A praxia is defined as a disorder of purposeful skilled movement that cannot be attributed to sensorimotor dysfunction (i.e., weakness, tremor, spasticity, loss of joint position sense) or comprehension deficits. While apraxia is the impairment, it refers to a loss of the skill known as praxis. Characteristics of the praxis system include the following:

1. It is most often lateralized to the left hemisphere.
2. It serves to store skilled motor information for future use.
3. It facilitates interaction with environment.
4. It provides a processing advantage so that new planning is not required each time an activity is started.
5. It can be described by a two-step process that results in execution of a purposeful activity:
   (1) Conceptual/ideation: provides information related to the overall concept and purpose of the task, information related to what to do, an overall plan to engage in the task, sequence of actions, and knowledge related to tool use. If an adult person without neurologic impairment is placed in front of a meal tray that person has an understanding of the purpose and goal of the task, understands which utensils to choose, understands how to use them, and can sequence the steps of the task to completion.
   (2) Production/planning: refers to knowing how
to perform the task, the implementation of a movement sequence including timing and spatial components of movement. A typical person can plan and program movements to open containers, cut with a knife, scoop or stir with a spoon, manipulate a fork in the hand, and place food in the mouth.

Execution of the task is the output of praxis and relies on sufficient sensory and motor skills to execute the task—enough strength to lift the hand to the mouth, no influence of tremor while drinking, sensory feedback for a piece of bread in your hand. A breakdown of the praxis skills (conceptual or production errors) results in apraxia, whereas a breakdown in execution is attributed to a primary motor or sensory deficit. Where the breakdown in function occurs (conceptual and/or production and/or execution) dictates the use of different intervention techniques.

BACKGROUND

One of the frustrations of reviewing the literature related to apraxia is the various definitions and terminology used to describe apraxia. These differences further emerge based on the country and discipline of the authors. Even a cursory review reveals the use of multiple terms related to apraxia, such as ideational, motor, constructional, dressing, ideomotor, kinetic, conduction, limb-kinetic, swallowing, oral, bucco-facial, respiratory, conceptual, frontal, axial, and oculomotor. Many of these terms are describing the same impairment; some are used to specify the body part affected by the impairment, whereas several are subcomponents of others. Two of the terms, dressing and constructional apraxia, may be misleading and confusing. Although commonly described in the past, recent analysis of those living with these particular subtypes of apraxia has revealed the deficits may be better described as a visuospatial deficits secondary to right hemispheric lesions as opposed to a praxis deficit. For, example, to dress efficiently and independently requires one to be able to interpret spatial relations so that clothing is oriented to the body correctly. The continued use of these terms as a descriptor of apraxia must be questioned. The decision as to which terms to use in this chapter was based on a review of the literature and an attempt to be consistent with the rehabilitation literature that focuses the discussion of apraxia on how the different types are related to functional performance.

Ideational Apraxia

Apraxia that is related to errors in content during performance is termed ideational apraxia and is defined as a breakdown of knowledge of what is to be done to perform—results from loss of a neuronal model or a mental representation about the concept required for performance; lack of knowledge regarding object/tool us. It also refers to sequencing of activity steps or use of objects in relation to each other. Some authors prefer the term conceptual apraxia as opposed to ideational apraxia particularly to focus on the problems related to tool use. During functional observations in naturalistic settings, impaired use of objects and problems related to the sequence of the task are often observed together, so for this chapter ideational and conceptual apraxia will be used synonymously.

Árnadóttir gives the following clinical examples of ideational apraxia: The person does not know what to do with toothbrush, toothpaste, or shaving cream; uses tools inappropriately (e.g., smears the toothpaste on face); and sequences activity steps incorrectly so that there are errors in end result of tasks (e.g., puts socks on top of shoes) (Figure 5-1).

The person does not know what to do related to the task at hand and has an overall loss of the concept. Clinical observations related to errors during task performance may include the following:

- Uses familiar objects/tools incorrectly: eats soap, toothbrush is used as hairbrush, attempts to place sock on head, attempts to maneuver wheelchair by pulling on the arm rest, chews on a washcloth, brings knife to mouth, does not understand what to do with a cane or walker.
- Difficulty relating objects to each other such as the relationship between a toothbrush and paste. This may occur in the presence of a person being able to name the objects correctly.
- Tasks requiring use of multiple objects and that are multistep are particularly difficult, for example, a morning grooming routine, self-feeding, or meal preparation.
- Does not use object when it is culturally appropriate and available: uses finger to brush teeth, eats with fingers when it is inappropriate, stirs coffee with finger.
- Performance latency (continues the task very slowly)
- Does not initiate the task or does not perform at all.
Organization and sequencing deficits such as misordering or missing steps of the task resulting in an incorrect end product: washing without water, attempting to drink milk without opening the container, underwear is placed over pants, disorganized workspace.

Perseveration: making the same mistakes over and over and perseverating on components of a task that was just completed.

The conceptual errors and resulting clinical behaviors described here are observed at the task level as opposed to the movement level. Clinicians...
must differentiate between ideational apraxia and other deficits during the clinical reasoning process. Comprehension must be considered and controlled because apraxia and aphasia may coexist. Using the person’s own tools or objects and performing a purposeful task in the appropriate naturalistic environment and at the appropriate time of day decrease the need for substantial verbal directions. Apraxia/aphasia relationships are further described later. In addition, primary visual deficits (such as acuity) and higher order visual functions (such as visual agnosia or the inability to recognize visual input) must also be considered (see Chapters 3 and 7).

Allowing the person to attempt to recognize and use objects appropriately through touch will help determine the cause of the error. For example, during a grooming evaluation at the sink, a man with visual agnosia will not be able to recognize objects through the visual system leading to him reaching out for a comb when in fact the goal of the task is to shave. He will be able to recognize the mistake as he identifies the object via the tactile system. If praxis is intact, he will either use the comb as a comb or put the comb down and continue to search for the razor. If ideational apraxia is the problem, he may use the comb as a razor. Processing sites are also different for apraxia (frontal and parietal lobe dysfunction) and visual agnosia (occipital lobe dysfunction) and this information, if available, can be used for clinical reasoning. Finally, a person with severe ideational apraxia may not perform at all (i.e., sit at the sink without doing anything). This also may be a problem related to initiation or motivation. Verbally or physically cueing the person to start the task, for example, initiating the task by hand-over-hand guidance, may result in the person “taking over” and completing the task without difficulty. This would not be consistent with ideational apraxia because problems most often would persist throughout the task. The areas of the cortex that, if damaged, may result in conceptual errors include the prefrontal and premotor cortex and the left inferior parietal lobe.

**Ideomotor Apraxia**

While ideational apraxia is a result of a breakdown in the conceptual praxis system, **ideomotor apraxia**, synonymous with motor apraxia, is a disorder of the production praxis system and may be defined as the loss of access to kinesthetic memory patterns so that purposeful movement cannot be produced or achieved because of defective planning and sequencing of movements, even though idea and the purpose of task is understood.

