Real world behavioral performance: Physical activity, play, and object-related behaviors of toddlers with and without disabilities

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Abstract

Purpose: The purposes of this study were to describe and compare the occurrence and co-occurrence of physical activity, play, and object-related behaviors in toddlers with and without disabilities. Methods: Participants included twenty-three toddlers (twenty-one with typical development and two with disabilities). Direct observation describes the type and level of physical activity, play interactions, and object-related behaviors through video recordings. Results: Typically developing toddlers demonstrated high variability, occurrence, and co-occurrence of all behaviors. Toddlers with disabilities displayed less variability, occurrence, and co-occurrence of several behaviors. Conclusions: Toddlers without disabilities engage simultaneously in physical activity, play and object-related behaviors for about three hours in a typical day. This same level of co-occurrence of behaviors may not be observed for children with disabilities. Intervention providers are encouraged to consider the behaviors of toddlers without disabilities, beyond the findings of this pilot study, as the ‘gold standard’ when implementing technology and intervention strategies for children with disabilities.
Introduction

The focus of physical therapy in early intervention is to enable children to utilize their perceptual-motor skills to explore, learn, and interact with objects and people in the environment. This is based on current theoretical support and disabilities models. Specifically, there has been growing support over the last decade that everyday perceptual-motor experiences are critical for building, shaping, and maintaining cognitive, social, and communicative abilities for individuals across the lifespan and particularly for young children.\textsuperscript{1,2,3} For example, object interaction, sitting, and locomotion experience all advance developmental outcomes across domains and time.\textsuperscript{4}

In addition, there is growing support for interventions that focus on improving activity and participation rather than those working solely at improvements at the impairment level. For example, early powered mobility interventions provide young children the means for early exploration and for enjoyment, socialization, and play.\textsuperscript{5,6} Therefore, we propose that pediatric physical therapy is more than a child performing a target behavior in an isolated, controlled environment. \textbf{Rather, children perform behaviors in a social, natural environment in a manner that encourages them to explore, learn, interact, and participate.} One potential model of how early learning and development is influenced by the interactions amongst action, people, and objects is presented in Figure 1.

There is a growing emphasis on embedding task performance goals of physical therapy in other domains.\textsuperscript{4} However, there is a lack of literature informing therapists about the relationships among physical activity, play interactions, and object use in early development. Physical activity is defined as “…any bodily movement produced by skeletal muscles that requires energy expenditure”\textsuperscript{7} Play interactions are defined as
direct and indirect social interactions that are generally ‘purposeless’, meaning that
interactions occur for their own sake without external considerations.\textsuperscript{8} Previous studies
have assessed exploration behaviors related to specific uses of objects.\textsuperscript{9,10,11} For the
purpose of this study, object use is defined more generally to include a child touching,
holding, or using a portable object with his/her hands. \textit{In reality, very little is known}
about how toddlers with typical development utilize these three categories of behavior in
their typical day.

Researchers in the field of kinesiology have studied physical activity of young
children and typically report physical activity in isolation of other important exploratory
and social behaviors.\textsuperscript{12-15} Studies have primarily focused on describing the relationship of
anthropometric measures such as body composition to the amount and intensity of
physical activity levels of toddlers through self-reported measures,\textsuperscript{14} accelerometry,\textsuperscript{15} or
energy expenditure.\textsuperscript{16} One study that addressed the connection of physical activity to the
social environment found that the presence of larger group sizes were associated with
higher intensity physical activity; however, social and play behaviors were not observed
at the interaction level.\textsuperscript{12} These studies included children without disabilities and do not
shed light onto the potential gap between their behaviors and those of children with
disabilities.

