), sensory and motor changes (Fjortoft, 2004; Palma, Pereira, & Valentini, 2014), and alterations in language abilities (Camarata, Nelson, & Camarata, 1994; Tamis-LeMonda, Shannon, Cabrera, & Lamb, 2004), leading to overall increased competence in daily life and improved school performance (Erikson, 1963; Piaget, 1962; Vygotsky, 1967). In

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addition, research shows that play is formative in supporting social participation, emotion regulation (Trister, Colker, & Heroman, 2002), and self-esteem/self-confidence, three areas parents of children with special needs report are of high priority (Cohn, Miller, & Tickle-Degnen, 2000).

Play in natural environments is mandated for children with disabilities and is central to school-based intervention (Hecimovic, Fox, Shores, & Strain, 1985; Koegel, Kuriakose, Singh, & Koegel, 2012). Natural settings are advocated by the Individuals With Disabilities Education Act (U.S. Department of Education, 2004) and by many professional organizations—for example, the American Occupational Therapy Association (American Occupational Therapy Association, 2014), the Division for Early Childhood (DEC/NAEYC, 2009), and the National Association for the Education of Young Children (DEC/NAEYC, 2009). Natural settings foster the generalization of skills more than therapy in specialized environments or therapy with specialized equipment commonly found in pediatric occupational therapy gyms (Fjortoft, 2004). Providing therapy in natural settings results in practicing where the skill is actually used, increasing the likelihood that the abilities learned will be integrated into everyday life (Kingsley & Mailloux, 2013).

Play environments can shape children's play behavior. The design of natural settings such as playgrounds affects the type, duration, and frequency of activities in which children engage (Barbour, 1999; Dyment & O'Connell, 2013). Traditional playgrounds offer many difficulties to children with special needs including those with sensory-processing disorder (Cosbey, Johnston, Dunn, & Bauman, 2012). Often the physical challenges are too great and inhibit the development of self-confidence/self-esteem. Socialization is also negatively impacted. Children with special needs require playgrounds that allow access to equipment wherein a range of appropriate motor challenges are available (Ripat & Becker, 2012). This allows any particular child to find the "just right challenge" (Ayres, 1972). Environments that support increased physical interactions enhance social skill development (Fjortoft, 2004).

Children with sensory-processing disorder (SPD) have difficulty interpreting everyday sensations and producing meaningful responses to sensory input. SPD occurs in 5% to 16% of the population (Ahn, Miller, Milberger, & McIntosh, 2004; Ben-Sasson, Carter, & Briggs-Gowan, 2009) and can occur separately from other disabilities (Carter, Ben-Sasson, & Briggs-Gowan, 2011; Van Hulle, Schmidt, & Goldsmith, 2012). SPD is often comorbid with other developmental disabilities such as autism (Tomchek & Dunn, 2007), attention deficit hyperactivity disorder (Ghanizadeh, 2011), and anxiety disorders (Ben-Sasson et al., 2009). Children with SPD are not as effective as their typically developing peers in many aspects of play on traditional playgrounds (Bundy, Shia, Qi, & Miller, 2007; Case-Smith & Kuhaneck, 2008; Cosbey et al., 2012). Based on a few studies, children with SPD may benefit from therapy conducted in natural environments (Anaby et al., 2013; Yuill, Strieth, Roake, Aspden, & Todd, 2007). Event coding techniques can now build evidence for the use of playgrounds for therapy (Shapiro, 2014).

Qualitative and quantitative differences in play exist in children with SPD compared to their typically developing peers (Bundy et al., 2007; Smyth & Anderson, 2000). Children with SPD are reported to be more solitary in their play, to avoid team activities, and to have decreased opportunity for socialization with peers (Bundy et al., 2007). When children with SPD do play with others on traditional playgrounds their abilities are relatively limited (Cosbey et al., 2012; Watts, Stagnitti, & Brown, 2014). Cosbey et al. (2012) found that children with SPD were less aware of social cues and tended to be more aggressive than typically developing peers in traditional playground environments. For example, children with SPD spent more time in low-social or nonsocial play activities and used simpler play schemes than age-matched peers.

Previous studies about the affordances of playground equipment were limited due to challenges conducting studies comprising naturalistic observations (Kendrick, Hernandez-Reif, Hudson, Jeon, & Horton, 2012). The benefits and drawbacks of live coding versus video coding are well documented (Leff & Lakin, 2005). The most difficult element is operationally defining critical behaviors and then ensuring that the rating scheme is objective and reliable. Studies with strong inter-rater reliability are needed as are well-defined observational schemes.

An important validity issue is whether specialized playground equipment elicits the behaviors suggested by its marketing literature. Evidence-based data are needed to objectively test the therapeutic value of playgrounds used in school-based or clinic-based occupational therapy practice. This evidence should include the change associated with use of the equipment and the beneficial effect of promoting developmental, relational, motor, communication, affective, and other abilities for users with special needs.