The person knows what to do related to the task at hand and has the overall concept of what to do. If language is intact and the person is questioned, he or she can explain the purpose of the task at hand. Instead, he or she cannot program, plan, or produce the movements necessary to accomplish the task despite having the sensory and motor skills to execute the task. Clinical observations related to errors during task performance may include the following:

- Difficulties related to motor planning in general, resulting in awkward or clumsy movements
- Difficulties when planning movements to cross the body’s midline. For example, difficulty

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*From references 2, 3, 4, 31, 34, 36, 43, and 54.*
in adjusting the grasp on a hairbrush when moving it from one side of head to other to turn the bristles toward the hair.\textsuperscript{3,4}  
- Difficulty orienting the upper extremity or hand to conform to objects such as picking up a juice bottle with the radial side of the hand down or via picking the bottle up with a pinch grip on the lip of the bottle instead of a typical cylindrical grip on the base  
- Inflexible and static hand patterns such as not being able to manipulate coins out of the palm of the hand to insert them into a vending machine or difficulty holding objects appropriately  
- Difficulty sequencing movements such as the sequence to get out of bed or off the floor, or sequencing complex upper limb movements such as picking up the phone and lifting it to the ear  
- Spatial orientation and spatial movement errors such as moving scissors laterally instead of forward or not spatially moving feeding utensils correctly\textsuperscript{34}  
- Difficulty coordinating two or more joints, such as coupling the shoulder and elbow movements for cutting.\textsuperscript{34} In general, the more joints involved in the tasks the more degraded the motor planning. In other words, an increase in degrees of freedom worsens the clinical presentation (Figure 5-2).  
- Difficulty timing movement such as a delay in initiation of movement, pauses, or difficulty related to the speed of movement.  
- Poor gesture production ability, particularly when gesturing the use of an object (transitive gestures)  
- Using a body part as an object when asked to pantomime use of an object. Usually, used as a diagnostic screen for ideomotor apraxia  
- Movements are imprecise. The production errors and resulting clinical behaviors described are observed at the movement level (Figure 5-3). Clinicians must differentiate between ideomotor apraxia and other deficits during the clinical reasoning process. As discussed, comprehension must be considered and controlled for. In addition, the presence of sensory and motor impairments must be considered. For example, loss of joint position sense may result in awkward or clumsy movements. Unlike those with ideomotor apraxia, visual guidance markedly improves function in a person with sensory loss. As described later, left hemispheric lesions usually result in bilateral ideomotor apraxia. Although it is typical to also have sensory or motor impairments on the right side of the body (making it difficult to assess for motor planning deficits), with a left-sided brain injury, the left side of the body should be sensory and motor spared. Testing the left side of the body in these cases will control for superimposed sensory and motor deficits.

Neurologic processing models have been proposed to explain the production aspects of praxis.\textsuperscript{2,4,34} Understanding the areas of the cortex responsible to support motor planning will aid clinicians in the clinical reasoning process. Key areas include the following:  
- Left inferior parietal lobe (supramarginal gyrus and angular gyrus): appears to be a storage area related to knowledge of motor skills or storage of motor plans. These "formulas for movement" or learned time-space movement representations or motor plans have been termed praxicons.\textsuperscript{34} When a skilled movement that has been previously learned such as shaving in an adult male is to be carried out, the representation for the act of shaving is retrieved and used to program the premotor cortex.  
- The arcuate fasciculus serves to connect the storage area in the left parietal lobe to the premotor area in the frontal lobe.  
- Using the formulas for movement, the premotor areas serve to selectively activate the motor cortex because this area of the cortex uses information from other cortical regions to select movements appropriate to the context of the action.  
- The anterior fibers of the corpus callosum serve to bring the shaving plans to the right hemisphere if the left side of the body will be used in the activity.  
- The primary motor cortex then innervates the muscle groups necessary to shave (Figures 5-4 and 5-5).

Clinically this is important because ideomotor apraxia can occur if the formulas for movement in the left parietal lobe are destroyed by a brain injury or if lesions occur anterior to this area in the frontal areas or the connecting pathways (i.e., disconnecting the critical cortical areas). If neuroimaging data are available, documented lesions in this area should serve as a "red flag" as to the possible presence of this impairment and the potential loss of function. In addition, the location of the lesion dictates the distribution of the motor planning difficulties. Lesions in the left hemisphere usually result in bilateral motor planning problems, whereas lesions
in the corpus collosum or right premotor area usually result in unilateral motor planning problems on the left side of the body only (see Figure 5-4).  

Finally, damage to the basal ganglia or thalamic lesions also may result in ideomotor apraxia, although this association is not as consistent in the published literature.  

It is important to differentiate the type of apraxia that is interfering with function because it will dictate cueing and environmental strategies.
Figure 5-3 Manifestations of ideomotor apraxia during performance of activities of daily living (grooming and feeding) based on Árnadóttir’s analysis of errors. A, The left apraxic hand may hold a brush and have no observable problem with brushing the hair on the left side of the scalp. B, Under normal circumstances, when the hand is moved to brush the right side, adjustments of hand position are automatically made by sequences of organized hand movements directed toward the goal of changing the position of the brush. C, The client with motor apraxia is unable to perform and sequence the required movements when the hand is moved over to the right side, resulting in an awkward grasp when considering the task requirements. D, During normal performance the client adjusts the movements of the wrist and forearm when approaching the mouth with the spoon. E, A client with motor apraxia may be able to hold the spoon correctly but is unable to adjust the movements when approaching the mouth, resulting in spilling from the spoon. F, The client holds the spoon with a very “clumsy” and inflexible grasp. She is totally unable to adjust her grasp when approaching the mouth, again resulting in spilling of the soup from the spoon.

(Continued)
necessary to improve performance. Ideational and ideomotor apraxia can occur together or separately. In a classic study of apraxia, 21% of those with left brain damage had both types of apraxia, whereas 14% had one form or the other. The correlation coefficient documented to test the strength of the association of the two types of apraxia has been reported as 0.41 \( (p < 0.001) \). Árnadóttir encourages analyzing errors made during task performance to differentiate the effect of the different types of apraxia (Box 5-1 and Figure 5-6).

**PREVALENCE AND RECOVERY**

Several studies have examined the prevalence of apraxia. In general, approximately one third of those with left brain damage present with apraxia. Recent findings include the following:
An examination of 100 stroke survivors revealed that for the group, 25.3% presented with apraxia; specifically apraxia was present in 51.3% of those with left-sided stroke and in 6% of those with right-sided stroke. Reviews of the literature consistently find that this impairment occurs after left-sided brain damage as opposed to right-sided damage. The prevalence of apraxia among 492 first left hemisphere stroke survivors in rehabilitation centers was 28% (96/338) and was higher in long-term care facilities at 37% (57/154).

Apraxia has been documented in a variety of populations including left hemisphere–acquired brain injury (errors related to content and planning), corticobasal degeneration (errors related to planning), Alzheimer’s disease (errors related to content and planning), Parkinson’s disease (errors related to planning), progressive supranuclear palsy (content and planning errors), and Huntington’s disease (planning errors).

Recovery patterns from apraxia also have been examined. Findings related to recovery include the following:

- Improvement from ideomotor apraxia may be related to the site of the lesion, anterior lesions may fare better.
- An examination of recovery of 26 clients with apraxia revealed that 13 remained apraxic 5 months later.
- Age, gender, aphasia, education level, and lesion size do not seem to influence recovery from apraxia.
- In long-term limb apraxia recovery, the more severe the initial impairment, the less complete the long-term outcome.

**Figure 5-4** Processing of motor praxis. Apraxia will manifest if praxicons usually “stored” in the left inferior parietal lobe (angular and supramarginal gyr) are destroyed by acquired brain injury or via disconnections between the processing areas (i.e., along the arcuate fasciculus or corpus callosum). Lesions in the left hemisphere may result in bilateral ideomotor apraxia, whereas lesions of the corpus callosum or right premotor area may result in unilateral ideomotor apraxia on the left side. (From Árnadóttir G: Impact of neurobehavioral deficits on activities of daily living. In Gillen G, Burkhardt A, editors: Stroke rehabilitation: a function-based approach, ed 2, St Louis, 2004, Elsevier/Mosby.)
Limb apraxia recovery showed no significant correlation with recovery of language deficits. 

Aphasia and apraxia seem to have related but distinguishable recovery processes.

In a long-term follow-up study of a group of 44 clients with ideomotor apraxia, the clients’ apraxia status was evaluated three times (1.6 months, 9.4 months, and 27.9 months’ mean time postonset). All but one client demonstrated some recovery from apraxia between the first and second examinations. After that point, very few of the clients showed further recovery and 6 clients worsened. At all three examinations, clients with anterior lesions had more severe apraxia, but unlike previous studies, the degree of recovery was not significantly different in the two groups.

