Developmental Dyspraxia

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Developmental dyspraxia is a neurologically based developmental disorder characterized by a deficit in praxis. Dyspraxia is the inability to choose, plan, sequence, and perform gesture movements in the absence of primary sensory or motor impairments in otherwise normal children. It is thought to affect 6% of children. Dyspraxia is not a simple disorder and may be part of the spectrum of several other specific learning and developmental disorders in children. These include specific language disorders, dyslexia, attention-deficit hyperactivity disorder, high-functioning autism, tic disorders, and genetic disorders that include Williams syndrome and Turner’s syndrome.

Dyspraxia is seen in cerebral palsy, traumatic brain injury, and epilepsy. Despite its prevalence in neurologic disorders, dyspraxia is often undiagnosed. Dyspraxia is not likely to be a specific chief complaint, and a high index of suspicion is needed to make the diagnosis. In adults, apraxia is seen after central nervous system insults. It is an impairment of the execution of a learned movement in response to a stimulus that would normally elicit the movement, subject to the condition that the afferent and efferent systems involved are intact, and in the absence of inattentiveness or lack of cooperation.

Normal Development of Praxis

Normal praxis follows a developmental continuum with stages characterized by different sets of skills (Table 40-1). The complexity of skilled movements observed at different ages suggests that praxis represents a higher cortical function. Several constructional abilities like assembly, copying, drawing, and other forms of praxis are listed in Table 40-1.

Clinical Signs: Index of Suspicion

The performance of learned motor tasks involves the ability to complete many of the child’s activities of daily living. Presenting symptoms may be isolated and include problems with motor control when learning to ride a bicycle, reproducing drawings, or playing with constructional toys, such as puzzles or building blocks (eg, Lego®), and coordination difficulties (eg, learning to tie shoelaces or doing up buttons, and writing). Here is a brief breakdown of findings in children with dyspraxia by age:

Between 0 and 3 years of age:
• Irritability and feeding problems
• Delay in developmental milestones
• Bottom shuffling instead of the crawling stages
• Avoidance of tasks that require good manual dexterity

Between 3 and 5 years of age:
• Difficulty with movements of the mouth and tongue
• Messy eating, prefers to eat with their fingers, frequently spills drinks
• Not playing with constructional toys, such as puzzles or building blocks (eg, Lego®)
• Difficulty with left/right orientation, laterality still not established
• Inability to pedal a tricycle, ride a bicycle, play ball games or sorting games
• Lack of pretend play (such as using a spoon to stir an empty bowl), little interest in “dressing up” or in playing appropriately in a doll house
• Limited concentration, tasks often left unfinished
By 7 years of age:

- Coordination difficulties in dressing (e.g., learning to tie shoelaces or doing up buttons)
- Holding a pencil, drawing, or copying a drawing, using scissors, picking up small objects, coordinating knife and fork
- Impaired control of eye movements (necessary for reading) or hand–eye coordination (necessary for writing)
- Limited concentration and poor listening skills
- Slow completion of class work

**Classification**

*Ideomotor dyspraxia* is an impairment in the selection, sequencing, and spatial orientation of a requested movement involved in gestures such as saluting, waving goodbye, or playing pretend actions (such as pantomiming the combing of one’s hair with an imaginary comb).

In some cases the child cannot gesture normally to command but performs well spontaneously (automatic-voluntary dissociation).

*Ideational dyspraxia* applies only to impairments of limb movement and denotes a failure to carry out a sequence of movements. It is the inability to demonstrate how to use a common object such as a toothbrush; when writing and sending a letter, the child may seal the envelope before inserting the letter.

*Constructional dyspraxia* refers to impairment of any type of performance in which parts are put together or articulate to form a single entity or object (assembling blocks to form a design or drawing four lines to form a square or a diamond). It is characterized by misalignment of lines, overwriting when drawing designs, lack of connection between lines, and multiple small strokes when creating a longer line.

Dressing *dyspraxia* is an inability to perform the relatively complex task of dressing. Preschool children who cannot put on a coat are suffering from dressing apraxia.

*Verbal dyspraxia* indicates that the child has difficulty with volitional control of nonspeech movement. It is an expressive disorder in which the child is extremely nonfluent.

