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BSc (Physiotherapy)

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The Effect of the Testing Environment on the Reliability of the Movement Assessment Battery for Children-2

Éanna Clifford

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Supervisor: Dr. Amanda Connell

PY4007 and PY4008 Final Year Project

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I, the undersigned declare that this project which I am submitting is all my own work and that the data presented is authentic.

_________________________  (Printed Name)

_________________________  (Signature)

Date    /    /
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To the family, I can’t thank you all enough for your help and support. Despite the fact that when I’m home, it’s never long before I’ve got a serious dose of ‘cabin fever’, it’s always great to get home.

To my Nan, because how could I not give her a mention when I’m ‘her boy’!
Abstract

The Effect of the Testing Environment on the Reliability of the Movement Assessment Battery for Children-2

Authors: Éanna Clifford, Dr Amanda Connell PhD MCSP MISCP

Background: To be considered ecologically valid, a test should reflect tasks performed in the ‘real’ world (Campbell et al. 2009). Physiotherapists work in many different settings, but whether the results of the MABC-2 (Henderson et al. 2007) are transferrable between these settings is unknown, as the effect of the testing environment on performance has yet to be investigated.

Objectives: To determine whether the MABC-2 is a reliable means of assessing motor skill proficiency in a population of 7-10 year old primary school children when applied in 2 different locations on separate occasions.

Methods: 11 2nd class children (11 male, mean age 7.55yrs SD 0.52yrs) were tested on 2 occasions, 2 weeks apart, using the MABC-2. The 1st testing session took place in the children’s school, the 2nd in a physiotherapy clinic, a setting unfamiliar to the participants.

Results: The total test score of the MABC-2 (ICC 0.91, 95% CI 0.70 – 0.97) was shown to have good test-retest reliability (Portney and Watkins 2000). The test components, manual dexterity (ICC 0.81), aiming and catching (ICC 0.76) and balance (ICC 0.79) were shown to have good reliability, but many of the individual components were shown to have moderate (ICC 0.50-0.74) or poor reliability (ICC<0.50).

Conclusions: The total test score of the 2nd age band of the MABC-2 appears to have good test-retest reliability between familiar and unfamiliar locations. Further research needs to be done to determine whether location affects motor performance in children using a larger sample size.

Keywords: movement assessment battery for children 2; MABC-2; reliability; setting; location; environment
1. Introduction

Some children have great difficulty performing activities requiring motor co-ordination to a level consistent with the norm for their age. In the absence of any medical explanation, these children are diagnosed with developmental co-ordination disorder (DCD) (Van Waelvelde et al. 2007). Simple tasks such as kicking a ball, dressing and writing can present great difficulty to a child with DCD (Lipson et al. 2003), and studies have shown that these difficulties can persist into adolescence and beyond (Losse et al. 1991). There is a growing body of evidence to suggest that DCD can be associated with avoidance of activities requiring motor skills (Mandich et al. 2003), decreased self-worth (Miyahara et al. 2006; Rose et al. 1997), depression (Piek et al. 2007), social withdrawal (Mandich et al. 2003) and anxiety (Skinner et al. 2001). These impairments can have a long-lasting effect on motor, academic and psychosocial development (Cantell et al. 1994; Hellgren et al. 1993; Rasmussen et al. 2000). Not only are these impairments distressing for the child, but also for the wider family (Lipson et al. 2003). Though prevalence figures vary, the American Psychiatric Association puts the figure at 4-15% of school aged children (APA, 1994). This makes DCD a common disorder, and highlights the importance of having a reliable measure with which to identify these children.

In order to minimise the effects of these impairments, early identification of children who are at risk of having poor motor skills or display impaired motor skills is vital. The diagnosis of DCD requires a full assessment of the child’s motor skills, as measured by standardised tests. Many different measures are commonly used, including the Bruininks Oseretsky Test of Motor Proficiency (BOT; Bruininks 1978) and the Movement Assessment Battery for Children (MABC; Henderson and Sugden 1992), but there is no “gold standard”, no one measure that can be confidently used alone to identify the problem (Crawford et al. 2001). Despite this, the MABC has become increasingly used for the identification of children with DCD, both clinically and in research (Rodger et al. 2003), by physiotherapists, occupational therapists, psychologists and educational professionals (Barnett and Henderson 1998).

The MABC is a widely-used, standardised measure of motor skills in children between the ages of 4 and 12 and is one of the most popular instruments in assessing children with
motor coordination problems (Ruiz et al. 2003). The test is compiled of 3 sections: ball skills, balance and manual dexterity. The total impairment score is the sum of 8 scores, ranging between 0 and 40. A lower score indicates a better performance and a lesser degree of motor impairment. The assessment gives quantitative and qualitative data about a child’s performance in relation to the age-appropriate standard.