Limb apraxia and oral apraxia appears to follow the same trajectory of recovery.

After the first few months of recovery, clients will plateau.

Clients with apraxia who improve during the rehabilitation stay on functional measures may worsen when discharged home. This may be due to the specificity of training and/or the inability to generalize. This issue may be addressed by home visits by the team and client during the rehabilitation process. A focus on home rehabilitation seems to be warranted based on this finding.

**APRAXIA’S RELATIONSHIP TO OTHER IMPAIRMENTS**

Although apraxia may occur in isolation, it is typical to see patterns of impairments in those living with apraxia. These include motor impairments, “cognitive dementia-like impairments,” memory difficulties, and comprehension difficulties. In addition, it is typical to identify organization and sequencing deficits. Most commonly, aphasia and apraxia may occur together. Both impairments are commonly seen in those living with left hemispheric
dysfunction. Because the two impairments have contiguous cortical structures they often occur concurrently but the two may be dissociated (i.e., a client may present with aphasia or apraxia, or both). 44

Alexander and associates 1 examined the relationship between aphasia and ideomotor apraxia and concluded that those presenting with conduction aphasia and anomic aphasia were not significantly apraxic compared with controls, and those with global aphasia were significantly more apraxic than all other groups. The method used to elicit the apraxic behaviors influenced their findings as well. There appears to be a stronger association between Broca’s aphasia and ideomotor apraxia. There also appears to be a stronger relationship with aphasia and severe ideational apraxia. 16 The combination of apraxia and aphasia may compound the difficulties related to functional retraining. In addition, a hallmark of ideomotor apraxia is impaired gesture production ability, a typical compensatory technique used during the rehabilitation of those with language impairments. From an assessment and intervention perspective, the presence of aphasia (particularly Wernicke’s/receptive aphasia and global aphasia) dictates the use of familiar tasks, performed in logical environments, at the appropriate time of day. Dressing practice during an afternoon session in a therapy clinic or isolated practice of object use in a therapy office does not provide the contextual cues necessary to elicit functional performance. This factor makes it impossible to differentiate between the effects of apraxia or difficulties related to comprehension. Using a familiar task in the appropriate environment circumvents the need to use excessive verbal cues and at least begins to control for the presence of aphasia.

**EFFECT OF APRAXIA ON DAILY LIFE AND REHABILITATION OUTCOMES**

Although the early literature discussed apraxia as being an impairment observed only during specific neurologic testing or during contrived clinical situations, it is now well recognized that apraxia does have a substantial negative effect on an individual’s ability to engage in meaningful activities and participate fully in the community. Specific findings include the following:

Apraxia affects behavior during meals. Foundas and associates examined mealtime behaviors of neurologically intact people as compared with those with left brain damage (most with apraxia) via videotapes. Even though all neurologically intact people were found to proceed through three specific phases of a meal (preparatory, eating, and cleanup), only 20% of those with left brain damage did. All intact controls had a preparatory phase, whereas only 40% of those with apraxia did. In addition, those with apraxia from left brain damage used fewer utensils, were less organized, were less efficient, ate haphazardly, placed too much or too little food on the utensils, and demonstrated action deficits (tool misuse, sequencing errors, etc.). A significant correlation was found between the severity of apraxia and difficulties observed with the meal.

Six months after discharge from hospitalization, apraxia and the need for assistance with daily activities are highly correlated. Those with apraxia require more assistance than those with other neurologic impairments. The absence of apraxia is a significant predictor of the ability to return to work. Apraxia severity is strongly related to meal preparation competency. Apraxia severity is moderately predictive of caregiver and client reports of functional independence. People with ideomotor apraxia have increased dependency in grooming, bathing, and toileting relative to age-matched control subjects. The number of errors made during basic ADL is correlated with the severity of apraxia. The number of errors made during complex ADL is correlated with the severity of apraxia. The relationship of severity of apraxia to long-term dependency after rehabilitation is strong. Learning of old and new skills is compromised in those with apraxia and requires increased repetitions.

Clearly the presence of apraxia warrants special attention from a rehabilitation perspective. Specific assessment and intervention strategies are necessary to improve functional performance in this population.

EVALUATION AND ASSESSMENTS

Two schools of thought exist related to the assessment of apraxia. One is focused on diagnosing the impairment of apraxia, whereas the other is focused on how apraxia affects everyday living skills. Although both are important, philosophically from a rehabilitation perspective the latter should be emphasized. The literature has typically focused on diagnosing apraxia using nonfunctional tasks out of context. These tests typically include selections from the following items:

- Gesturing to command. Focusing on pantomime of the use of tools, that is, transitive movements (“Show me how you would use a hammer”) and nonverbal communications or intransitive moments (“Show me how you would wave goodbye”).
- Gesture to imitation.
- Gesture or pantomime in response to seeing a tool. For example, showing the person a toothbrush and asking him or her to pantomime its use.
- Demonstrate tool use albeit not in the context of a functional task.
- Imitation of the examiner using a tool.
- Discriminating correct and incorrect movements of the examiner.
- Performing serial acts (putting batteries in a flashlight and turning it on, making a sandwich, etc.).

Many of the tests used to diagnose the presence of apraxia were developed as research tools and some that are commonly used in clinical settings are not standardized. The following are examples of standardized impairment tests used to make the diagnosis of apraxia:

- Florida Apraxia Screening Test-Revised: a short screening of apraxia and part of the larger Florida Apraxia Battery. It includes 30 items that must be gestured to command. The test includes 20 transitive (requiring pantomime of a tool) and 10 intransitive (not requiring a tool) items. All are related to arm and hand movements and can be done with one hand. Examples include showing how to salute, go away, how to use a scoop to serve ice cream, wave goodbye, stop, use a salt shaker to salt food, and hitchhike. Scoring is based on error type: content, temporal, spatial, and others.
- Cambridge Apraxia Battery: includes 11 items such as imitation of posture, imitation of sequence, bilateral motor coordination, functional object description, finger maze, and manual form perception.
- Kaufman Hand Movement Test: a standardized test that requires subjects to imitate 75 hand positions.
• Limb Apraxia Test\(^{20}\): an objective, quantifiable, valid, and reliable measure of the ability to imitate 252 movements.
• Ideomotor Apraxia Test\(^{17}\): developed for older adults, the test consists of demonstrating 10 gestures (3 one-handed symbolic gestures and 7 two-handed meaningless gestures).
• Movement Imitation Test\(^{15}\): includes 24 gestures classified according to type of movement (finger versus hand, symbolic vs. nonsymbolic gestures, etc.).
• Diagnostic Test for Apraxia\(^{67,73}\): a test to diagnose the presence of ideational and ideomotor apraxia via demonstration of object use (ideational) and imitation of gestures (ideomotor).

Impairment tests aimed at diagnosing the impairment of apraxia must be interpreted with caution from a rehabilitation perspective as they are performed out of context and one cannot generalize poor test performance to real-world performance (see Chapter 1). Therefore, from a clinical rehabilitative practice perspective, they are recommended as a screening only if they are to be used at all. Those engaged in clinical research such as testing the effectiveness of interventions for those living with apraxia should consider using an impairment test of apraxia in conjunction with objective performance-based measures of activity limitations, participation restrictions, and quality of life.