\textit{In contrast,} researchers in the fields of developmental psychology and pediatric
rehabilitation have taken a broader view of physical activity, emphasizing \textit{how} physical
activity is used to participate, explore, and engage in the physical environment and the
social world.\textsuperscript{17-19} There is a rich history within these fields of describing the typical
qualitative development of children’s behaviors and recent research has begun to
quantitatively assess these processes.\textsuperscript{20-22} For example, recent research found that typically developing toddlers walk 2,368 steps and fall 17 times/hour on average.\textsuperscript{23} In recent decades, some research has aimed to describe how these developmental experiences differ for those with disabilities. For example, for two-to three-year olds with disabilities, a greater number of strides per day has been shown to be associated with increased social participation.\textsuperscript{16} In terms of interaction with objects, children with disabilities often interact with objects less with respect to time and variability of behaviors and these early differences in object exploration and information gathering are associated with poorer performance on cognitive tasks such as object discrimination and causal learning tasks.\textsuperscript{24-26}

There is a gap in the literature on comparing physical activity, play, and object-related behaviors for children with and without disabilities within the same study. There were three purposes of the present study: 1) to describe the performance of physical activity, play, and object-related behaviors for toddlers with and without disabilities, 2) to describe the co-occurrence of physical activity, play, and object-related behaviors for toddlers with and without disabilities, and 3) to compare the performance and co-occurrence of physical activity, play, and object-related behaviors for toddlers with and without disabilities. We hypothesized that the behavioral landscapes would differ between toddlers with and without disabilities across the three categories of behavior. We also hypothesized that there would be less co-occurrence of the three different categories of behavior and that behaviors may occur more in isolation. These hypotheses were based on a proposed model (Figure 1) suggesting that the inability to initiate actions to engage, explore, and interact would be related to decreased interaction with people and objects in
the dynamic social context of an early childcare setting. Together, this diminished behavioral performance would be expected to negatively impact early learning and cognitive development.\(^4,27\) We interpret our results within the dynamic systems and grounded cognition frameworks.

**Methods**

Participants included 23 toddlers. 21 were typically developing toddlers (11 boys and 10 girls; \(M\) age = 23.5 ± 4.9 months old). Participants’ parents reported their ethnicities as: Caucasian (48%), African-American (38%), and Asian (14%).

Participants also included two toddlers with disabilities. They will be referred to as “D1” and “D2” to protect their identities. Cognitive function was not measured for either child. We cannot rule out a cognitive influence on each child’s behaviors observed for the present study. D1 was a Caucasian girl (age = 31 months old). Her primary diagnosis is cerebral palsy with secondary diagnoses of microcephaly, hypotonia, and cortical vision impairment/persistent fetal vascular syndrome. She had the ability to interact with cause and effect toys such as those that light up or make sounds. She could also distinguish between different types of animals and colors. She also was able to recognize and respond to different people such as her teacher, physical therapist, and parent/caregivers. She had the ability to roll on the floor. She was able to sit on the floor with close supervision and hands-on support. She was unable to pull to stand or walk (even with use of an assistive technology device). She used a wheelchair throughout the day since it provided the additional support she required. She was unable to independently move the wheelchair from one place to another and required assistance for
this task. She vocalized often but did not say words. Her Gross Motor Function Classification was level IV.

D2 was an African American boy (age = 33 months old). His primary diagnosis is developmental delay with secondary diagnoses of mild hearing loss in the left ear and epilepsy (type: electrical status epilepticus during sleep). Similar to D1, he responded to cause and effect toys, had the ability to categorize objects and responded to the people whom he interacted with on a regular basis. He had the ability to respond to and follow instructions although there were demonstrated behavioral issues related to self-regulation. He was able to independently sit, stand, and walk without assistance. However, his movements were ataxic and he usually required physical and/or verbal prompts and assistance to initiate movements. He vocalized often but said few words—generally names of people or objects. His Gross Motor Function Classification was level I.

Procedure

Approval from the university Institutional Review Board and written parent/guardian consent was obtained prior to data collection. Twenty-one toddlers were video recorded for 20 minutes in each of three contexts: classroom, gym, and playground (60 minutes total per child). D1 and D2 were each video recorded for 60 minutes per context. Video recording occurred from 8:30 a.m. (after breakfast) until 11:30 a.m. (before lunch) at the Early Learning Center, a daycare and preschool that serves approximately 230 children from the broader community. At the time of the study, there were two children with disabilities enrolled in the Early Learning Center and they included in the study.
Data coding was performed for video of each child using momentary time sampling to avoid excessive and unnecessary coding time while obtaining large samples of the data. This means video was broken down into consecutive 15-second intervals where experimenters coded the first 5 seconds of each interval. The protocol was adapted from Brown et al. (2006) who used a 5-second observation and 25-second recording interval. Research has shown that physical activity of young children tends to occur in short, intermittent bouts. Thus, we shortened the recording interval for the present study so that more frequent observations were collected. Behaviors across the three categories of physical activity, play, and object use, were all coded during each 5-second coding interval. This allowed for the description of the co-occurrence of behaviors.