The present study evaluates a newly developed behavioral coding system, designed to quantify behaviors displayed on specific playground equipment in children with and without special needs. The study characterizes pieces of playground equipment using an objective and standardized coding system that categorizes the social, emotion, regulation, motor, and play of children with and without disabilities. A case study reflecting use of the coding system to document changes in treatment is presented.

Specific aims of this study are to (a) categorize unique features of a specialized playground using the behavioral coding system (Camarata, Miller, & Schoen, 2015), (b) investigate the association between behaviors observed on the equipment; (c) quantify areas impacted for a child with sensory challenges, and (d) measure changes for this child in mastery of parent's goals. We hypothesize the following:

(1) The coding scheme will successfully differentiate pieces of playground equipment based on behaviors and themes observed.
(2) Positive relations will be obtained between certain behavioral codes reflecting predictions based on the association between sensation, social interaction, motor skill, play level, and self regulation.
(3) Changes in social functioning, emotion functioning, regulation, motor functioning, and play on the playground will be demonstrated using the coding scheme.
(4) The case study will quantify changes in parent-derived goals.

Method

This study builds on previous qualitative research (Schoen, Miller, & Hampton, 2014) using a pilot version of a behavioral coding system (Camarata et al., 2015) to evaluate the unique features of a sensory-friendly playground designed by Landscape Structures, Inc. Conducted in the spring, summer, and fall of 2015, children were video-taped during afternoon playground periods open to the community at STAR Institute for Sensory Processing Disorder near Denver, Colorado. Thirty-two hours of videotape were collected from July 2014 to October 2014 during 2-hour playground sessions every Thursday afternoon for 16 weeks. Analysis took 160 hours over a 6-month period from January

2015 to June 2015. Approximately 12–15 children, a third of whom had developmental disabilities, attended each 2-hour session. No families refused to participate.

Participants

Eighty-nine parents of 181 children permitted them to participate in the study, providing signed informed consent to videotape and analyze their performance. One hundred and forty children were typically developing constituting a volunteer community sample (male = 56%) and 41 children had a variety of developmental disabilities including autism, ADHD, sensory and regulatory disorders and were receiving therapy services at STAR Center (male = 76%), from 3 to 15 years of age. Specific demographic information was not collected on participants only on groups. The Rocky Mountain University of Health Professions Institutional Review Board approved this study and the informed consent/assent procedures.

Procedures

Data collection

Data were collected using an Axis P5534-E PTZ Pan/Tilt/Zoom Dome Network Camera mounted outside, on a building adjacent to the playground and stored for access on an exacqVision EL-Toaster Network Video Recording Appliance. Audio data were recorded with a Sennheiser EW100-ENG G2 Wireless Lavalier Microphone system that was attached to an adult on the playground who was instructed to be in proximity to the majority of the children. The microphone interfaced with a Sennheiser EW100-ENG G2 True Diversity Receiver and connected to the camera and storage system network with an Axis P8221 Network I/O (Input/Output) Audio Module.

Research assistants rotated filming in hour-long blocks during which data were acquired remotely from a computer located in the office that was connected to the outside camera so that there was no social interference. The research assistants were instructed to capture use of as many pieces of playground equipment as possible while also focusing on social interactions. Filming focused on groups of children and was dictated by the most frequently selected pieces of equipment. Six primary pieces of playground equipment were sought out by the participants and are focused on in this paper: (1) a sand and water table, which contains dry sand and water in a design that allows children to circle around the structure with a water nozzle that emits a short burst of water producing damp sand and water; (2) a jungle gym/clubhouse, “STAR-Base-1,” which includes a series of graduated levels of climbing elements from stairs to a step climber made of logs and an unstable wiggling chain ladder that houses a double slide consisting of two parallel slide chutes; (3) the Roller Slide, with a sliding incline surface made of rolling segments; (4) the Mobius Climber, a mobius strip–shaped climbing wall that allows users to climb in multiple orientations; (5) the Cozy Dome, which is an igloo shaped climbing dome with a textured surface and a series of small and large peepholes; and (6) the Omnispin Spinner, a bowl-shaped merry-go-round with a gently sloped interior high back support and seats facing inward within which riders can sit and be spun or participate more actively as the agent pushing (spinning) others. The equipment is depicted in Figure 1.

Figure 1. Photograph of Landscape Structures, Inc., playground at STAR Center.

Development of coding scheme

Principal investigators Dr. Camarata (Vanderbilt University) and Drs. Miller and Schoen (STAR Institute) developed the coding scheme over a 2-year time period based on video-taped treatment sessions from STAR Institute. The codes were tested and modified until advanced practitioners could reliably code the videos. Two research assistants at each location (Vanderbilt University and STAR Institute) were trained in the coding scheme by the principal investigators. Operational definitions were refined and clarified in an iterative process to ensure accuracy. Pilot video-taped segments were viewed, discussed, and scored until agreement was reached. Disagreements were resolved through discussion until > 90% inter-rater agreement was reached.