Instead, from a rehabilitation perspective, the focus of assessment should be on determining if/how the presence of apraxia interferes with a person’s ability to perform basic self-care, instrumental activities of daily living, work, and play/leisure abilities. Arndóttir\(^{2-4}\), van Heugten and colleagues\(^{71}\), and Goldenberg and Hagmann\(^{29}\) have concluded that structured observation of the errors that people make during functional activities is a valid method of assessing apraxia. Success using this method of assessment is based on the assumption that apraxia results in an observable problem related to function, allowing people with apraxia to make safe errors during task performance, analyzing the errors to classify them based on type of apraxia and error type, and using consistent descriptive terminology and operational definitions\(^{2,4}\).

van Heugten and colleagues\(^{68,70}\) and others have documented at least three types of errors that can be observed during structured observations of functional tasks including content, temporal, and spatial (Table 5-1). Identifying the error type enables clinicians to develop the appropriate intervention plan (discussed later). van Heugten and colleagues\(^{68,70}\)

### Table 5-1: Potential Apraxic Errors Made During Functional Task Performance

<table>
<thead>
<tr>
<th>ERROR</th>
<th>OBSERVABLE BEHAVIOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulties initiating the task</td>
<td>Difficulty choosing the proper plan of action</td>
</tr>
<tr>
<td>Difficulty choosing the correct objects</td>
<td></td>
</tr>
<tr>
<td>Difficulty executing the task</td>
<td>Difficulty performing the plan</td>
</tr>
<tr>
<td>Difficulty controlling the task</td>
<td>Inability to evaluate the results of the task</td>
</tr>
<tr>
<td>Inability to make corrections for mistakes</td>
<td></td>
</tr>
<tr>
<td>Content/object errors</td>
<td>Related errors: uses knife instead of fork</td>
</tr>
<tr>
<td>Nonrelated errors: eats soap</td>
<td></td>
</tr>
<tr>
<td>Perseverative errors: integrates a component of the previous task into a new task (e.g., after eating soup from a bowl with a spoon, brings spoon toward the glass of milk)</td>
<td></td>
</tr>
<tr>
<td>Temporal errors</td>
<td>Difficulty sequencing movements</td>
</tr>
<tr>
<td>Increased, decreased, or irregular speed of movements</td>
<td></td>
</tr>
<tr>
<td>Spatial errors</td>
<td>Increased or decreased amplitude of movement</td>
</tr>
<tr>
<td>Difficulty configuring the hand to hold an object</td>
<td></td>
</tr>
<tr>
<td>Difficulty orienting the limbs and trunk to an object</td>
<td></td>
</tr>
<tr>
<td>Sits too far away from workspace or body is improperly aligned</td>
<td></td>
</tr>
</tbody>
</table>

developed a standardized assessment to document the presence of disabilities resulting from apraxia. Scoring is based on structured observation of ADL and a client-chosen activity (Box 5-2).

Árnadóttir proposed a relationship between the presence of impairments such as apraxia and observable errors during a variety of daily living tasks. Although these observations are typically made in a nonstandardized manner (Table 5-2), they also have been standardized (Table 5-3).

### REVIEW OF EVIDENCE-BASED INTERVENTIONS TO IMPROVE ACTIVITY AND PARTICIPATION FOR THOSE LIVING WITH APRAXIA

Empirical research focused on interventions for those living with apraxia falls into two categories: interventions focused on attempting to decrease the apraxic impairment itself and those focused on improving activity performance despite apraxia.

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**Box 5-2 Observation and Scoring of Activities of Daily Living**

**PURPOSE:**
- To assess the presence of disabilities resulting from apraxia
- To gain an insight in the style of action of the patient and the sort of errors made
- To prepare treatment goals for specific training

**METHOD:**
The therapist observes the following activities and scores the findings for each activity and each aspect.
1. Personal hygiene: washing the face and upper body
2. Dressing: putting on a shirt or blouse
3. Feeding: preparing and eating a sandwich
4. The therapist chooses an activity that is relevant for the patient or standard at the department

**I. SCORE OF INDEPENDENCE**
0—The patient is totally independent, can function without any help in any situation.
1—The patient is able to perform the activity but needs some supervision.
   - The patient needs minimal verbal assistance to perform adequately.
   - The patient needs maximal verbal assistance to perform adequately.
2—The patient needs minimal physical assistance to perform adequately.
3—The patient cannot perform the task despite full assistance.

**II. THE COURSE OF AN ACTIVITY**
In every aspect the patient can encounter problems; however, for each aspect only one score can be entered.

**A. Initiation**
0—There are no observable problems: the patient understands the instruction and initiates the activity.
1—The verbal instruction has to be adapted or extended.
   - The therapist has to demonstrate the activity.
   - It is necessary to show pictures or write down the instructions.
   - The objects needed to perform the task have to be given to the patient.
2—The therapist has to initiate the activity together with the patient.
   - The activity has to be modified in order to be performed adequately.
3—The therapist has to take over.

**B. Execution**
0—There are no observable problems: the activity is performed correctly.
1—The patient needs verbal guidance.
   - Verbal guidance has to be combined with gestures, pantomime, and intonation.
   - Pictures of the proper sequence of action have to be shown.
2—The patient needs physical guidance.
3—The therapist has to take over.

**C. Control**
0—There are no observable problems: the patient does not need feedback.
1—The patient needs verbal feedback about the result of the performance.
   - The patient needs physical feedback about the result of the performance.
2—The patient needs verbal feedback about the execution.
   - The patient needs physical feedback about the execution.
   - It is necessary to use mirrors or video recordings.
3—The therapist has to take over.

The available research does not support the sometimes assumed relationship that decreasing the severity of apraxia will automatically result in improved daily function. Examples of interventions that have focused on treating the impairment of apraxia include the following:

- Using tactile and kinesthetic stimulation in addition to visual and verbal mediation input, such as deep pressure, sharp touch input, soft touch, self-touch, and proprioceptive input.\(^{10,11}\)

- Practice of gestures.\(^{42,50}\)

- Practice of object use via conductive education.\(^{53}\)

These interventions have been tested by case studies that have concluded that in general the interventions demonstrated only immediate changes in motor performance without any carryover related to sensory stimulation. The major limitation is that either functional outcomes were not considered or changes in functional performance were not observed for these interventions. In addition, no generalizations to untrained actions were noted. At this point they cannot be recommended for use in clinical practice.

van Heugten\(^{66}\) states that “recovery from apraxia is not a realistic goal for therapy. Instead, the aim of rehabilitation should be to help the client develop new patterns of cognitive activity through internal or external compensatory mechanisms, or through adaptation of tasks or environments.” The following paragraphs review tested interventions that have focused on decreasing activity limitations and participation restrictions for those living with apraxia.

### Strategy Training

van Heugten and colleagues\(^{70}\) described an intervention study designed for use by occupational therapists based on teaching clients strategies to compensate for the presence of apraxia. The treatment was focused on training activities that were relevant to the individual client. The therapist and client decided on which activities to focus. Interest checklists were also used to choose activities in addition to focusing on activities that were important to carry out in the future. Every two weeks other activities were chosen.

The focus of the intervention was error specific and determined by the specific problems observed during standardized ADL observations. Specifically, interventions were focused on errors related to the following:

- **Initiation**: inclusive of developing a plan of action and selection of necessary and correct objects

- **Execution**: performance of the plan

- **Control**: inclusive of controlling and correcting the activity to ensure an adequate end result

Difficulties related to initiation were treated via specific instructions. Instructions were hierarchical in nature and could include verbal instructions,

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**Table 5-2** Sample Observable Apraxic Errors Made During Functional Task Performance