A mutually exclusive coding protocol was used within each assessment of physical activity, play, and object-related behaviors. Thus, within each of the three categories only one behavior was recorded for each observation interval. For example, if during a 5-s observational period a child sat for three seconds and stood for two seconds, only sitting was coded since that behavior was demonstrated a majority of the time. Four observation intervals were coded each minute. This resulted in 5,040 observation intervals for the typically developing sample and 720 intervals for each D1 and D2. To be clear, all data are descriptive and we did not perform statistical analyses to compare behaviors between children with and without disabilities. Interpretations and comparisons of the data will be based on visual analysis. To meet the purposes of the study to describe behavior, we presented results as a percentage of time since this is an easily understood representation of the amount of time behaviors are occurring. Error bars were provided
on the bar graphs for typical children, but since data is presented individually for each child with a disability, a measure of variance is not reported.

Two experienced and trained coders analyzed all video recordings. Inter- and intra-rater reliability of at least 85% agreement was established for each variable on 10% of the video recordings using the ratio of [agreements/(agreements + disagreements)] X100 to establish a percentage of agreement.

Assessment of Physical Activity

Physical activity level was classified according to the Observational System for Recording Physical Activity in Children- Preschool version. This protocol has been used previously to measure physical activity of 2-3 year olds in the early childcare setting. This system classifies physical activity by type and level of exertion (i.e. intensity). Activity type was defined as lying down, crawling, kneeling, sitting, squatting, cycling, standing, walking, and running. Activity level categories include stationary/motionless, stationary with trunk and limb movement, slow-easy, moderate, and fast movement. Slow-easy, moderate, and fast movements require locomotion from one location to another defined as at least three steps in any direction at varying intensity.

Assessment of Play

Play behaviors were defined according to Howes’ Peer Play Scale. This scale includes the following types of play: solitary: a child is more than three feet away from peers and teachers and are not engaged in verbal or physical interaction with anyone; parallel: a child is within three feet of a peer or teacher but with no direct verbal or physical interaction; peer interaction: direct verbal and/or physical interaction with a peer; and teacher interaction: direct verbal and/or physical interaction with a teacher.
Assessment of Object-related behaviors

Object-related behaviors were classified by whether a child was touching, holding, or using a portable object with his/her hands. A portable object included any toy or other piece of equipment that could be moved by a child from one place to another. For example, a pencil, ball, and a bicycle were all considered portable objects if manipulated in any way by a child. Although a bicycle is large, it was still considered a portable object since a child could move it from one place to another. Examples of non-portable objects included stair rails, tables, and playground equipment.

Occurrence of Behaviors

For each assessment, the mean percent of time spent in each behavior is described. Mean percent of time was calculated by the following formula: [Observed intervals for each behavior/total intervals] X 100].

Co-Occurrence of Behaviors

In order to examine the co-occurrence of behaviors, a child’s behavior for each observation interval was classified as a) ‘movement’ if the level of physical activity was coded as any level except for motionless or ‘no movement’ if coded as motionless; b) ‘social’ if the type of play was coded as any type except solitary play and ‘not social’ if coded as solitary play; and c) ‘object-related’ if a child touched, held, or manipulated a portable object in any way and “not object-related” when portable objects were not being contacted.

Results

Physical Activity Type

Toddlers With Typical Development
Toddlers engaged in a variety of types of physical activity almost always associated with some level of play. See Figure 2. Standing (31%), walking (20%), and sitting (20%) occurred most frequently, while 29% of the assessment was spent in all other types of physical activity. At an individual participant level, 17 out of 21 typically developing children engaged in every type of physical activity. Three children did not engage in cycling at any point and one child did not engage in crawling at some point during observation.

**Toddlers With Disabilities**

D1 engaged in limited types of physical activity but this activity was almost always associated with some level of play. See Figure 2. Sitting (53%), standing (29%) and lying down (16%) occurred most frequently, while only 2% of the assessment was spent in all other types of physical activity. This participant was not observed engaging in kneeling, cycling, walking, or running.

