Working
With People Who have Limb
Apraxia: Evidence Based
Approaches and Practical
Considerations

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Objectives

Participants will:

- Appreciate the current understanding of apraxia
- Be able to discuss current top-down and bottom-up intervention approaches to treatment
- Apply learned knowledge to a case study
Outline

1. Incidence, Impact and Definitions
2. Selected Model
3. Assessment
4. Intervention approaches and possible strategies to sensory, conceptual and production issues
5. Occupation based approaches
6. Case study
Incidence and Definitions
Incidence & Impact of Apraxia

- **Incidence:** 28 – 57% – left hemisphere damage  
  0 – 34% – right hemisphere damage  
  (Donkervoort, Dekker, Van den Ende, Stehmann–Saris, & Deelman, 2000)  
  – problem persists in 20% diagnosed  (Basso, Capitani, Sala, Liacona, & Spinnler, 1987)

- **Impact:**  
  ◦ direct impact on functional performance  (Foundas, 1995 (eating), Hanna–Pladdy et al., 2003(toiletting and bathing))  
  ◦ increased caregiver burden  (Sundet et al., 1988)
Definitions

“a disorder of skilled movement not caused by weakness, akinesia, deafferentation, abnormal tone or posture, movement disorders such as tremors or chorea, intellectual deterioration, poor comprehension, or uncooperativeness.”

Ideomotor Apraxia

“A deficit of learned skilled purposive movements that specifically effects the efficiency and accuracy of the production of a movement and cannot be accounted for by elemental sensorimotor, cognitive or attentional deficits.” Rothi & Heilman, 1997, p 294.

- gestures are inaccurate (clumsy) due to abnormal spatial (posture, orientation of hand to objects and direction of movement) and/or temporal (timing) aspects of movement. (Smania et al., 2006)
- person knows what to do with the object but cannot call upon the nervous system to execute the command
- seen in conditions of verbal command (pantomime) and/or imitation and/or object use (Staminova et al., 2012)
Ideational Apraxia

- Has been used to describe impairments in actual tool use (De Renzi, 1985) or an inability to perform a sequence of acts using tools and objects to achieve an intended goal (Poeck, 1983; Poeck & Lehmkuhl, 1980).

- Ochipa, Rothi and Heilman (1992) suggest ideational apraxia is a problem in sequencing movements and **conceptual apraxia** is based on errors due to loss of object knowledge.

- Typical errors involve sequencing or object use errors.

- Classically, errors are seen, more in Pantomime and Object Use (Roy, 2001) but not in imitation.
<table>
<thead>
<tr>
<th>Ideational</th>
<th>Ideomotor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool/Object Related Errors</td>
<td>Spatial Errors</td>
</tr>
<tr>
<td>Inappropriate tool selection</td>
<td>Spatial orientation of hands incorrect to imagined tool (internal configuration)*</td>
</tr>
<tr>
<td>Performance of a related but incorrect action to the target object*</td>
<td>Finger arm and hand in inappropriate position with respect to imagined tool and object (external configuration)*</td>
</tr>
<tr>
<td>Performance of an unrelated action to the target object*</td>
<td>Movement in the wrong plane +</td>
</tr>
<tr>
<td>Use of hand to perform action rather than imagining target tool*</td>
<td>use of wrong muscle groups (movement)*</td>
</tr>
<tr>
<td></td>
<td>Body part as tool * +</td>
</tr>
<tr>
<td></td>
<td>Note:  Tools are the instruments performing the action.  Objects are the recipients of the action.</td>
</tr>
</tbody>
</table>

| Sequencing Errors                                                        | Temporal Errors                                                                                                                          |
| Perseveration of part of the series of the action+*                      | Timing of movement irregular*                                                                                                              |
| Problems in Terminating movements +                                     | Occurrence or increase in repetitions required for the action*                                                                           |
| Sequence of action out of order +                                       | Unsustained action                                                                                                                        |
| Blending of two actions +                                               | Clumsiness                                                                                                                               |
| Omission of action part +                                               | Sequencing of pantomime *                                                                                                                 |
| Repetitions +                                                           | Other                                                                                                                                 |
| substitution of movements unrelated to the movement +                   | Perseveration of sub part of the action+                                                                                                 |
| +                                                                        | No response                                                                                                                             |
| sequencing of individual movements in an action +                       | Perplexity +                                                                                                                             |
| Other                                                                   | Other                                                                                                                                   |
| No response                                                             | Perserveration of sub part of the action+                                                                                                 |
| Perplexity +                                                            | No response                                                                                                                             |
|                                                                          | amorphous movements                                                                                                                      |
|                                                                          | gestural or verbal augmentation when performing the movement                                                                            |