<table>
<thead>
<tr>
<th>ACTIVITY DOMAIN</th>
<th>OBSERVABLE ERROR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeding</td>
<td>Uses a spoon as a straw (IA)</td>
</tr>
<tr>
<td></td>
<td>Unable to adjust movements to guide spoon to mouth smoothly without spilling (MA)</td>
</tr>
<tr>
<td></td>
<td>Puts butter in coffee (IA)</td>
</tr>
<tr>
<td></td>
<td>Awkward grip on knife interferes with cutting skills (MA)</td>
</tr>
<tr>
<td>Grooming and hygiene</td>
<td>Smears toothpaste on sink (IA)</td>
</tr>
<tr>
<td></td>
<td>Can’t maintain razor in contact with face when crossing midline (MA)</td>
</tr>
<tr>
<td></td>
<td>Doesn’t “know how” to turn on water faucet (IA)</td>
</tr>
<tr>
<td></td>
<td>Can’t plan squeezing toothpaste out of tube (MA)</td>
</tr>
<tr>
<td>Dressing</td>
<td>Attempts to put socks on hands (IA)</td>
</tr>
<tr>
<td></td>
<td>Not able to plan movement sequence for donning a shirt (MA)</td>
</tr>
<tr>
<td></td>
<td>Socks are put on over shoes (IA)</td>
</tr>
<tr>
<td></td>
<td>Not able to readjust sock within the hand after picking it up (MA)</td>
</tr>
<tr>
<td>Mobility</td>
<td>Attempts to propel wheelchair by pushing on the brakes repetitively (IA)</td>
</tr>
<tr>
<td></td>
<td>Cannot plan movements to roll and sit up over the edge of the bed (MA)</td>
</tr>
<tr>
<td></td>
<td>Attempts to lock wheelchair brakes by pulling on the armrest (IA)</td>
</tr>
<tr>
<td></td>
<td>More than expected difficulty in learning the motor sequence of propelling the wheelchair with one side of the body (MA)</td>
</tr>
</tbody>
</table>


IA, Ideational apraxia; MA, ideomotor apraxia
<table>
<thead>
<tr>
<th>INSTRUMENT AND AUTHOR</th>
<th>INSTRUMENT DESCRIPTION</th>
<th>POPULATION</th>
<th>VALIDITY AND RELIABILITY</th>
<th>RELIABILITY</th>
<th>DIMENSION BASED ON INTERNATIONAL CLASSIFICATION OF FUNCTION*</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADL Observations to Measure Disabilities in those with apraxia, van Heugten et al, 1999<em>2, 2000</em>4</td>
<td>Standardized assessments of basic activities of daily living (ADL) Standardized assessments of instrumental ADL (IADL) Standardized assessments of leisure Standardized assessments of participation Standardized assessments of quality of life</td>
<td>Adults living with apraxia</td>
<td>Discriminative: able to differentiate between those with and without apraxia Construct: highly associated with impairment tests of apraxia and the Barthel Index Interrater based on intraclass correlation for the total score is 0.98 Cronbach’s alpha = 0.94</td>
<td>Activity limitations</td>
<td>Activity limitations Provide information related to how apraxia affects everyday living Warrants further investigation</td>
<td></td>
</tr>
<tr>
<td>ADL Test for those with apraxia, Goldenberg and Hagmann, 1998*5</td>
<td>Observation of spreading margarine on bread, putting on a T-shirt, brushing teeth, or putting cream on hands Scores based on reparable or fatal errors related to selection of objects, movements, or sequencing</td>
<td>Adults with apraxia</td>
<td>Significant correlations with five impairment tests of apraxia Interrater: 0.83 for reparable errors and 0.96 for fatal errors</td>
<td>Activity limitations</td>
<td>Provides information related to how apraxia affects everyday living Warrants further investigation Initial data are available related to complex ADL as well</td>
<td></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
<td><strong>Content</strong></td>
<td><strong>Impairments</strong></td>
<td><strong>Activity limitations</strong></td>
<td><strong>Notes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------</td>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Arnadóttir Occupational Therapy-ADL Neurobehavioral Evaluation (A-ONE), Arnadóttir, 1990; 2004</strong></td>
<td>Structured observation of basic ADL including feeding, grooming and hygiene, dressing, transfers and mobility to detect the impact of multiple underlying impairments including ideational and motor apraxia on these tasks</td>
<td>Those 16 years and older with central nervous system involvement</td>
<td>Content: via expert review and literature review Concurrent: Barthel Index, Katz Index, Mini Mental Status Examination Valid for multiple diagnoses including: stroke, brain tumor, dementia, etc.</td>
<td>Interrater: 0.84 Test-retest: 0.86 Provides information related to how apraxia affects everyday living Includes items related to both ideational and motor apraxia Requires training</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Assessment of Motor and Process Skills (AMPS), Fisher, 2003</strong></td>
<td>An observational assessment that is used to measure the quality of a person’s ADL assessed by rating the effort, efficiency, safety, and independence of 16 ADL motor and 20 ADL process skill items Includes choices from 85 tasks</td>
<td>Those 3 years old and up and difficulties related to occupational performance</td>
<td>Strong validity and appropriate to use with multiple diagnoses and cultures</td>
<td>Cronbach’s alpha range from 0.74 to 0.93 Test-retest range from 0.7 to 0.91 Provides information related to everyday function Requires training</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
alerting the client with tactile or auditory cues, gesturing, pointing, handing objects, or starting the activity together. Assistance was the intervention provided when problems related to execution of the activity occurred. Also hierarchical, assistance could range from various types of verbal assist, stimulating verbalization of steps, naming the steps of the activity, to physical assistance such as guiding movements. When having difficulty with control (i.e., clients do not detect or correct the errors they make during the activity), feedback was provided. Feedback ranged from verbal feedback related to knowledge of results to taking control of the task and controlling for errors. The specific strategy training intervention protocol is included in Box 5-3.

This strategy training approach for apraxia has been tested with promising results. A pretest-posttest study design demonstrated significant improvements and large effects for three different ADL measures (Barthel Index, a standardized evaluation of personal hygiene, dressing, preparing food and a client-chosen activity, and an ADL questionnaire that was filled out by therapists as well as clients). In addition, significant improvements were documented on tests of apraxia (small-medium effects).

<table>
<thead>
<tr>
<th>Box 5-3</th>
<th>Protocol for Strategy Training for Those Living with Functional Deficits Secondary to Apraxia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSTRUCTIONS</strong></td>
<td>The occupational therapist can give the following instructions:</td>
</tr>
<tr>
<td>• Start with a verbal instruction.</td>
<td>• Use gestures, mimics, and vary intonation in your speech.</td>
</tr>
<tr>
<td>• Shift to a relevant environment for the task at hand.</td>
<td>• Show pictures of the proper sequence of steps in the activity.</td>
</tr>
<tr>
<td>• Alert the patient by:</td>
<td>• Physical assistance is needed:</td>
</tr>
<tr>
<td>• Touching</td>
<td>• By guiding the limbs.</td>
</tr>
<tr>
<td>• Using the patient’s name</td>
<td>• In positioning the limbs.</td>
</tr>
<tr>
<td>• Asking questions about the instruction</td>
<td>• To use the neurodevelopmental treatment method (NDT).</td>
</tr>
<tr>
<td>• Use gestures, point to the objects.</td>
<td>• To use aids to support the activity.</td>
</tr>
<tr>
<td>• Demonstrate (part of) the task.</td>
<td>• To take over until the patient starts performing.</td>
</tr>
<tr>
<td>• Show pictures of the activity.</td>
<td>• To provoke movements.</td>
</tr>
<tr>
<td>• Write down the instruction.</td>
<td>• Finally, take over the task.</td>
</tr>
<tr>
<td>• Place the objects near the patient, point to the objects, put the objects in the proper sequence.</td>
<td><strong>FEEDBACK</strong></td>
</tr>
<tr>
<td>• Hand the objects one at a time to the patient.</td>
<td>Feedback can be offered in the following ways:</td>
</tr>
<tr>
<td>• Start the activity together with the patient one or more times.</td>
<td>• No feedback is necessary because the result is adequate.</td>
</tr>
<tr>
<td>• Adjust the task to make it easier for the patient.</td>
<td>• Verbal feedback is needed in terms of the result (knowledge of results).</td>
</tr>
<tr>
<td>• Finally, take over the task because all efforts did not lead to the desired result.</td>
<td>• Verbal feedback by telling the patient to consciously use the senses to evaluate the result (tell the patient see, hear, feel, smell, or taste).</td>
</tr>
<tr>
<td><strong>ASSISTANCE</strong></td>
<td>Physical feedback is needed in terms of the result (knowledge of results):</td>
</tr>
<tr>
<td>The following forms of assistance can be given by the therapist:</td>
<td>• To evaluate the posture of the patient.</td>
</tr>
<tr>
<td>• There is no need to assist the patient during the execution of the activity.</td>
<td>• To evaluate the position of the limbs.</td>
</tr>
<tr>
<td>• Verbal assistance is needed:</td>
<td>• To support the limbs.</td>
</tr>
<tr>
<td>• By offering rhythm and not interrupting performance.</td>
<td>• Physical feedback is given by pointing or handing the objects to the patient.</td>
</tr>
<tr>
<td>• To stimulate verbalization of the steps in the activity.</td>
<td>• Verbal feedback is needed in terms of performance (knowledge of performance).</td>
</tr>
<tr>
<td>• To name the steps in the activity or name the objects.</td>
<td>• Physical feedback is needed in terms of performance (knowledge of performance).</td>
</tr>
<tr>
<td>• To direct the attention to the task at hand.</td>
<td>• Place the patient in front of a mirror.</td>
</tr>
<tr>
<td></td>
<td>• Make video recordings of the patient’s performance and show the recordings.</td>
</tr>
<tr>
<td></td>
<td>• Take over the control of the task and correct possible errors.</td>
</tr>
</tbody>
</table>