**Developmental Dyspraxia and Visuospatial Ability**

Dyspraxia is defined by exclusion and the neurologic examination will determine whether the abnormal motor performance is accounted for by nondyspraxic motor, sensory, or cognitive disorders. The presence of subtle or elemental motor defects does not exclude dyspraxia, but one must interpret the result of praxis testing in light of the knowledge gained from the neurologic examination. Children with perceptual-motor dysfunction, such as synkinesias, may have normal gesture ability. The perceptual-motor dysfunction may not interfere with the conceptual development of skilled movements but might result in clumsily formed gestures. In contrast, perceptual-motor integrative problems during the early years of development might lead to permanent abnormalities in the concept required to perform skilled movements or gestures.

The type of errors made by children with dyspraxia may help define the nature of the defect. Transitive (open a door with a key) and intransitive (salute) gestures to verbal command and imitation can be used to exclude comprehension deficits. Dyspraxia errors can be categorized as content or production errors. Content errors could include related or unrelated responses. An example of related response would be pantomime playing of a trumpet when playing a guitar was requested. An unrelated response

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**TABLE 40-1. Normal Development of Praxis**

<table>
<thead>
<tr>
<th>Age (y,m)</th>
<th>Assembly</th>
<th>Drawing</th>
<th>Autonomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,11</td>
<td>Put block in cup</td>
<td>Scribble</td>
<td>Drink from cup</td>
</tr>
<tr>
<td>1,03</td>
<td>Build tower of 2 cubes</td>
<td>Supinate pencil grasp, recognize shapes</td>
<td>Use spoon, fork</td>
</tr>
<tr>
<td>1,08</td>
<td>Build tower of 4 cubes</td>
<td>Imitate vertical line</td>
<td>Remove garment</td>
</tr>
<tr>
<td>1,11</td>
<td>Build tower of 6 cubes</td>
<td>Copy</td>
<td>Brush teeth with help</td>
</tr>
<tr>
<td>2,04</td>
<td>Build tower of 8 cubes</td>
<td>Copy O, pencil grasp: tripod</td>
<td>Put on clothing</td>
</tr>
<tr>
<td>3,00</td>
<td>Copy 3-cube bridge</td>
<td>Copy +</td>
<td>Wash, dry hands</td>
</tr>
<tr>
<td>3,03</td>
<td>Copy 4-cube train</td>
<td>Draw person (3 parts)</td>
<td>Put on T-shirt</td>
</tr>
<tr>
<td>4,02</td>
<td>Copy 3-cube steps</td>
<td>Copy O, (demonstrated)</td>
<td>Prepare cereal</td>
</tr>
<tr>
<td>4,06</td>
<td>Copy 4-cube steps</td>
<td>Copy Draw person (3 parts)</td>
<td>Brush teeth, no help</td>
</tr>
<tr>
<td>5,02</td>
<td></td>
<td>Copy</td>
<td>Dress, no help</td>
</tr>
<tr>
<td>5,03</td>
<td></td>
<td>Copy O, (demonstrated)</td>
<td></td>
</tr>
</tbody>
</table>

Adapted from Denver developmental scale and Egan visual-motor-integration test.
would be when requested to use scissors, the child pantomime plays a trumpet.

Production errors include spatial and temporal errors. Spatial errors can be subdivided into postural, orientation, and movement errors. Postural errors occur when a child uses part of the body as a tool (eg, when pantomiming the use of scissors, the child uses fingers as blades). Orientation errors occur when a child demonstrates incorrect orientation; when pantomiming cutting a piece of paper in half with an imaginary scissors, the child orientates the scissors laterally or fails to maintain it in a consistent plane. Movement errors occur when a child is instructed to perform a specific movement (eg, a salute), but the child performs the wrong gesture. Temporal errors include delayed or very slow movements.