D2 engaged in a variety of types of physical activity, except for cycling and, and was almost always associated with some level of play. See Figure 2. Sitting (38%), standing (21%), and walking (19%) occurred most frequently, while 22% of the assessment was spent in all other types of physical activity.

**Physical Activity Level of Exertion**

**Toddlers With Typical Development**

As seen with the types of physical activity, toddlers engaged in a variety of physical activity levels almost always associated with some level of play. See Figure 3. Trunk and limb movements occurred most frequently (47%). Moderate movements
occurred least frequently (5%). At an individual participant level, every child engaged in
every level of physical activity at some point during observation.

**Toddlers With Disabilities**

D1 engaged in limited levels of physical activity but this activity was almost always associated with some level of play. See Figure 3. Trunk and limb movements occurred most frequently (78%). She spent the remaining time (22%) motionless and did not engage in slow-easy, moderate, or fast movements at all.

D2 engaged in a variety of levels of physical activity, except for fast movements, almost always associated with some level of play. See Figure 3. Trunk and limb movements occurred most frequently (67%). He spent the least amount of time in moderate (6%) movements.

**Play**

**Toddlers With Typical Development**

Children engaged in a variety of types of play that were almost always associated with movement. See Figure 4. Children spent on average in the following percent of time in each type of play: parallel (34%), solitary (28%), teacher interaction (27%), and peer interaction (11%). Children were engaged in movement (all physical activity levels except motionless) a majority of the time across all types of play, so play and movement co-occurred most of the time play was performed.

**Toddlers With Disabilities**

D1 engaged in all types of play, with the exception of peer interaction, and her play was almost always associated with movement. See Figure 4. She spent on average in
the following percent of time in each type of play: teacher interaction (76%), solitary 
(12%), parallel (12%), and peer interaction (< 1%).

D2 engaged in a variety of types of play almost always associated with 
movement. See Figure 4. He spent on average in the following percent of time in each 
type of play: parallel (54%), teacher interaction (27%), solitary (17%), and peer 
interaction (2%).

Object-related behaviors

Toddlers With Typical Development

Toddlers were often engaged in object-related behaviors and often these behaviors 
were associated with movement or play. On average, children spent 54% of the time 
engaged in object-related behaviors. Of that 54% of time engaging with objects, 52% of 
the time was also associated with movement or play.

Toddlers With Disabilities

D1 spent limited time engaged in object-related behaviors and when she did, these 
behaviors were not frequently associated with movement or play. On average, D1 spent 
13% of the time engaged in object-related behaviors. Of that 13% of time engaging with 
objects, only 12% of the time was also associated with movement or play.

D2 often engaged in object-related behaviors that were always associated with 
movement or play. On average, D2 spent 59% of the time engaged in object-related 
behaviors and 100% of that time was also associated with movement or play.

Based on an average of 10.2 hours awake/day\textsuperscript{33}, the occurrence of key behaviors 
was translated to the number hours/day, month, and year were translated to provide 
practical relevance and meaning to the results. See Table 1.
Co-Occurrence of all behaviors

**Toddlers With Typical Development**

Toddlers were most often engaged in behaviors in which movement and play co-occurred either with or without objects. See Table 2. Movement and play co-occurred with an object 31% of time and without an object 25% of time. Children spent 77% of time engaged in at least two types of behaviors; movement, play, and/or object-related.

**Toddlers With Disabilities**

D1 most often engaged in behaviors in which movement and play co-occurred primarily without objects. See Table 2. Results indicate that movement and play co-occurred with an object 9% of time and without an object 60% of time. D1 spent 72% of time engaged in at least two types of behaviors; movement, play, and/or object-related.

D2 most often engaged in behaviors in which movement and play co-occurred either with (44%) or without objects (31%). See Table 2. D2 spent 90% of time engaged in at least two types of behaviors; movement, play, and/or object-related. Movement, play, and object related behaviors co-occurred 44% of the time.