and motor function (small effects). Improved ADL function was still significant after correcting for the improvement on the apraxia measures, motor measure, and time poststroke. Of the clients in this study, 84% perceived complete recovery or substantial improvement because of the intervention. The authors concluded that the “therapy programme succeeded in teaching clients compensatory strategies, which enable them to function more independently.” Further analysis of these data revealed that older age, the presence of additional cognitive impairments, and/or severe motor impairment did not diminish the effects of the strategy training intervention. In fact, the initially more severely impaired clients showed the most marked improvement. Of note is that although the intervention did not explicitly focus on decreasing the apraxic impairment, the strategy training approach during participation in functional activities decreased activity limitations as well as severity of impairment.

Donkervoort and coworkers also tested this intervention via a randomized clinical trial comparing usual occupational therapy to strategy training integrated into usual occupational therapy. Blind evaluators administered measures of ADL, apraxia, and motor function pre- and postintervention. Postintervention, those receiving strategy training improved significantly on ADL observations (small to medium effect size) as well as the Barthel Index (medium effect size) as compared with those who received usual care. Although a 5-month follow-up did not demonstrate beneficial effects (i.e., the groups were similar), it was noted that those in the usual care group required continued occupational therapy to obtain a corresponding level of improvement. It is possible that this finding may reveal that the strategy training approach improved the efficiency of the rehabilitation process, but further examination of this hypothesis is required. The authors concluded that the trial “showed beneficial effects of strategy training on ADL functioning in left hemisphere stroke clients with apraxia. The results suggest that the therapy programme is successful in teaching clients compensatory strategies, which enable them to function more independently, despite the lasting effects of apraxia.”

A posthoc analysis of Donkervoort and coworkers’ data (Geusgens and associates) focused on whether the strategy training approach results in transfer of training to untrained tasks. The hypothesis is that in strategy training, transfer is expected as the intervention is not focused on learning specific tasks but on teaching clients new ways to cope with and manage the impairments during performance of tasks in general. The analyses revealed that both intervention groups (traditional occupational therapy [OT] and traditional OT combined with strategy training) demonstrated significantly improved scores on tasks that were not trained. Change scores of the nontrained activities were significantly larger in the strategy training group as compared with usual occupational therapy. The authors hypothesized that this success was secondary to the design of the intervention (i.e., strategies are selected based on the specific type of error each client makes during engagement in ADL). Strategy training for apraxia is considered a practice standard by the American Congress of Rehabilitation Medicine.

**Errorless Completion and Training of Details**

Goldenberg and Hagmann tested a method of specifically training ADL for those living with apraxia. They specifically examined spreading margarine on a slice of bread, putting on a T-shirt, and brushing teeth or applying hand cream. Each of the activities was trained for 1 week by an occupational therapist. Those not being trained were carried out with maximal support and without specific training. When an activity was being trained, the focus was on errorless completion of the whole activity. As opposed to trial-and-error learning, errorless learning or completion is a technique in which the person learns the activity by doing it. The therapist intervenes to prevent errors from occurring during the learning process. This technique also has been used for those with memory impairments (see Chapter 9). Support from the therapist was provided at various stages of the activity until the client could move through the area of difficulty on his or her own. Specific interventions included the following:

- Guiding the hand through a difficult aspect of the activity
- Sitting beside the client (parallel position) and doing the same action simultaneously with the client
- Demonstrating the required action and ask the client to copy it afterwards

In addition, the intervention focused on training of details. This was aimed at directing the client’s attention to “the functional significance of single perceptual details and to critical features of the actions associated with them.” Specific difficult steps of the activity were trained using this approach. To promote knowledge of object use, key
details of ADL objects were explored and examined such as the bristles on a toothbrush and the teeth on a comb. Actions connected to the details were then practiced (e.g., searching for and positioning a shirtsleeve for a person with dressing difficulties) outside of therapy. Specific necessary motor actions also were practiced in other activities and contexts (e.g., squeezing paint from tubes as a similar action as squeezing toothpaste).

Goldenberg and Hagmann tested this intervention by examining 15 clients with apraxia with repeated measures of ADL function. Success of therapy was based on the reduction of errors of specific tasks. The authors differentiated between reparable errors (the client succeeds in continuing the task) or fatal errors (the client is unable to proceed without help or the task is completed but did not fulfill its purpose). Across the whole group, the number of fatal errors decreased significantly, whereas the number of reparable errors did not significantly change. The authors also noted several clinically relevant observations:

- Even though therapy led to significant improvements in trained ADL, there was no improvement in ADL if left to spontaneous recovery.
- Long-term success of the intervention was based on continued practice and ADL participation after completion of the intervention.
- The success of the intervention seemed to be based on teaching clients “instructions of use” related to specific objects.
- Specific training can restore independence for trained activities.
- There was no generalization from trained to untrained tasks.

In terms of the lack of generalization to untrained tasks, by definition the errorless component of the intervention is in fact task specific and training of details is aimed only at object use errors seen in those living with apraxia and not other difficulties encountered by this population. This may represent a limitation of the intervention, but further research is necessary.

**Direct Training of the Whole Activity versus Exploration Training**

Goldenberg and colleagues developed and compared two therapy interventions aimed at restoring the ability to engage in complex ADL for those living with apraxia. Exploration training was aimed at having clients infer function from structure and solve mechanical problems embedded in tasks. During treatment, the therapist directs the client’s attention to functionally significant details of the object (e.g., prongs on a fork, serrations on a butter knife, bristles on a toothbrush, etc.). The therapist explained the functional significance via verbal, gestural, bristles, and pointing cues. The clients did not practice use of the tools. Specific interventions related to exploration training included explanation, touching, and comparing objects with photographs.

The direct training focused on the client’s carrying out the whole activity with a minimum of errors. The technique is similar to errorless completion as reviewed above and included guided movements and the therapist sitting beside the client to perform the task simultaneously. Particularly difficult components of the activity were practiced, but the whole activity was always completed. Specific interventions for direct training included guided performance of the whole activity, passive guidance, guidance by example, and rehearsal of steps.

Goldenberg and colleagues tested these interventions related to the training of four complex ADL: preparing coffee from an automatic coffee maker, fixing a carpet knife to cut out cardboard, changing batteries on a tape recorder and playing a cassette, and slicing bread followed by spreading margarine and jam. Necessary objects were available as well as distracters (nonsensical objects not related to the task at hand such as a toothbrush for meal preparation). The authors found that exploration training had no effect on performance, whereas direct training resulted in a significant reduction of errors and the amount of assist required to complete the task. Follow-up 3 months later revealed that gains were maintained. Although exploration training was not found to be successful in this study, it should be pointed out that the protocol did not allow the clients to practice actual use of the objects or the actions associated with them. Future studies should examine whether combining exploration training with practice is more beneficial.