Videotape coding

Videotapes were divided into 60-second epochs and event-coding was applied to each epoch by coding every behavior observed within the epoch with a code of "1." Whenever a behavior was observed it was assigned a code, not the number of times a behavior was observed. Observations typically included groups of children not just one individual. Codes were not mutually exclusive, thus multiple behavior codes could be assigned for each epoch. All 32 hours of videotape were reviewed and coded in 1-minute increments and included children receiving intervention as well as those from the community. *Behaviors* observed were categorized and defined within the following *themes*: (a) *sensory features* of the play activity, reflecting how the child used the equipment to enhance their tactile, proprioceptive, or vestibular experience, such as digging in the sand (tactile), climbing on the Cozy Dome, hanging from the rungs of the Roller Slide (proprioceptive), spinning on the Omni Spinner (vestibular); (b) *social interaction*, including both nonverbal and verbal communication, attention and referencing, and social skills such as turn taking, working together, and helping others; (c) *self-regulation*, including regaining regulation, positive affect, and self-esteem (i.e., speech shows pride and behavior shows pride); (d) *motor skills*, including novel motor use of equipment (e.g.,

Table 1. Operational definitions of playground behaviors.

Theme	Code	Operational definition
Sensory features	proprioception	Child engages in an activity that enhances sensations derived from stimulation to the muscles and (to a lesser extent) the joint receptors especially from resistance to movement.
	vestibular	Child engages in an activity that enhances sensations derived from stimulation to the vestibular mechanism in the inner ear that occurs through movement and position of the head. This includes any displacement of the head in any of the three directions—up/down, left/right, and forward/backward—balancing activities.
	tactile	Child engages in activity to enhance sensations derived from stimulation to the skin.
Social interaction	spontaneous verbalization	Child *initiates* conversation with communicative intent either through verbalization or directed vocalizations. Communications are not prompted.
	elicited verbalization	Child *responds* to conversation with communicative intent either through verbalizations or directed vocalizations.
	initiated joint attention	Child references some object or activity verbally or nonverbally and then *looks* to another to meet their end. The child must be looking at another person.
	responding to joint attention	Behavior contingent on child's eye gaze following a verbal reference or indication toward an object or activity. The child must first look at the object/activity referenced, then turn eye gaze to the person who made the reference.
	shared enjoyment (referencing)	Child first references an object/activity and then looks to another to share enjoyment. The child must direct eye-gaze to another person.
	helping behavior	Child offers assistance in some task.
	working together	Child works with someone else to accomplish the same task.
	turn taking	Child waits to interact with an object until another person is no longer using it.
Self-regulation	regaining regulation	Child uses equipment to regain a calm/engaged state following dysregulation.
	speech shows pride	Any verbalization showing pride after an activity/task (e.g., "Look at me!" "I did it!").
	behavior shows pride	Any behavior showing pride after an activity/task (e.g., high-five, arms up in the air).
	positive affect	Child expresses excitement, joy, surprise, etc., that shows positive affect.
Motor skills	novel use	Child uses the equipment in a novel way. Novel use is reliant upon whether the variation was intentional.
	motor planning	Skilled, nonhabitual movements used to accomplish multistep tasks. The child often uses inefficient motor patterns when attempting to complete a task and continues their attempts until they are successful.
Play levels	associative play	Child and play partner play the same game and converse but do not work together. If they are working together, there are not assigned roles. The children must be playing *with* each other not just near each other.
	cooperative play	Child and play partner play the same game, converse, and work together using assigned roles.
	symbolic play	Child engages in pretend play using actions, objects, or ideas to represent other actions/objects/ideas.

ideation) and motor planning; and (e) *play level*, including associative, cooperative, and symbolic play. The coding scheme with operational definitions appears in Table 1.

Inter-rater reliability

Inter-rater reliability calculations were computed monthly between the two research assistants to ensure that there was no drift in the coding. Reliability was computed as agreement/(agreement + disagreement) × 100. The six reliability scores were as follow: 75%, 80%, 89%, 86%, 90%, and 91%. Thus, the average reliability across all codes was 85%.

Data analysis

Frequency tables were compiled with counts of the number of observations for each behavior on each piece of equipment. Frequency counts were converted into percentage of time observed, and behaviors were compared within themes. Thus, counts of each behavior were divided by the total number of observations within their respective theme. For example, for the theme *play level*, which includes the behavioral observation of associative play, cooperative play, and symbolic play, percentages were the relative frequency of each type of play behavior in relation to the other play behaviors within play level.