**Discussion**

This is the first study to describe the amount, variety, and co-occurrence of physical activity, play, and object-related behaviors of typically developing toddlers and those with disabilities in their natural environment. Two main observations begin to provide a snapshot of the real-world doses of these behaviors. First, toddlers demonstrated a wide variety of behaviors. Second, all behaviors occurred and co-
occurred with high quantity and frequency. Within each of these observations, typically
developing children and those with disabilities engaged differently throughout the day.
Below we synthesize and discuss the results in more detail.

**Toddlers with Disabilities Engaged in Less Variable Physical Activity**

Typically developing toddlers demonstrated a high variability of physical activity.
Almost every child engaged in every possible type of physical activity. Every child
engaged in all levels of physical activity. This behavioral and exploratory variability was
not seen as readily in the toddlers with disabilities.

Each toddler with disabilities demonstrated relatively low variability in their
physical activity behaviors. D1 spent a majority of her time sitting, standing, and lying
down with limited time spent squatting and crawling. She never engaged in kneeling,
cycling, walking, or running. Furthermore, D1 spent a majority of the time (78%)
engaged in trunk and limb movements and did not engage in slow-easy, moderate, or fast
movements at all. D2 also displayed limited variability in physical activity. He spent an
increased amount of time in trunk and limb movements, and no time at all cycling or in
fast movements. This suggests that regardless of level of impairment, variability was
dramatically decreased for toddlers with disabilities.

Dynamic systems theory as applied to behavior provides a theoretical framework
to interpret these results. In this framework, one’s everyday experiences and behaviors
shape his/her future developmental landscape and abilities. A key component of early
dynamic development is the presence of variability. The idea is that a range of complex
and varied experiences allows subsequent behavior to be shaped and optimized based on
characteristics of the environment. The contribution of variability to healthy development
has been demonstrated across domains such as social interactions and play,\textsuperscript{35-37} motor abilities,\textsuperscript{38} and language development.\textsuperscript{39}

**Toddlers With Disabilities Interacted Less With Their Peers**

Key differences emerged between typically developing toddlers and those with disabilities in the occurrence of peer interactions. Typically developing toddlers engaged in peer interaction 11\% of the time compared to less than 1\% and 2\% for D1 and D2, respectively. Based on an average of 10.2 hours awake/day\textsuperscript{33}, this amounts to about one hour of peer interaction per day in typical development compared to about six minutes/day for D1 and 20 minutes per day for D2 (34 hours/month, 409 hours/year in typical development versus three hours/month, 37 hours/year for D1, and six hours/month, 74 hours per year for D2). This result is especially disheartening. At first glance of a toddler classroom, children with disabilities often appear to be right in the middle of the action with their typically developing peers. However, this finding quantifies a serious gap in peer interaction and play behaviors between typically developing toddlers and those with disabilities. A lack of ability to participate in a variety of physical activity behavior likely results in a lack of ability to seek out and initiate play experiences that are so important for social development in early childhood.

According to the grounded cognition perspective, limited function in one domain is likely to affect other domains.\textsuperscript{40} Previous research supports this concept through studies that demonstrate how impairment in one domain affects development in other domains.\textsuperscript{41} For example, children with cerebral palsy often have limited ability to participate in physical activity and have less than optimal social and participation experiences.\textsuperscript{42,43} Another example is children diagnosed with language impairment
demonstrate less peer interaction and more withdrawn social behaviors on the playground compared to typical peers. Results of the present study lend further evidence in support of previous findings.

Toddlers With Disabilities May Combine Their Physical Activity, Play, and Object-Related Behaviors Less Often

Typically developing children and D2’s physical activity, play, and object-related behaviors co-occurred 31% of the time compared to only 9% for D1 and 44% for D2. This finding highlights the high co-occurrence of behaviors for typically developing toddlers and how this co-occurrence is disrupted for a child with significant physical impairments associated with cerebral palsy. Based on an average of 10.2 hours awake/day, this amounts to co-occurrence of these behaviors about three hours/day in typical development, one hour/day for D1, and four hours/day for D2 (96 hours/month, 1153 hours/year in typical development versus 28 hours/month, 335 hours/year for D1 and 136 hours/month, 1637 hours/year for D2).