Of note was that the authors again documented that there was no generalization from trained to untrained tasks. This lack of generalization was at times evident even when the same task was tested with different objects. They concluded that therapy “should be tailored to the specific needs and desires of the clients and their relatives, and it should be tied as closely as possible to the normal environment of the client’s daily life. Otherwise, it runs the danger of remaining a pure exercise of therapeutic efficiency which does not help the client to master the challenges of daily life.” Similar to the preceding critique, direct training is in and of itself...
a task-specific training method (i.e., transfer is not expected to occur). Nonetheless, the idea of transfer of training remains controversial and should be considered when developing an individualized treatment program. At this point, only the strategy training approach as discussed has been found to result in generalization.

**Task-Specific Training**

Poole examined the ability of those living with apraxia to master the technique of one-handed shoe tying (commonly a necessary skill to be mastered after brain injury). She compared those living with a stroke without apraxia, those living stroke with apraxia, and healthy adults. The task was taught using published standardized procedures via demonstration and simultaneously verbalizing instructions. Repetition of demonstrations and instructions was used until the task was achieved. The mean number of trials to learn the task was higher for those with apraxia \((M = 6.4)\) as compared with those stroke survivors without apraxia \((M = 3.2)\) versus healthy controls \((M = 1.2)\). Although the number of trial required to learn the task was greater, the majority of those with apraxia were able to learn and retain the task.

Wilson documented a task-specific training program for a young woman after an anoxic brain injury. Two tasks focused on were drinking from a cup and sitting on a chair followed by positioning it correctly at the table. Functional performance was improved for this woman via the techniques of breaking down the steps of the tasks followed by practice of the steps, chaining procedures, and verbal mediation. The author noted that generalization to untrained tasks was not evident.

Smania and coworkers examined the effectiveness of a behavioral training program consisting of gesture-production exercises for those living with apraxia via a randomized controlled trial. Subjects with left-sided strokes averaging 5 months post onset were included. The study compared the experimental group with a control group who received conventional treatment for aphasia. The interventions consisted of the following:

- **Transitive gesture training** in which the client was required to show the use of common tools (i.e., a spoon) followed by the client being shown a picture illustrating a transitive gesture (i.e., using a spoon), and then required to produce the corresponding gestural pantomime, followed by the client being presented a picture showing a common tool (i.e., a spoon), and then was required to pantomime the use of that object.
- **Intransitive-symbolic gesture training** in which the client was shown two pictures, one of which illustrated a given context (i.e., a man eating a sandwich), and the other showing a symbolic gesture related to that context (i.e., the gesture of eating). After the presentation, the client was asked to reproduce the symbolic gesture shown in the picture. Following this intervention, the task was to produce the correct gesture (i.e., the gesture of eating) after the presentation of the context picture alone (i.e., a man eating a sandwich), followed by the task of producing the correct gesture (i.e., gesture of eating) after the presentation of a picture showing a new, though similar, contextual situation (i.e., a man eating canned food with a fork).
- **Intransitive-nonsymbolic gesture training** in which the client was asked to imitate meaningless intransitive gestures previously shown by the examiner.

Multiple neuropsychological tests were used as outcome measures including aphasia, verbal comprehension, intelligence, oral apraxia, constructional apraxia, ideational apraxia, ideomotor apraxia, and gesture recognition. The clients in the study group achieved a significant improvement of performance in both ideational and ideomotor apraxia tests. In addition, they showed a significant reduction of errors committed during the apraxia tests. No significant changes occurred in the control group. The authors concluded that “the results show the possible effectiveness of a specific training programme for the treatment of limb apraxia.” A follow-up to this study involved further investigation of nine clients in the study group and eight clients in the control group 2 months after the end of the treatment. The outcome measures used in the follow-up evaluation were impairment-based apraxia tests and an ADL questionnaire. The authors found that those who received specific apraxia training not only improved the ability to produce a wide range of gestures but also required less assistance from caregivers during ADL. In other words they concluded that training generalized to untrained tasks.

In summary, based on the available research related to apraxia and consistent with the above findings, Cappa and associates concluded that “there is grade A evidence for the effectiveness of apraxia treatment with compensatory strategies. Treatment should focus on functional activities, which are structured and practised using errorless
learning approaches. As transfer of training is difficult to achieve, training should focus on specific activities in a specific context close to the normal routines of the clients. Recovery of apraxia should not be the goal for rehabilitation. Further studies of treatment interventions are needed, which also address if the treatment effects generalize to non-trained activities and situations.”

Appendix 5-1 lists a summary of interventions. These referenced studies provide clinicians with guidance regarding how to design an ineffective intervention plan for those who are living with

**Box 5-4 Potential Interventions for Those Living with Functional Limitations Secondary to Apraxia**

- Use functional tasks (previously learned and new tasks that are necessary to perform secondary to neurologic impairments) as the basis of the interventions (i.e., an individualized task-specific approach).
- “Tap into” an individual’s routines and habits.
- Collaborate with the client and significant others/caregivers in order to choose the tasks that will be focused on and that will become the goals of therapy (i.e., a client-centered approach).
- Practice these activities in the appropriate environments and at the appropriate time of day (i.e., context specific with full contextual cues).
- Use strategy-training interventions to develop internal or external compensations during the performance of functional activities. See Box 5-3.
- Focus interventions based on the errors that are made during the task: initiation, execution, and control (i.e., error-specific interventions).
- Practice functional activities with vanishing cues.
- Provide graded assistance via graded instructions, assistance, or feedback during task performance.
- Practice functional activities using errorless learning (preempting the error via assistance) approaches.
- If physical guiding of the limbs is used during a task, incorporate the suggested principles of guiding:
  - The therapist should place his/her hands over the client’s whole hand, down to the fingertips.
  - Keep talking to a minimum.
  - Guide both sides of the body when possible.
  - Move along a supported surface to give the client maximum tactile feedback.
  - Involve the whole body in the task to challenge posture.
  - Provide changes in resistance during the activity.
  - Allow the client to make mistakes to give opportunities to solve problems.
  - Encourage tactile exploration of functional objects and tools to enhance performance as somatosensory feedback from the tool may play a role in organizing movements.
- Object affordances (the functional utility of particular objects within a context) support motor performance. Using meaningful objects and tasks will yield better results than movements performed in isolation.
- Because those with apraxia have compromised learning of old and new tasks, increased repetitions and practice will be necessary. Goals should be scaled accordingly.
- Encourage practice of learned skills outside of therapy and throughout the day.
- For those with ideomotor apraxia, experiment with decreasing the degrees of freedom (i.e., number of joints) used to perform the task. For example, encourage a woman who is attempting to apply makeup to keep her elbow on the table. Grade required functional movements from simple to complex such as grading from smoothing out a bedspread, to removing a pillow from a pillowcase, to placing a pillow into a pillowcase, to folding a large sheet, to making a bed, etc.
- Grade the number of tools and distracters used in a task. For example, finger feeding (no tools), followed by eating applesauce with only a spoon available, followed by eating applesauce with the choice of one to three utensils, followed by eating a meal requiring the choice of various tools for different aspects of the task (spoon to stir coffee, knife to cut and spread butter, etc.), followed by a meal with the necessary and usual utensils in addition to distracter tools such as comb, toothbrush, etc.
- Grade the number of steps of an activity via chaining procedures. The whole task should be completed for each trial.
- Grade the number of tasks that will be performed in succession such as during a morning routine.
- Use clear and short directions.
- Use multiple cues to elicit functions: visual demonstration, verbal explanation, and tactile guiding.
- Demonstrate the task while sitting parallel to the person with apraxia to help develop a visual model of the task at hand.
- Encourage verbalization of what is to be done.
Box 5-5 Interventions for Caregivers of Those Living with Functional Limitations Secondary to Apraxia

- Be mindful that cognitive and perceptual deficits in general are not commonly understood by the lay community. In particular, it is difficult to watch a person with apraxia function (e.g., using tools incorrectly), and education as to the nature of the deficit for family members is warranted early on.
- Make sure that caregivers understand that the behaviors observed are not caused by a lack of motivation.
- Emphasize the importance of maintaining habits and routines and keeping a consistent sequence of daily activities.
- Emphasize that more time will be needed to complete daily activities and rushing should be avoided.
- Based on evaluation findings, teach caregivers appropriate cueing strategies (gestures, tactile, visual, and/or auditory) that enhance function.
- Emphasize the need to allow for independent performance of at least part if not the whole activity—educating as to the importance of not overassisting.

functional limitations secondary to apraxia. Other authors have made useful treatment suggestions that warrant further empirical testing. Box 5-4 lists further potential interventions based on these studies and the available literature. In addition, interventions and education for caregivers are crucial and are included in Box 5-5.