After reviewing the frequency data, associations between behaviors were explored based on frequency codes and hypothesized relations. Low frequency codes were not included in the analyses (e.g., a behavior that was observed less than 10% of the time across all pieces of equipment) such as *initiates joint attention, responds to joint attention*, and *shared enjoyment referencing*.

Correlations were computed using Spearman rho because the data were not normally distributed. Rationale for the correlations was based on literature related to theories of sensory integration, motor learning, social relationships, and play. Specifically, proprioception has been linked to self-regulation (Blanche & Schaaf, 2001), social interaction (Koomar & Bundy, 2002), and motor skill performance (Blanche & Schaaf, 2001; Wong, Kistemaker, Chin, & Gribble, 2012). Motor skills have also been linked to self-esteem (Lodal & Bond, 2016). Positive affect has been linked to aspects of social interaction (Diener & Seligman, 2002), and play has been associated with motor abilities (Bart et al., 2009) and social skills (Bulotsky-Shearer et al., 2012; Bundy et al., 2011; Gagnon & Nagle, 2004). Due to the exploratory nature of this analysis, a correction for multiple comparisons was not conducted.

Results

Frequency analyses

Sensory features

Enhanced sensory features that were observed on each piece of equipment appear in Table 2. For this study, *enhanced sensory features* refers to sensory experiences that were augmented during use of a piece of equipment (e.g., hanging from a bar on the Roller Slide was a form of enhanced proprioception). All pieces of playground equipment were inherently multisensory in nature. The one sensory domain that was most often enhanced was *proprioception* (ranging from 49.35% to 86.75% of the time).

Table 2. Percentage of time sensory feature is observed by equipment.

Equipment	Proprioceptive	Sensory features Vestibular	Tactile
Sand and water	66.12	7.65	26.23
Roller Slide	52.17	5.59	42.24
Omnispin	49.35	49.35	1.30
STAR Base 1	86.75	8.43	4.82
Cozy Dome	66.67	30	3.33
Mobius	69.70	27.27	3.03

Table 3. Percentage of time social interaction is observed by equipment.

	Social interaction							
Equipment	Spontaneous verbalization	Elicited verbalization	Initiated joint attention	Respond to joint attention	Shared enjoyment referencing	Helping behavior	Working together	Turn taking
Sand and water	39.88	28.34	1.82	1.42	0.81	8.10	14.98	4.66
Roller Slide	37.08	27.34	2.25	0.37	7.87	1.87	4.12	19.10
Omnispin	36.56	31.72	0.88	0.00	1.32	21.15	7.05	1.32
STAR Base 1	44.50	34.86	4.13	0.00	4.59	0.92	0.92	10.09
Cozy Dome	51.89	38.68	0.94	0.94	7.55	0.00	0.00	0.00
Mobius	47.92	37.50	5.21	0.00	4.17	0.00	5.21	0.00

Social interaction

Social interaction behaviors that were observed on each piece of equipment appear in Table 3. Behaviors most often observed were *spontaneous verbalization* (36.56% to 51.89%) and *elicited verbalization* (27.34% to 38.68%). Also observed were *helping behaviors* (21.15% on the Omnispin), *working together* (14.98% at the sand and water table) and *turn taking* (19.10% on the Roller Slide). There were few observations of joint attention and referencing behaviors.

Self- regulation

Self-regulation behaviors that were observed on each piece of equipment appear in Table 4. The behavior most often observed across all pieces of equipment was *positive affect*, ranging from 44.12% on the Cozy Dome to 93.62% on the sand and water table. *Regaining regulation* was most often observed on the Cozy Dome and *speech shows pride* (e.g. self-esteem) on the Mobius Climber.

Motor skills

Table 4. Percentage of time self-regulating behavior is observed by equipment.

	Emotion regulation			
Equipment	Regaining regulation	Speech shows pride	Behavior shows pride	Positive affect
Sand and water	1.42	4.96	0.00	93.62
Roller Slide	1.89	9.43	2.83	85.85
Omnispin	14.61	2.25	0.00	83.15
STAR Base 1	1.18	10.59	1.18	87.06
Cozy Dome	36.76	17.65	1.47	44.12
Mobius	0.00	30.00	3.33	66.67

Table 5. Percentage of time motor skills behavior is observed by equipment.

	Motor skills	
Equipment	Novel use	Motor planning
Sand and water	97.66	2.34
Roller Slide	89.69	10.31
Omnispin	95.83	4.17
STAR Base 1	76.25	23.75
Cozy Dome	67.57	32.43
Mobius	41.82	58.18

Motor skills observed on each piece of equipment appear in Table 5. The behavior most often observed across all pieces of equipment was *novel use*, ranging from 41.82% on the Mobius to 97.66% on the sand and water table. Motor planning was highest for the Mobius Climber (58.18%).