In children, there is often a prevalence of a chief complaint of impairment on a construction task or visuoconstructional ability such as drawing or object assembly, and 3-dimensional constructional difficulties (block design). There is an important relationship between visuoperceptive and visuoconstructive disabilities. The child may present with pure constructional dyspraxia or with visuoconstructional dyspraxia. In most cases of dyspraxia, a deficiency on a construction task such as spontaneously drawing a geometric figure or with performance of a task such as copying a block design will not be caused by a visuoperceptual disorder. But impaired visuospatial ability or visuoconstructional dyspraxia may create similar difficulty with both copied and spontaneous drawing, or the child may perform better with spontaneous than copied drawing. The most frequently observed constructional disorder is usually elicited on drawing tasks. The provision of a model for copying improves performance of subjects with pure constructive dyspraxia but worsens performance of children with visuospatial dyspraxia or visuospatial disabilities (Table 40-2). The results obtained on tests of nonverbal intelligence have a very high predictive power with regard to constructional dyspraxia, giving a discrepancy between verbal and performance scores.

### Testing

Dyspraxia symptoms are strongly dependent on the age of the child. A wide variety of testing material is requested. Basic and specific tests are required. At first, we must be attentive to the history and to possible etiologies (eg, prematurity, meningitis) because this information will drive the type of testing required to fully characterize the dyspraxia. Quantitative tests are used to assess the intelligence quotient (IQ) score, evaluate visuospatial and constructional abilities, evaluate graphics abilities, and characterize gestural abilities.

In most cases, IQ scores may be characterized by a marked discrepancy between verbal IQ and performance IQ (18 points or more). But this discordance cannot be observed in children with both developmental language disorders and dyspraxia. The general configuration reveals a number of difficulties on tasks involving complex visuospatial organizational skills within the context of somewhat better performance on activities involving some verbal and auditory-perceptual abilities. More specifically, differences are observed in each scale: In the verbal scale, lower scores in math are typical. In the performance scale, there is almost always failure in the block design subtest and sometimes in the object assembly subtest. Poor performance on the coding subtest may indicate an impairment of gestural ability (delays before initiating a movement, slowness of execution, slow handwriting) or

<table>
<thead>
<tr>
<th>Tests</th>
<th>Constructional Dyspraxia</th>
<th>Visuoconstructional Dyspraxia</th>
<th>Visuospatial Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing/puzzles</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Verbal order</td>
<td>Deteriorated</td>
<td>Improved</td>
<td>Improved</td>
</tr>
<tr>
<td>Copying</td>
<td>Improved</td>
<td>Deteriorated</td>
<td>Deteriorated</td>
</tr>
<tr>
<td>Kohs block design</td>
<td>Poor</td>
<td>Poor</td>
<td>Variable</td>
</tr>
<tr>
<td>Model</td>
<td>Improved</td>
<td>Not improved</td>
<td>Not improved</td>
</tr>
<tr>
<td>Verbal explanation</td>
<td>Improved</td>
<td>Improved</td>
<td>Variable</td>
</tr>
<tr>
<td>Block design (WISC-III)</td>
<td>Poor</td>
<td>Poor</td>
<td>Variable</td>
</tr>
<tr>
<td>Object assembly (WISC-III)</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Mazes (WPPSI-R)</td>
<td>Normal</td>
<td>Variable</td>
<td>Poor</td>
</tr>
<tr>
<td>Rey Complex Figure</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>d2 test</td>
<td>Normal</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Frostig</td>
<td>Variable</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Space positions</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Space relations</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
</tbody>
</table>

These tasks are used to analyze the relations between constructional dyspraxia, visuoconstructional dyspraxia, and visuospatial disturbances in children. Adapted from Mazeau, 2003.
difficulty in complex hand-eye coordination. The subtest Maze requires the subject to draw paths through mazes within the limit and provides a measure of planning; these skills may be impaired in children with visuoconstructual dyspraxia, but not in children with pure dyspraxia. Children with visuospatial deficit have also great difficulty on the Maze test. Nevertheless, it is important to account for individual variations.

**Evaluation of Visuospatial and Constructional Abilities**

Several tests are available for visuospatial evaluation. They evaluate abilities to detect, analyze, and interpret orientations. For example, the Frostig test (to test space relations and space positions), or Brickenkamp’s barrage test d2 (to assess sustained attention and visual scanning ability) can be used. For the constructional evaluation, we observe children making constructions with blocks (Kohs block design test) or completing the stick construction test (Goldstein-Sheerer Tests).