Unmarked  Other items From Tate and MacDonald (1995)
Model of Apraxia
Some Models

- Liepmann’s Model (1905 –1920)
- Roy’s Model (1996), Stamenova, Black and Roy (2013)
- Cubelli et al. (2000)
- Rothi and Heilman (1997)
- Buxbaum and Kalenine Model (2010)
- Rouinis and Humphreys (2015)
## Component Model Approach

*(Roy and Square, 1994; Roy, 1996; Stamenova, Black & Roy 2013)*

<table>
<thead>
<tr>
<th>System</th>
<th>Purpose of System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory–perceptual system</td>
<td>Analysis of visual–gestural and auditory–verbal information and visual–tool</td>
</tr>
<tr>
<td>Conceptual</td>
<td>Tool function and action storage</td>
</tr>
<tr>
<td>Production System</td>
<td>Motor execution and motor control</td>
</tr>
</tbody>
</table>
Component Model Approach
(Roy and Square, 1994; Roy, 1996, Stamenova et. al, 2012)

Sensory/Perceptual System
- Visual/Gestural Information
- Auditory/Verbal Information
- Visual Tool/Object Information

Conceptual System
- Knowledge of Action
- Knowledge of Tool/Object Function

Production System
- Response Selection
- Image Generation
- Working Memory
- Response Organization/Control

## 8 Patterns of Performance

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Gesture – Tool Recognition</th>
<th>System Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>P+ / DI− / CI−</td>
<td>−</td>
<td>Sensory Perceptual Problem</td>
</tr>
<tr>
<td>P− / DI+ / CI+</td>
<td>−</td>
<td>Conceptual System (Ideational)</td>
</tr>
<tr>
<td>P− / DI+ / CI+</td>
<td>+</td>
<td>Production System (e.g. Response Selection)</td>
</tr>
<tr>
<td>P+ / DI− / CI+</td>
<td>+</td>
<td>Production System (working memory)</td>
</tr>
<tr>
<td>P− / DI− / CI+</td>
<td>+</td>
<td>Production System (preserved analysis)</td>
</tr>
<tr>
<td>P+ / DI− / CI−</td>
<td>+</td>
<td>Production System (Response Organization and Control)</td>
</tr>
<tr>
<td>P− / DI− / CI−</td>
<td>+</td>
<td>Production System Impairment (Ideomotor)</td>
</tr>
<tr>
<td>P− / DI− / CI−</td>
<td>−</td>
<td>All System Impairment</td>
</tr>
</tbody>
</table>
Challenges with Assessment in Apraxia

- Testing complicated by lack of agreed upon terminology (Tate and MacDonald, 1995)
- Comparability of research tests of apraxia questionable (Butler, 2002)
- No Gold Standard
- Clinically non-directive
Testing for Apraxia

- Observational
- Screening – Identification of the problem and it’s severity
- Assessment Batteries – identify the place where the praxis process breaks down
Observational

- A–One – Arnadottir (1990)
- AMPS – Fisher (1990)

Comprehensive TULIA Items

- Imitation – non-symbolic
- Imitation – intransitive
- Imitation – transitive
- Pantomime – non-symbolic
- Pantomime – intransitive
- Pantomime – transitive

48 items – 6 point error based scoring method (0–5)

Also TULIA (AST) 12 item version (Vanbenlingen et al., 2011)
Maximum score = 12 with cut off < 9 indicating apraxia
Suggested Ideal Assessment

- Aphasia Screen, Visual Screen, Perceptual Test
- Traditional Apraxia Tests (Transitive Representational and Non Representational Gestures) Error scoring is desirable.
- Tool and Action Identification Tests
- Card Sequencing
- Multiple Objects Tests
- Mechanical Problem Solving (new learning)