Play levels

Play levels are reported in Table 6. Associative, cooperative, and symbolic play were each observed on at least one piece of equipment. *Symbolic play* most notably occurred on the Cozy Dome (62.50% of the time) and the sand and water table (53.26% of the time).

Correlation analyses

Correlations between behaviors are organized by themes as described in the following sections.

Sensory features

Correlations with *proprioception* were as follows:

Novel use (*rho* = .943, $p < .001$) (ideation)
Positive affect (*rho* = .898, $p < .001$)
Spontaneous verbalization (*rho* = .894, $p < .001$)
Elicited verbalizations (*rho* = .888, $p < .001$)
Turn taking (*rho* = .786, $p = .001$)
Working together (*rho* = .423, $p = .117$)
Helping behavior (*rho* = .473, $p = .075$)
Regaining regulation (*rho* = .143, $p = .712$)
Motor planning (*rho* = .485, $p = .067$)

Table 6. Percentage of time play level is observed by equipment.

	Play levels		
Equipment	Associative play	Cooperative play	Symbolic play
Sand and water	41.30	5.43	53.26
Roller Slide	61.90	0.00	38.10
Omnispin	78.57	0.00	21.43
STAR Base 1	46.67	33.33	20.00
Cozy Dome	25.00	12.50	62.50
Mobius	50.00	50.00	0.00

Self-regulation

Correlations with *positive affect* were as follows:

Novel use ($rho = .919$, $p < .001$)
Spontaneous verbalization ($rho = .986$, $p < .001$)
Elicited verbalization ($rho = .973$, $p < .001$)
Turn taking ($rho = .805$, $p < .001$)
Working together ($rho = .475$, $p = .074$)
Helping behavior ($rho = .619$, $p = .014$)
Motor planning ($rho = .448$, $p = .094$)

Motor skills

Correlations with *motor planning* were as follows:

Speech shows pride ($rho = .749$, $p = .001$),
Behavior shows pride ($rho = .656$, $p = .008$).

Play levels

Correlations with *associative play* were as follows:

Spontaneous verbalization ($rho = .746$, $p = .001$)
Elicited verbalizations ($rho = .748$, $p = .001$)
Novel use ($rho = .875$, $p < .001$)
Positive affect ($rho = .765$, $p = .001$)
Working together ($rho = .652$, $p = .008$)
Helping behavior ($rho = .454$, $p = .089$)
Turn taking ($rho = .564$, $p = .028$)
Correlations with *symbolic play* were as follows:
Spontaneous verbalization ($rho = .641$, $p = .01$)
Elicited verbalizations ($rho = .648$, $p = .009$)
Novel use ($rho = .653$, $p = .008$)
Positive affect ($rho = .598$, $p = .018$)
Working together ($rho = .384$, $p = .158$)
Helping behavior ($rho = .383$, $p = .158$)
Turn taking ($rho = .404$, $p = .135$)

Summary

The description above shows that playgrounds can be evaluated in terms of behaviors observed on the developed coding scheme. Sensory features analyses suggest that proprioception is most often enhanced through active use of the playground equipment. Increased expressive language and enjoyment and pleasure (joy) were observed across all pieces of equipment. The equipment fostered play activity with a play partner and higher-level play abilities including symbolic play. Behaviors reflecting the ability to regain regulation and expressions of self-esteem (e.g., pride) were also quantifiable.

Correlations suggest new associations and support hypothesized relations between behaviors within each theme. Proprioception is often thought to have a calming effect on individuals who get dysregulated due to sensory challenges. We hypothesize that children in this study maintained a well-regulated state by consistently enhancing the proprioception they received from the playground equipment. It is possible that this well-regulated state supported the increase in verbalizations, the emergence of helping behaviors, working together and turn taking, novel use of the equipment, and an overall positive emotional response to play. Thus, the low incidence of needing to regain regulation in addition to the relation between positive affect and these social interaction and motor skills seems to be consistent with the literature (Meyers & Berk, 2014). Expressions of enjoyment, pleasure, and good feelings have been shown to accompany increases in peer interactions and improved motor abilities (Stanley, Boshoff, & Dollman, 2012).

Motor skills were correlated with a measure of self-esteem (Miyahara & Piek, 2006). Clinically, successful motor interactions are expected to foster an increase in self-confidence so that children will attempt more challenging tasks and therefore continue to build feelings of pride and a sense of accomplishment in their performance.

Results suggest the playground equipment supports the emergence of symbolic play skills. These higher-level play skills were associated with increased language and social skills, novel use of equipment and a positive emotional response while playing.

Confirmation/verification of these occurrences and associations suggests an evidence base for this inclusive playground. A well-designed–sensory-rich playground, such as the one described in this study, supports children's development across multiple domains and can elicit positive behaviors for children with sensory challenges.

Content validity study

The following pilot work assesses the validity of the behavioral coding scheme to quantify specific play and play-related behaviors exhibited on the playground equipment over the course of an occupational therapy treatment program for one child.