**Evaluation of Graphic Abilities**

Clinically, we observe graphic quality and writing speed. Generally, spontaneous drawings are poorly structured. A test of visual-motor integration (VMI) is also useful in assessing visuoconstructual abilities. First, classic evaluation allows assessment relative to peers. Second, the observation may show difficulty with obliques, absence of global planning, piecemeal strategy with detail juxtaposition, and multiple sheet rotations with badly spaced organization. Bender’s test, which involves the reproduction of geometric forms, allows the evaluation of orientation, angles, and relative position indices.

**Evaluation of Gestural Abilities**

There are tools available to assess gestural abilities. For example, we use the Praxic Abilities Task (Hill), the hand movements subtest from the Kaufman Assessment Battery for Children (K-ABC), the Assess Neuropsychological Development in Children (NEPSY), or the Imitation of gesture without significance test (Test d’imitation de gestes Bergès and Lézine). Complex hand–eye coordination can be measured with the Grooved Pegboard Test.

In conclusion, all these tests allow the examiner to make a definitive diagnosis and to formulate a specific individualized treatment plan. In addition, global neuropsychological evaluation is performed to assess strengths and weaknesses in each child. It is also important to have several tests showing a deficit, that is to say, consistency of results, before giving a diagnosis. This is even more important with young children. We must always remember that children are individuals and their abilities vary over time and in comparison with each other.

**Treatment**

Dyspraxia can be a lifelong concern. Treatment is designed to promote compensatory skills. Neuropsychologists, occupational therapists, and speech therapists are key to management. Caregivers and teachers should also participate in treatment by helping children divide routines in stages (for example, to get dressed: I must put on my panties, put on my socks, put on my T-shirt, with the tags close to me) and to also assist the child with gestures (for example, do the forms of letters). They can also help with strategies to enhance activities of daily living: preference of Velcro over shoelaces, making an imaginary ball between shoes (half in right and half in left, so the union of the two shoes makes a ball). Failure in drawing or in geometry can also be helped by breaking down the task into several stages. These strategies promote independence and increase self-esteem. Because dyspraxia can take an emotional toll on children, caregivers and teachers must be attentive to cues.

**Case Studies**

**Case Study #1—Loic**

An 11-year-old named Loic had difficulty with puzzles and building blocks, delay in riding a bike, and problems with dressing, tying shoes, and using utensils. Past medical history was noncontributory. Results of testing showed: VIQ 98 (math subtest: 8) and PIQ 65 (maze subtest: 1, block design subtest: 5, and object assembly subtest: 5). Loic had more difficulty with copying than with writing from memory (Figure 40-1A). He had poor handwriting and slow writing, difficulty in visual sweeping, deficits in the Barrage d2 testing (errors with orientations), difficulty with embedded drawn, and a deficient Rey Complex Figure test (Figure 40-1B). Loic was diagnosed with visuoconstructual dyspraxia.

**Case Study #2—Raphael**

A 9-year-old named Raphael had similar presenting complaints as Loic (see above). Past medical history was noncontributory. Results of testing showed: VIQ 108 and PIQ 82 (geometric figure subtest: 2). He had poor handwriting and slow writing, difficulty in visual sweeping, deficits in the d2 Barrage testing (errors with orientations and lines jumped), problems with imitation of gestures without significance, and a deficient Rey Complex Figure test.
In this case study, the child found it more difficult to draw from memory than to copy (for example, Figure 40-2). So, visualization helped him perform the task. Raphael was diagnosed with constructional dyspraxia.

Acknowledgments

We are indebted to Ms. M. Kennedy who reviewed this chapter.

Suggested Readings


Practitioner and Patient Resources

Dyspraxia Foundation (DF)
8 West Alley
Hitchin
Hertfordshire SG5 1EG
United Kingdom
http://www.dyspraxiafoundation.org.uk

DF is a UK charity that exists to help people understand and cope with dyspraxia. The organization is a resource for parents, for teenagers and adults who have the condition, and for professionals who help all of them. You can use this site to find out what dyspraxia is, to find out how joining the Dyspraxia Foundation could help you, to get practical information about coping with daily life and what you can do as a parent, and to find links to other useful sites.