(See Florida Assessment Battery (Rothi et al. 1997); Florida Apraxia Battery–Extended and Revised Sydney (FABERS), (Power et al. 2010) and Component Model Assessments)
Picture Sequencing Task
Multiple Objects Task
Mechanical Problem Solving
Interventions
Special Considerations for Choosing Interventions

Current Context:

- decreased time for intervention and length of stay
- lack of research based on models of praxis
- assessment time minimal
- high complexity and variability in presentation of apraxia and co-morbidities – few people fall into experimental population
  - eg. Aphasia and apraxia are often co-morbid (Kobayashi & Ugawa, 2013)

- natural environments best for praxis intervention – not often the setting for clients
Limited RCTs

West et al. (2009) Cochrane systematic review found 3 trials and concluded not enough evidence to support or refute effectiveness.

Lindsten-McQueen et al. (2014)
- Systematic review using FAME approach (Murphy et al, 2009)
Apraxic clients have an impaired ability to learn & retain information (Heilman et al, 1975 (rotary pursuit); Kimura, 1977 (manual sequence box); Poole, 1991 (tying shoes)

Learning is specific to targeted interventions and generalization must be taught? (For exception see Smania et al., 2000, Geusgens et al. 2007)

Interventions may not improve apraxia dramatically but may improve occupational performance.
Sensory–Perceptual Interventions
1. Maximizing sensory reception (Mary Warren, 1990)

Vision:
- Use of proper corrective lenses
- Good lighting
- Good contrast between objects and background
- Allow ample time to study environmental cues
- Improve scanning accuracy and speed
- Augment features of items important for movement by using color or arrows
- Decrease environmental complexity (decrease patterns on items and numbers of items) Remove unnecessary items for task.
Audition

- Use hearing aids
- Ensure reception of command by asking for repetition of commands
- Allow ample processing time
- Simplify statements – less information
- Decrease steps
Sensory–Perceptual Maximization

Tactile:
- Ensure ample processing time for exploration of items
- Augment sensory awareness through texture
- Re–educate re important features of objects
- Kinesthetic: Assist client to move slowly enough to ensure appreciation of movement
Assumption: Apraxia key problem is inadequate sensory integration or an inability to select the most important sensory information – could be addressed through sensory input or enhancement (Ayres, 1985; Croce, 1993; Goodgold-Edwards & Cermak, 1990)

- Sensory Stimulation (Butler, 1997, 2001)
Sensory Stimulation (Butler, 1997, 2001)

e.g. 2001 Case Study Male with Ideomotor and Ideational Apraxia

- sensory stim. Protocol + 20 mins Verbal and Visual Mediation of motor activities (touching targets, imitation, bilateral imitation, verbalizing hand position) which continued from baseline
- Outcomes – Improvements on motor tests, tests of ideational apraxia and imitating gestures and less inconsistency of movements.
Finding the Best Method/Sensory Modality to Evoke Movement

Which works best as a request for movement?

- visual object, visual picture, visual sequence of pictures, concurrent model imitation, delayed model imitation, tactile object presentation, combination tactile/visual object presentation, kinesthetic imitation.

- Utilize the strongest method or modality when requesting movement and correcting movement during a task.

- When re-teaching a gesture (as in learning gestures for communication) – use multiple cues and fade out stronger cues first (Maher et al., 1991; Code and Gaunt, 1986)

- Cuing may assist client to remember conceptual representations that are inaccessible. (Jefferies et al, 2007)
Structure and Function Relearning

Based on the notion that persons with conceptual apraxia have poor mechanical knowledge and problem solving with respect to objects (Goldenberg 2001).

Re-educate patients on the relationship between the structure of objects and their function. E.g. What features of objects go with what functions. (Mechanical Problem Solving)
Some Studies

- **Cubelli et al., 1991**: Single case study: Client’s acquisition of communicative gestures improved with Structure/Function training coupled with modeling gestures that represent the use of the object.

- **Goldenberg & Hagmann, 1998, 2001**: Studies found that this “exploratory intervention” was not successful in changing function in contrast to direct Errorless ADL intervention. Exploration training involved: explanation, copying, touching, comparison between objects, comparison of objects with photographs.
Limit objects for a task to those needed to decrease confusion caused by objects that might afford similar actions.