REVIEW QUESTIONS
1. How would ideational apraxia present during a meal preparation? How would ideomotor apraxia present during the same activity?
2. Which limbs would present with motor planning deficits if the left hemisphere is damaged?
3. What are the limitations to using impairment based tests for apraxia such as “gesture on command”?
4. What are the three specific interventions recommended when using a strategy training approach to treat apraxia?
5. How would a strategy training approach to intervention be implemented during a morning grooming session?

REFERENCES
## Evidence-Based Interventions for Apraxia Focused on Improving Daily Function

### APPENDIX 5-1

**Table 1  Summary of Research**

<table>
<thead>
<tr>
<th>STUDY</th>
<th>INTERVENTION DESCRIPTION</th>
<th>PARTICIPANT CHARACTERISTICS</th>
<th>n</th>
<th>AGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>van Heugten et al, 1998</td>
<td>Strategy training to compensate for the presence of apraxia</td>
<td>Stroke survivors ranging from 1.6 to 21.4 weeks poststroke ($M = 9$ weeks poststroke)</td>
<td>33</td>
<td>$M = 70.1$ ($SD = 11$); range = 39 to 91</td>
</tr>
<tr>
<td>Donkervoort et al, 2001</td>
<td>Strategy training to compensate for the presence of apraxia</td>
<td>Left hemisphere stroke survivors</td>
<td>113</td>
<td>$M = 67.6$ ($SD = 11.7$)</td>
</tr>
<tr>
<td>Goldenberg and Hagmann, 1998</td>
<td>Specific training of activities of daily living (ADL) focusing on errorless completion of the whole activity and training of details</td>
<td>Stroke survivors with right hemiplegia</td>
<td>15</td>
<td>$M = 55.7$; range 36 to 72</td>
</tr>
<tr>
<td>Goldenberg et al, 2001</td>
<td>Specific training of complex ADL focusing on exploration training and direct training</td>
<td>Left middle cerebral artery stroke survivors at least 6 months poststroke</td>
<td>6</td>
<td>$M = 54.4$; range 31 to 81</td>
</tr>
<tr>
<td>Poole, 1998</td>
<td>Specific training of one-handed shoe tying</td>
<td>Ten left hemispheric chronic stroke survivors (5 with apraxia) and 5 controls</td>
<td>15</td>
<td>$M = 70$</td>
</tr>
<tr>
<td>Wilson, 1988</td>
<td>Step-by-step practice, chaining procedures, verbal mediation</td>
<td>An adolescent with an anoxic brain injury</td>
<td>1</td>
<td>Adolescent</td>
</tr>
<tr>
<td>Smania et al, 2006</td>
<td>Behavioral training of gesture production</td>
<td>Those with apraxia secondary to a stroke</td>
<td>9</td>
<td>$M = 65.67$ ($SD = 9.83$)</td>
</tr>
</tbody>
</table>

*M, Mean; SD, standard deviation.*
<table>
<thead>
<tr>
<th>STUDY</th>
<th>STUDY DESIGN</th>
<th>OUTCOME MEASURE</th>
<th>RESULTS</th>
<th>STATISTICALLY VALID</th>
<th>DIMENSION BASED ON INTERNATIONAL CLASSIFICATION OF FUNCTION*</th>
</tr>
</thead>
<tbody>
<tr>
<td>van Heugten et al, 1998</td>
<td>Pretest/posttest</td>
<td>Apraxia: gesture imitation and object use demonstration</td>
<td>+</td>
<td>$p &lt; 0.01$</td>
<td>Impairment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motor function: balance, motor control of the upper extremity, and sensation</td>
<td>+</td>
<td>$p &lt; 0.05$</td>
<td>Impairment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADL: standardized observation</td>
<td>+</td>
<td>$p &lt; 0.001$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADL: Barthe Index</td>
<td>+</td>
<td>$p &lt; 0.01$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADL: questionnaires</td>
<td>+</td>
<td>$p &lt; 0.01$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td>Donkervoort et al, 2001</td>
<td>Randomized controlled trial</td>
<td>Apraxia: gesture imitation and object use demonstration</td>
<td>No difference</td>
<td>$p &lt; 0.25$</td>
<td>Impairment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motor Function: Motricity Index</td>
<td>No difference</td>
<td>$p &lt; 0.39$</td>
<td>Impairment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Functional motor test</td>
<td>No difference</td>
<td>$p &lt; 0.13$</td>
<td>Impairment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADL: standardized observation</td>
<td>+</td>
<td>$p &lt; 0.03$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADL: Barthe Index</td>
<td>+</td>
<td>$p &lt; 0.00$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADL: questionnaires</td>
<td>No difference</td>
<td>$p &lt; 0.48$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td>Goldenberg and Hagmann, 1998</td>
<td>Pretest/posttest</td>
<td>ADL: spreading margarine on bread, brushing teeth, and putting on a T-shirt. Measures of decrease in number of:</td>
<td>+</td>
<td>$p &lt; 0.01$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fatal errors</td>
<td>No difference</td>
<td>$p &gt; 0.5$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reparable errors</td>
<td>No difference</td>
<td>$p &lt; 0.01$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td>Goldenberg et al, 2001</td>
<td>Pretest/posttest</td>
<td>Complex ADL: spreading margarine and jam after cutting bread, making coffee, fixing a carpet knife and cutting, managing a tape recorder. Measures of error reduction and decrease in assistance needed based on:</td>
<td>+</td>
<td>$p = 0.027$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Direct training</td>
<td>No difference</td>
<td>$p = 0.17$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exploration training</td>
<td>No difference</td>
<td>$p = 0.027$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td>Poole, 1998</td>
<td>Description of learning one handed techniques</td>
<td>ADL: compared to controls, the number of trials to:</td>
<td>+</td>
<td>$p = 0.0001$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Learn to tie a shoe</td>
<td>No difference</td>
<td>$p &lt; 0.0001$</td>
<td></td>
</tr>
<tr>
<td>Wilson, 1988</td>
<td>Case study</td>
<td>Drinking from a cup</td>
<td>+</td>
<td>No statistics</td>
<td>Activity limitations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Positioning a chair at the table</td>
<td>+</td>
<td>No statistics</td>
<td>Activity limitations</td>
</tr>
<tr>
<td>Smania et al, 2006</td>
<td>Randomized controlled trial</td>
<td>ADL questionnaire</td>
<td>+</td>
<td>$p &lt; 0.001$</td>
<td>Activity limitations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ideational apraxia</td>
<td>+</td>
<td>$p &lt; 0.01$</td>
<td>Impairment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ideomotor apraxia</td>
<td>+</td>
<td>$p &lt; 0.01$</td>
<td>Impairment</td>
</tr>
</tbody>
</table>

* Dimension based on World Health Organization’s (WHO) International Classification of Function (ICF). Impairments are problems in body function (physiologic functions of body systems) or structure (anatomic parts of the body such as organs, limbs, and their components) such as a significant deviation or loss. Activity limitations are difficulties an individual may have in executing activities. Participation restrictions are problems an individual may experience in involvement in life situations.

+, Improvement in the outcome measure that was beneficial to the participants; —, worsening or no change in status based on the outcome measure.