Bryan is a 9-year-old boy who received occupational therapy at the STAR Institute. His family reported that he was overresponsive to touch (e.g., wears only one pair of shorts and one shirt, does not wear underwear or socks, and is uncomfortable brushing his teeth) overresponsive to sound. His parents documented concerns with motor coordination (e.g., difficulty riding a bike and problems with writing) and reported problems with self-regulation (e.g., tends to yell when frustrated).

Bryan had a comprehensive occupational therapy evaluation including administration of a standardized motor assessment, standardized parent report measures, and structured and unstructured observations in the clinic. In the clinically significant range (< −2.00 SD) were the (a) gross motor score on the Goal Oriented Assessment of Life Skills (Miller, 2006), (b) parent report of participation in self-care on the Adaptive Behavior Assessment System-II (Harrison & Oakland, 2003), and (c) depression and somatization on the Behavior Assessment System for Children—2 (Reynolds & Kamphaus, 2003). Challenges in sensory modulation were supported by clinically significant scores on the Short Sensory Profile (McIntosh, Miller, Shyu, & Dunn, 1999), which reflected overresponsivity in the auditory and the tactile domains and problems in low energy/weak and movement sensitivity (see Table 7).

The occupational therapy report concluded that Bryan's tactile overresponsivity affected his tolerance for wearing clothes. Bryan's disrupted vestibular and proprioceptive

Table 7. Assessment scores.

Measures	Standardized scales	
	Standard score	*z* score
GOAL *(M* = 100, *SD* = 15)		
Gross motor	52	−3.20
Fine motor	97	−0.02
ABAS (*M* = 10, *SD* = 3)		
Self care	3	−3.33
BASC (*M* = 50, *SD* = 10)		
Depression	72	−2.25
Somatization	70	−2.00
	Raw score	*z* score
SSP (*M* = 0, *SD* = 1)		
Tactile sensitivity	18	−4.67
Movement sensitivity	7	−3.50
Low energy/weak	10	−6.33
Visual/auditory sensitivity	15	−2.00

processing affected his understanding of where he was in space and which way and how fast his body was moving and his ability to judge the appropriate amount of force for activities, all impacting his ability to ride a bike. He was easily frustrated when he was not successful, and his self-esteem and self-confidence were poor.

Bryan participated in twenty 50-minute sessions of occupational therapy, four times a week for 5 weeks. Approximately 60% of his treatment was delivered on the STAR Institute's outdoor playground, where he spent approximately 30 of 50 minutes on the playground; the remaining 40% (20 minutes) was spent indoors on equipment in the sensory gyms.

Four sessions on the outdoor playground were video-taped by a research assistant using a handheld Kodak Play Touch camera with a built-in microphone. The video recordings were

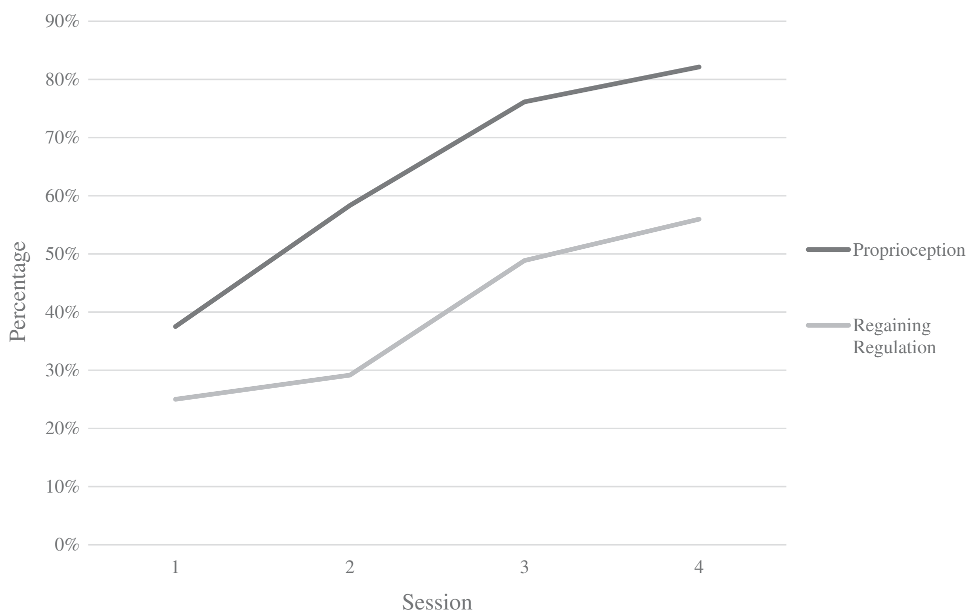

Figure 2. Relation between proprioceptive sensation and regaining regulation across session observations in case study.