Highlighting objects with a visual symbol of the action may cue the action associated with the object. (Miller, 1986)

Pictures demonstrating object function for common objects (in context)

Bypass the conceptual system and request tasks through imitation

Teach client to self cue by humming/verbalizing rhythmically through a task – up/down/up/down

Utilize errors such as perseveration to start and complete an action – e.g. feeding
Why address production errors?
- Important in relearning communicative gestures
- Important in increasing efficiency of movement

Two types of problems:
- Correction of production errors, spatial and temporal
- Recognition/awareness of making errors
Intervention to Correct Gesture Errors

Sample Model (Based on Maher et al., 1991)

1. Select gestures for common items used in tasks important to the client (number could be determined or could select communicative gestures)
2. Request task using multiple cues (actual tool, picture of tool, verbal, imitation). Fade cues until you get correct production of gesture to visual target tool.
3. Provide feedback immediately on correctness of response
4. Correct error using physical manipulation or imitation
5. Set criterion of correct execution 3 times before moving on.
Targeting Specific Errors

- Targeting approach of limb to task, positioning of hand and activating the correct joint using verbal guidance and repetition,  
  (Ochipa et al, 1995)
2000 RCT: Training was graded for each type of gesture (transitive, intransitive symbolic and non-symbolic gestures).

- E.g. Transitive Gestures: Tool Use – Picture of someone doing a gesture – Picture of tool

- Participants cued manually, verbally, visually

- 50 mins, 3 Xs per week, 35 sessions produce improved performance on untrained IA and IMA tasks. No long term follow-up.

2006 RCT: Participants treated for apraxia

- 50 mins, 3 Xs per week, 30 sessions improved in praxis measures for ideational and ideomotor apraxia and ADL (caregiver burden) – effects sustained 2 months post stroke
Recognition of Errors

- If client can detect error but does not, slow down the activity
- If client cannot detect error utilize:
  - Stop action
  - Videotape
  - Awareness training
Rehabilitation of Disruption of Sequencing in ADL Context – Top Down

- Most logical focus
- Most articles address this method of rehabilitation
Verbal Mediation

- Theoretical roots in the Conductive Education technique (Cotton and Sutton, 1986)

- Aimed at reorganization of action through using speech to regulate movement

- Utilized in studies and reports by Wilson (1986) and Pilgrim and Humphreys (1994), Butler
break the desired movement/action down into sub-movements.

client executes each sub-movement while the instructor (& client) verbalize the intent of each sub movement & indicates timing of movement & perhaps sequencing

assistance to complete each sub movement is given as required

assistance is faded and then the verbal mediation is faded (in original form of conductive education, the client is instructed to internalize this mediated speech or say the instructions to his/herself)
not been investigated in isolation in apraxia intervention literature but has been used for procedural memory types of training (Wilson, 1987)

objective is to reestablish the ordered connection of the subtasks by increasing demands on the client to perform additional links of the chain together
Curran, M. C., Hussain, Z., Park, N. W. (presented at 109th meeting APA, San Francisco npark@yorku.ca)

- Goal: To teach novel naturalistic skills (e.g. wheelchair transfers, preparing food)
- Clients who were given a demonstration with verbal descriptions accompanying each step (verbal scaffolding) performed in a superior fashion to those who had a demonstration only.
Compensatory Strategies for Sequencing Issues

- Picture cards with steps of action
- Checklists
- Lay out objects in order of action
- Use of recorders
Intervention During Context of ADL– Strategy Training


Intervention geared at phases of activity with problems

1. Initiation (selection of action and objects). Instructions were the focus of intervention
2. Performance (executing the activity) Assistance
3. Correcting and Controlling Activity Feedback Strategies
van Heugten et al. 1998
- pre/post no control group,
- 12 weeks of (3 – 5 xs/wk, 30 mins) training
- 33 subjects improved on motor function (Motricity Index), apraxia tests (object use and imitation) and to a greater extent on ADL observation and Barthel

van Heugten et al. 2000
- used previous treatment cohort and added control cohort of non-apraxic participants to compare co-morbidities
- demonstrated improvements could occur with cognitive co-morbidity
- most severe apraxic participants (praxis and motor control) initially improved the most
Donkervoort et al. 2001
- strategy training experimental and usual-treatment control group – used previous tests
- tested 8 weeks and 5 months – treatment time average 25 sessions and 15 hrs (strategy group) and 27 sessions and 19hrs (control)
- strategy training group showed superior performance on ADL observation test
- no difference 5 months follow-up

Geuegens et al. 2006
- examined trained and untrained ADL observation tasks in study above.
- change scores in strategy training group were larger for non-trained tasks than in usual treatment group
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Geusgens et al, 2007

29 participants with apraxia

8 weeks strategy training on 4 out of 6 tasks selected from AMPS tasks with same level of difficulty. Two were untrained.