Grounded cognition places an emphasis on the embedded and interconnectedness of cognitive, social, language, and motor experiences. The behaviors associated with these experiences continually shape development and are occurring constantly throughout daily life. The current study provides further evidence for the relatedness of developmental domains at a micro-level; real-time embedding of physical activity, play, and object-related behaviors.

Application to Clinical Interventions

We suggest that the quantity and frequency of behaviors of typically developing children be considered a general ‘gold standard’ to compare the effectiveness of
technology and training in children with disabilities. The results of this pilot study begin to describe and quantify these behaviors. Therapy should focus on improving a child’s abilities, providing supports, and removing environmental and cultural barriers to maximize physical activity, social interaction, and play. This study suggests that typically developing children engage in a variety of behaviors and those behaviors occur and co-occur in a high quantity and frequency during daily life. Other recent research confirms a high level of intensity and variability for typical play throughout the first two years of life and that the amount and variability of play is less for infants and toddlers at risk for or with disabilities.46

Given this information and the confirmation that typical behavioral development requires an intense amount of practice, clinicians should focus on ways to use technology and training to maximize behavioral performance in children with disabilities both within and outside of therapy sessions. These data suggest that education aimed at changing everyday behaviors and interactions is likely the most important task of pediatric physical therapists. This can involve changing how young children are handled and positioned, changing play and social interactions with caregivers and children, and adapting everyday tasks to promote performance of key behaviors.47-49 Novel, inexpensive technologies that can enter the real world may also be increasingly helpful in increasing the amount of behavioral performance between therapy sessions to enhance early learning and development. For example, modified ride-on cars may be used to promote mobility and interaction with people and objects in young children with disabilities.5,6 The associated experience with this self-initiated mobility may also have broad benefits for early development and cognition (Figure 1). Affordable exoskeletons50 and ‘smart garments’
are also becoming available that have potential to promote behavioral performance, play with objects, and interaction with peers.51-53

Limitations

A limitation of the current study includes the descriptive study design that does not allow for causal inferences for differences observed between typically developing children and those with disabilities. Another limitation is the low sample size (n = 2) of children with disabilities and results should be interpreted cautiously and without generalization to larger populations. Also, we did not formally assess cognition for the children in this study so it is not clear if/how cognition impacted children's physical activity. It is possible that children with severe cognitive issues may engage differently in physical activity, play, and object-related behaviors. This question can be addressed in future research by including a larger sample size of children with a variety of cognitive and physical impairments to determine how these impairments may be a confounding variable in engaging in physical activity, play, and object-related behaviors. Future research should continue to study typically developing toddlers to establish high expectations of the variety, occurrence, and co-occurrence of behaviors to inform the design and implementation of technology and intervention strategies for children with disabilities.

Future research

There are many potential directions of future research. The current study is descriptive and provides basic information regarding the variety, occurrence, and co-occurrence of physical activity, play, and object-related behaviors. Future studies that include a larger sample size would allow for statistical analyses to provide further
understanding to the relationship amongst these behaviors and test more specific hypotheses related to providing technology and training to children with disabilities. Also, it is important to examine how children engage in different behaviors across contexts. For this study, all observations were combined across the classroom, gym, and playground. It is important to examine these behaviors in the home and community contexts to further understand the daily life of toddlers. For example, car rides, trips to the grocery store, meals, and bedtime routines are all important aspects of daily life and likely a gap exists between typically developing children and those with disabilities.

Conclusions

A recent position statement in Pediatric Physical Therapy states “The physical therapy profession will transform society by optimizing movement for all people of all ages to improve the human experience”.54 This suggests that the quantity and frequency of movement should be optimized on an individual basis. Understanding the intensity of behavioral practice that occurs in typical development, for instance that physical activity, play, and object-related behaviors co-occur 4.3 hours/day, 133 hours/month, and almost 1,600 hours per year, reminds early intervention professionals of the high level of accumulated experience that intervention should target. Our pilot data highlight that there may be a large gap in the amount and variability of physical activity, play, and object-related behaviors for children with motor disabilities. The goal for early intervention should be to use educational techniques and rehabilitative technologies to effectively bridge this gap and optimize everyday physical activity, play, and interaction with people and objects. In order to reach this goal, early intervention providers will likely need to embed treatment within dynamic, social settings such as classrooms, playgrounds, and
other community spaces where children typically spend their day exploring rich and
dynamic environments.
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Figure Legends:

Figure 1. Proposed model demonstrating how self-initiated actions, interactions with people, and interactions with objects work together to promote learning and global development in childhood. These behaviors often co-occur in development and performance of any one type of behavior likely increases performance of the others.

