Box and Block Test vs. Nine Hole Peg Test to Assess Manual Dexterity Skills in Adults who Experience Upper-Extremity Hemiparesis Post-Stroke.

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What is Manual Dexterity?

- Stroke is the leading cause of adult disability with an estimated 25,500 new stroke events occurring annually in Ontario (Ontario Stroke Network, 2016).
- Upper-extremity hemiparesis is an impairment that can impact an individual's motor abilities post-stroke and decrease their manual dexterity skills.
- Manual dexterity includes the ability to grip, manipulate, and release objects (Teremetz, Colle, Hamdoun, Maier, & Lindberg, 2015).
- Important skill to possess to support engagement in activities of daily living including grooming tasks, meal preparation, writing, and playing a musical instrument.
Rational for Measurement

- Important in the clinical setting for therapists to be able to select the most appropriate upper-extremity/dexterity outcome measure(s) to:
  - determine if a client requires upper-extremity intervention.
  - determine if a client is making progress in rehabilitation.
  - justify changing or stopping treatment if a client is not making progress.

Measurement Tools

- **Box and Block Test (BBT)**
- **Nine Hole Peg Test (NHPT)**
Measurement Tools

**BBT**
- Measures unilateral gross manual dexterity.
- Consists of a wooden box divided into two compartments by a partition. The client has 60 seconds to move blocks from one compartment to the other with their affected upper-extremity.
- Initially developed by Jean Hyres and Patricia Buhler in 1957 but modified to current version in 1976.
- Quick and simple measurement tool to administer.
- No standardized training required.
- Utilized with a wide range of populations, including clients with stroke.

**NHPT**
- Measures finger dexterity, also known as fine manual dexterity.
- Consists of a square board with 9 holes where the pegs are inserted into. The client is timed on their ability to insert and remove the 9 pegs with their affected upper-limb.
- Quick to administer and inexpensive to purchase.
- No standardized training required.
- Can be utilized with a wide range of populations, including clients with stroke.

Psychometric Properties

**Reliability**

- **Test-retest reliability:**
  - Ekstrand, Lexell, and Brogardh (2016) evaluated test-retest reliability on common manual dexterity assessments with individuals who had mild to moderate hemiparesis post-stroke. The intra-class correlation coefficient (ICC) for the BBT in this study was excellent ICC=0.98 for the affected hand and ICC= 0.85 for the unaffected hand. The NHPT test-retest reliability was also excellent ICCs= 0.99 and 0.93.

- **Inter-rater reliability:**
  - Platz and colleagues (2005) examined the inter-rater reliability of three common upper-limb assessments including the BBT in patients who experienced hemiparesis secondary to a neurological event including stroke. Excellent inter-rater reliability was reported for the BBT with an ICC=0.99.
  - Heller and colleagues (1987) assessed inter-rater reliability of the Frenchay Arm Test, NHPT, finger tapping rate, and grip strength in the acute phase of stroke recovery. This research study demonstrated that the NHPT also has excellent inter-rater reliability with an ICC=0.95.
Psychometric Properties

Validity

- **Predictive Validity:**
  - Higgins, Mayo, Desrosiers, Salbach, and Ahmed (2005) examined the predictive validity of the BBT compared to the NHPT and three other common upper-limb assessments. Results from this study demonstrated that when conducted at one week post-stroke the BBT is the best predictor of upper-extremity function at five months post-stroke.

- **Convergent Validity:**
  - Ekstrand and colleagues (2016) also examined the convergent validity of three dexterity assessments. The results of this study revealed that the content correlation between outcome measures were adequate to excellent with the greatest connection demonstrated between the NHPT and the mSHFT with a Spearman rank correlation (rho) of 0.41 and the lowest correlation between the BBT and the mSHFT rho of -0.86.

- **Concurrent Validity:**
  - Lin, Chuang, Wu, Hsieh, and Chang (2010) studied the concurrent validity of the Action Research Arm Test (ARAT), BBT, and NHPT when compared to the Fugl-Meyer Assessment, Motor Activity Log, and Stroke Impact Scale. The results of this research study revealed that the correlations between upper-limb assessments were moderate to good at pretreatment rho= -0.55 to -0.80 and moderate posttreatment rho= -0.57 to -0.71.

Psychometric Properties

Responsiveness

- **Responsiveness:**
  - Lin and colleagues (2010) assessed the responsiveness of the ARAT, BBT, and NHPT. This study demonstrated that all three outcome measures were moderately sensitive to changes in hand dexterity with a standard response mean (SRM) of 0.64 (ARAT), 0.79 (BBT), and 0.74 (NHPT).
Clinical Utility

<table>
<thead>
<tr>
<th>BBT</th>
<th>NHPT</th>
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<tr>
<td>Quick assessment to administer taking approximately 2-5 minutes to conduct.</td>
<td>Simple and quick outcome measure to administer taking less than 10 minutes to conduct.</td>
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<td>No specialized training required and accessible online for purchase.</td>
<td>Standardized equipment required to complete testing but is accessible online for purchase.</td>
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<td>Seated position makes it practical to administer with patients post-stroke especially in the acute phase of recovery.</td>
<td>Appropriate to use with individuals post-stroke who have mild to moderate upper-extremity hemiparesis.</td>
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<td>Acceptable outcome measure to utilize with clients post-stroke who have mild or moderate hemiparesis and are in the acute, subacute, or chronic phase of stroke recovery.</td>
<td>Not acceptable to use with individuals in the acute phase of stroke recovery and those who have severe hemiparesis due to inability to adequately participate in testing (Jacob-Lloyd, Dunn, Brain, &amp; Lamb, 2005).</td>
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<tr>
<td>Not appropriate to use with individuals who have severe upper-extremity impairment post-stroke and/or a cognitive impairment (Chanubol et al., 2012).</td>
<td>Limited in assessing a variety of upper-extremity movements and results reflect fine manual dexterity skills.</td>
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<td>Limited in its ability to assess a variety of upper-extremity movements as it only measures gross manual dexterity skills.</td>
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Conclusion

- Evidence within the literature demonstrates that the BBT and the NHPT both have excellent test-retest reliability, inter-rater reliability, and adequate to excellent item correlation between measures.
- Both outcome measures have demonstrated to be moderately sensitive to changes in manual dexterity skills following a stroke.
- Clinically, both outcome measures do not pose a lot of burden on patients due to a seated testing position and limited time required to complete administration.
- The NHPT is not appropriate to use with individuals in the acute phase of stroke recovery or with severe upper-extremity hemiparesis because of the level of difficulty required to participate in testing.
- The BBT is also not acceptable with individuals who have severe hemiparesis but appropriate to use with clients who have experienced mild to moderate hemiparesis and are within the acute, subacute, or chronic phase of stroke recovery.

- BBT vs. NHPT??? ------------------>BBT
Questions??

References