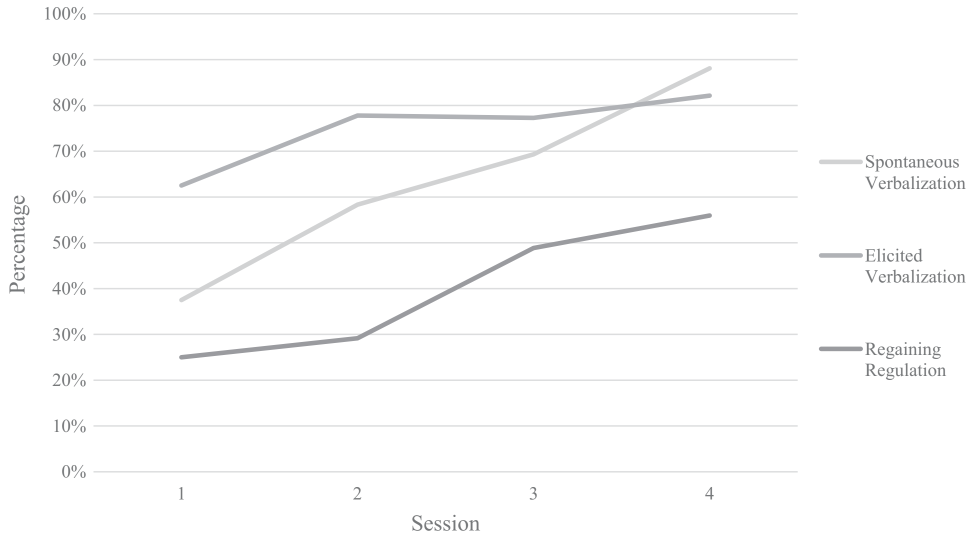

Figure 3. Relation between spontaneous and elicited verbalizations and regaining regulation across session observations in case study.

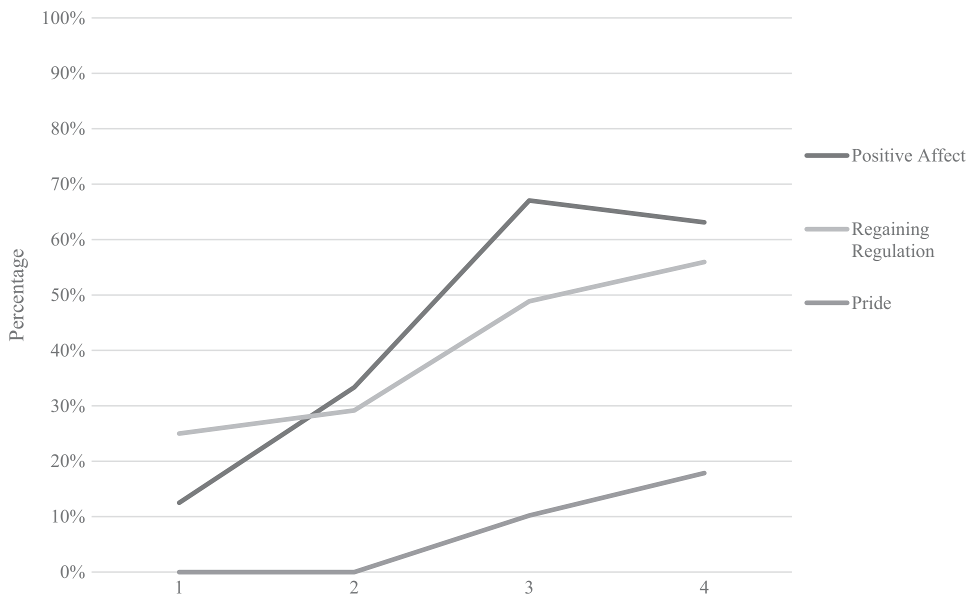

Figure 4. Relations among regaining regulation, positive affect, and pride across session observations in case study.

spaced approximately a week apart. The focus of those analyses was to evaluate the usefulness of the natural playground setting in quantifying changes over time, using the previously described behavioral coding system, and accomplishing the goals set by this child's parents. Event coding was applied to 15-second epochs due to the shorter duration of the sessions.

Figures 2, 3, and 4 display changes in three primary areas: regaining regulation, self-esteem, and positive affect. In particular, Bryan's increase in proprioceptive simulation on equipment such as the Mobius Climber and Roller Slide paralleled the increase in self- regulation (see Figure 2). Bryan's increase in regulation paralleled his elicited and spontaneous verbalization (see Figure 3). In addition, his increase in regulation paralleled changes in his positive affect and demonstrations of pride in his accomplishments (e.g., evidenced by his proclamations, "Look Mom I did this myself" and "Wow look at me way up here"; see Figure 4). Thus, we hypothesize that Bryan's feelings about his accomplishments on the playground and ability to maintain a regulated state were associated with an increase in the joy he experienced from play. Further, his parents reported a reduction in tactile overresponsivity resulting in increased tolerance to wearing new clothes and improved balance, strength, and coordination that are foundational to bike-riding success.