Tested pre–treatment, 8 weeks, 8 weeks at home and 5 months

Replicated earlier studies. Strategy training Improved ADL scores on trained and untrained tasks at hospital, home and 5 months later and was maintained over time.

Apraxia scores also improved
Direct Treatment: Focused on errorless completion of ADL; Support withdrawn when client could do on own; used hand over hand – “parallel” concurrent imitation – demonstration

- 15 subjects
- 1 of 3 activities trained per week followed by an ADL test. Repeated until subjects could perform with 0 or 1 fatal error
- no improvement on untrained tasks
- 6 months later 7 were retested. Improvements were maintained in only those who practiced at home.
Errorless Learning: Goldenberg, Daumuller and Hagmann, 2001

- Compared direct treatment and exploratory treatment.
- Direct therapy done in intervals of 6 sessions – 1 hour each. 4 activities trained. One pair were trained with exploratory and then direct. Next pair reversed. 1 week post tested with a variant of objects used. 3 months tested using original objects.
- Exploratory not effective. Direct Treatment post ADL assessment showed reduction in errors (reparable and fatal) & need for assistance.
- Treatment effects were maintained on follow-up but error rates were increased with different tools.
- Concluded training should be specific to individual
Capitalizing on Mirror Neuron System – Action Observation, Motor Imagery and Imitation (Garrison et al, 2010)

- Wu et al., 2011: Case study combining mental and physical practice with a 44 yr. old male with hemiparesis and ideomotor apraxia
  - Tasks practiced: Reach and grasp for cup and turning pages
  - Person first physically practiced tasks for the day for 30 mins then did 30 mins of audio guided mental practice for the task. 3xs/week, 6 weeks
  - Post intervention demonstrated improved function on Arm Mobility Scale and reported improved performance and satisfaction untrained tasks (COPM).
Compensatory Technological Solutions

Alex Milhailidis, Geoff Fernie & colleagues
(http://www.iatsl.org)
Intelligent ADL Prompting

- Client’s hands, the soap and the towel tracked through the video feed from overhead camera
- Using artificial intelligence, the system can play a verbal audio prompt if (and only if) the client misses or repeats a step in the activity
- Prompt specificity automatically adjusts to suit the client’s abilities
- 3rd set of clinical trials are underway, which also investigate the use of video cues
- No images are recorded and the system runs autonomously
Mr. P. is a 65 yr. old male with a left hemisphere bleed affecting his frontal and parietal areas.

- He has a mild receptive aphasia.
- He has difficulty producing movements in all aspects of apraxia testing – pantomime, imitation and object use and multiple object tests. He can recognize objects.
- During everyday tasks he misuses objects and often picks up any object to start a task.
- Currently he needs help with dressing and grooming. He can eat on his own.

He has a 6 week length of stay. He will return to live with his wife and children but will be alone during the lunch hour. He wants to prepare lunch for himself at home.

What is your approach?
51 yr. old person with stroke affecting left parietal area
On testing, she can pantomime to verbal command and can match objects and gestures but makes spatial and timing errors during execution of tasks. This suggests she has preserved conceptual abilities. Imitation of postures demonstrates the same types of awkward posturing. In everyday tasks such as brushing her teeth and putting sugar in her tea, she grasps the correct tool but does so incorrectly. She keeps on attempting these tasks though she is failing.

What type of apraxia?

What approach would you choose?
Interventions choices are still limited in apraxia intervention. The team are left to their own creativity to develop or co-develop strategies with the client to achieve daily living activities.

Occupation based interventions seem the most practical in current climate.

Inspired strategies for treating people with apraxia that stem from the understanding of praxis literature should be shared and evaluated.

Bring on the clinical case reports and studies!


Selected References


Selected References