Figure 2. Association of physical activity types and play. Percent of time spent in each type of physical activity with and without play behavior.

Figure 3. Association of physical activity levels and play. Percent of time spent in each level of physical activity with and without play behavior.

Figure 4. Association of types of play to levels of physical activity. Percent of time spent in each type of play behavior, associated with each level of physical activity.
Figure 3

Association of Physical Activity Levels and Play

Levels of Physical Activity

Percent of Time

Motionless

Trunk and Limb Movements

Slow-Easy

Moderate

Fast
Figure 4
Association of Types of Play to Levels of Physical Activity

- Fast
- Moderate
- Slow-Easy
- Trunk and Limb Movements
- Motionless

Types of Play:
- Solitary Play
- Parallel Play
- Peer Interaction
- Teacher Interaction

Percent of Time

(Chart showing data for different types of play with varying heights and bars indicating physical activity levels.)
Table 1. Description (in percent of time) of how toddlers with and without disabilities perform physical activity, play, and object-related behaviors. Based on an average of 10.2 hours awake/day for two-year-olds\textsuperscript{33}, the percentage of time spent in key behaviors were translated to the number of hours/day, month, and year expected for children with and without disabilities. NOTE: Locomotion includes crawling, walking, and running.

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<tr>
<td><strong>D1</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Locomotion</td>
<td>1%</td>
<td>.1</td>
<td>3</td>
<td>37</td>
</tr>
<tr>
<td>Motionless</td>
<td>22%</td>
<td>2</td>
<td>68</td>
<td>819</td>
</tr>
<tr>
<td>Trunk &amp; Limb</td>
<td>78%</td>
<td>8</td>
<td>242</td>
<td>2902</td>
</tr>
<tr>
<td>Peer Interaction</td>
<td>1%</td>
<td>.1</td>
<td>3</td>
<td>37</td>
</tr>
<tr>
<td>Object-Related</td>
<td>13%</td>
<td>1</td>
<td>40</td>
<td>484</td>
</tr>
<tr>
<td><strong>D2</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Locomotion</td>
<td>21%</td>
<td>2</td>
<td>65</td>
<td>781</td>
</tr>
<tr>
<td>Motionless</td>
<td>8%</td>
<td>1</td>
<td>25</td>
<td>298</td>
</tr>
<tr>
<td>Trunk &amp; Limb</td>
<td>67%</td>
<td>7</td>
<td>208</td>
<td>2493</td>
</tr>
<tr>
<td>Peer Interaction</td>
<td>2%</td>
<td>.2</td>
<td>6</td>
<td>74</td>
</tr>
<tr>
<td>Object-Related</td>
<td>59%</td>
<td>6</td>
<td>183</td>
<td>2195</td>
</tr>
</tbody>
</table>
Table 2. Description (in percent of time) of the co-occurrence of physical activity, play, and object-related behaviors for toddlers with and without disabilities.

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Typically Developing</th>
<th>D1</th>
<th>D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Activity, Play, Object-Related</td>
<td>31%</td>
<td>9%</td>
<td>44%</td>
</tr>
<tr>
<td>Physical Activity and Play</td>
<td>25%</td>
<td>60%</td>
<td>31%</td>
</tr>
<tr>
<td>Physical Activity and Object-Related</td>
<td>14%</td>
<td>1%</td>
<td>8%</td>
</tr>
<tr>
<td>Play and Object-Related</td>
<td>7%</td>
<td>2%</td>
<td>7%</td>
</tr>
<tr>
<td>Play Only</td>
<td>10%</td>
<td>18%</td>
<td>2%</td>
</tr>
<tr>
<td>Physical Activity Only</td>
<td>9%</td>
<td>7%</td>
<td>9%</td>
</tr>
<tr>
<td>Object-Related Only</td>
<td>2%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>No Observed Behaviors</td>
<td>2%</td>
<td>2%</td>
<td>0%</td>
</tr>
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</table>