Discussion

We conclude that an intentionally designed, sensory-rich play environment impacts the nature and quality of play behaviors and has a positive effect on the treatment goals of children with sensory challenges. Evidence is provided that our behavioral coding system (Camarata et al., 2015) categorized behaviors related to social interaction, self-regulation, motor skills, and play levels displayed on this specially designed playground. Associations between behaviors observed suggest the importance of proprioception in maintaining a well-regulated state as a mediator for increases in verbalizations, working together, taking turns with peers, expressions of positive emotions, creative use of play materials, and improved play abilities. The playground equipment was effective as part of an overall treatment program for Bryan. The case study elucidates the usefulness of treatment in the naturalistic setting of the playground and provides a means for quantifying the changes observed in the clinic, school, or community setting. The case study presented also shows that therapy in natural settings can foster success.

The importance of play as a public health priority cannot be overstated. There is recognition of the role of play in learning and development (United Nations General Assembly, 1989) and in the prevention of obesity and chronic diseases (Organization, 2007). A playground that promotes access, social interaction, and play between children with and without special needs, both in school and in the community, is critical to achieving this health initiative. We suggest that an inclusive playground serves an important role in supporting this mandate.

This study provides preliminary information related to the role that a sensory-rich playground can have in supporting multiple areas of development and should be considered part of a comprehensive occupational therapy program. Our analysis showed that the most commonly observed behaviors across all equipment were increased verbalizations and positive affect, both of which directly impact social interaction. This is consistent with the recognition in the literature that playgrounds are not just spaces that stimulate different play but rather are environments that should be specifically designed to support sociability (Czalczynska-Podolska, 2014). The playground equipment described in this study can offer support for many aspects of play, regulation, and social-skill development including increased turn taking, working together, and helping behaviors. The association obtained between proprioception and social-interaction behaviors, and the case study, demonstrate that physical play can strongly support well-regulated behavior, which is critical to enhanced social interactions between child and therapist and in social play encounters with peers in the community or in school (Meyers & Berk, 2014).

Promoting the inclusion of children on playgrounds in school and in the community is a topic that has received little attention in the literature (Nabors, Willoughby, Leff, & McMenamin, 2001). The results of this study suggest that the playground described here is accessible to children both with and without disabilities. Several aspects of the playground may have influenced the access and use for our sample. The equipment provided variety, flexibility, and graded sensory and motor challenges. The case study and the correlations obtained between self-esteem (e.g., speech shows pride) and motor planning suggest that access to, and choice of, different levels of achievement can contribute to one's sense of self-confidence and self-worth. In addition, the playground had unique features and used enticing colors and multitextured materials. Finally, the playground was in a well-defined space that provided a sense of safety, freedom, and independence and allowed fluid movement between the pieces of equipment. Children selected the equipment they wanted to interact with and thus developed motor skills, mastery, and self-esteem (Stanley et al., 2012). Parents experienced a sense of choice in either being involved or stepping back and observing. Taken all together, playgrounds that afford the opportunity for sociability and support critical elements of playability across a diverse population of children (Czalczynska-Podolska, 2014) are well-suited for use in pediatric occupational therapy practice.

Limitations

This study was conducted at one therapy clinic and may not be generalizable to other pediatric populations. The sample included children with and without disabilities. Therefore, we are unable to compare the percentage of observed behaviors for each piece of equipment by group. Issues related to videotaping were relatively minimal; there were occasional audio failures, and periodically a child moved out of view of the camera.

Recordings included every piece of equipment, but the study focused only on those pieces that were frequented most often. Additionally, the case study was included to support use of the coding system for measuring change. A more rigorous research design with systematic data collection is needed in the future to provide evidence of treatment effectiveness.

Conclusion

This study makes important contributions to the quantification of play behaviors elicited on the playground. The behavioral coding system employed in this study has potential for documenting the features of specific playground equipment and the benefits of an outdoor playground in future studies of treatment effectiveness in the school or community. This coding system successfully quantified the social-emotional and physical benefits of each piece of playground equipment and was a useful tool for describing change in the case study. Thus, playground design and the specific features of this playground equipment appear to impact use by children with and without special needs.

This research provides useful information for the development of similar environments in child development centers, schools, and community park settings. Intentionally designed, sensory-rich playgrounds with a wide range of developmentally appropriate and varied sensory experiences can support children to attain mastery, self-esteem, and motor skills. The environment also gives children the opportunity for social interaction, positive emotional experiences, and self-regulation to which they might not otherwise be exposed. It is suggested that social growth can occur naturally due to the characteristics and proximity of play elements that contribute to a child's sense of success.

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