In 2007, a revised version of the MABC, the MABC-2 (Henderson et al. 2007) was released with some items reviewed and some new items introduced. The MABC-2 was developed to create a “reliable, easily administered and valid measure of competence in three broad and carefully selected areas of motor performance” (Henderson et al. 2007). The differences between the MABC and the MABC-2 for age band 2 are outlined in Figure 1. Raw scores are converted into standard scores, the sum of which make up the total test score (TTS). A TTS below or equal to 56 points places a child at or below the 5th percentile, in a red zone. Scores between 57 and 67 inclusive place a child between the 5th and 15th percentile, in an amber zone. Performance falls within the green zone, normal range, if the TTS score is above the 15th percentile, above 67. In this green zone there are no movement problems detected. A higher score indicates a better performance and a lesser degree of motor impairment. The manual suggests that children whose scores fall below the 5th percentile be looked upon as having a definite impairment, and those falling below the 15th percentile be regarded as being at risk. Norms are provided for three Age Bands (3:0–6:11 years, 7:0–10:11 years, and 11:0–16:11 years).
In clinical practice, outcome measures used to identify children with motor skill deficits need to be reliable and accurate (Lexell et al. 2005). The test authors assume that the reliability data and validity information reported for the MABC can be generalised to the MABC-2. “Confidence in the MABC-2 score interpretation can be derived not only from the UK standardisation study but also from the extensive validation data reported in this and earlier manuals” (Henderson et al. 2007, p. 132). The reliability of the MABC has been widely investigated, with a general consensus that the MABC has good test-retest and inter-rater reliability (Chow and Henderson 2003, Croce et al. 2001, Smits-Engelsman et al. 2008, Van Waelvelde et al. 2007). However, considering the age band structure has changed, and certain items have been amended or replaced, essentially, the MABC-2 is a new, discrete test that needs to have its own specific measurement properties evaluated. At present, the primary weakness of the MABC-2 is the lack of evidence on reliability and validity, as there is considerable variability between the quality, comprehensiveness, and

<table>
<thead>
<tr>
<th>Task</th>
<th>MABC+ task age bands 2/3</th>
<th>MABC-2+ Task age band 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual dexterity 1</td>
<td>Placing pegs/shifting pegs by rows</td>
<td>Placing pegs (new starting position and layout)</td>
</tr>
<tr>
<td>Manual dexterity 2</td>
<td>Threading lace/threading nuts on bolt</td>
<td>Threading lace (lacing board is longer)</td>
</tr>
<tr>
<td>Manual dexterity 3</td>
<td>Flower visual trail/flower visual trail</td>
<td>Drawing trail 2 (shape of visual trail has changed)</td>
</tr>
<tr>
<td>Aiming and catching 1</td>
<td>Two-hand catch/one hand bounce and catch</td>
<td>Catching with two hands</td>
</tr>
<tr>
<td>Aiming and catching 2</td>
<td>Throwing bean bag/throwing bean bag into box</td>
<td>Throwing bean bag onto matt (mat with target now used instead of box)</td>
</tr>
<tr>
<td>Balance 1</td>
<td>Stork balance/one-board balance</td>
<td>One-board balance</td>
</tr>
<tr>
<td>Balance 2</td>
<td>Heel-to-toe walking/ball balance</td>
<td>Walking heel-to-toe forwards</td>
</tr>
<tr>
<td>Balance 3</td>
<td>Jumping in squares/hopping in squares</td>
<td>Hopping on mats (mats used for this task)</td>
</tr>
</tbody>
</table>


*MABC: Movement Assessment Battery for Children.

Figure 1 - Changes in age band 2 tasks from MABC to MABC-2

Source: (Henderson et al. 2007, p. 118).
precision of reliability and validity studies reported in the test manual (Brown and Lalor 2009).

Interestingly, any study investigating the reliability of the MABC-2, or its predecessor, the MABC, has tested the children in the same room on both occasions. In order to be ecologically valid, a test should reflect the tasks performed in the ‘real’ world (Campbell et al. 2009). Paediatric Chartered Physiotherapists work in many different settings, e.g. hospitals, clinics, special schools, primary care teams, educational and developmental centres and a child’s own home (ISCP 2011), and in reality testing may take place in any of these locations. As outlined in Figure 2, the environment plays a major role in activity performance and participation in the developing child. Hence, it is important that the possible effect of the testing environment be acknowledged. Following an exhaustive search of the databases, no study could be found investigating the effect of the testing location on the motor performance of children. The MABC-2 examiner’s manual states that “when a medical room or staff room is used [for testing], care should be taken to ensure that the child feels at ease and understands that the test is not threatening” (Henderson et al. 2007, p14), acknowledging the potential effect of an unfamiliar environment on a child’s performance. The influence of the environment on a child’s performance and functioning is particularly important to document in this phase of the life-span (Simeonsson et al. 2003). According to Schneidert et al. (2003), who researched the role of the environment in the International Classification of Functioning, Disability and Health (ICF), an appropriate framework for researching and explaining the person-environment relationship needs to be developed.
Figure 2 - Modelling dimensions of functioning and disability: Child-Environment interaction

Source: Simeonsson et al. 2003
2. Aim

To determine the intra-rater reliability of the Movement Assessment Battery for Children-2 when applied in different settings.

2.1. Objective

- To determine whether the Movement Assessment Battery for Children-2 is a reliable means of assessing motor skill proficiency in a population of 7-10 year old primary school children when applied in two different locations on separate occasions.
3. Methodology

3.1. Study design

The reliability study consisted of two days testing, with exactly two weeks between testing sessions. Leemrijse et al. (1999) detected a practice effect over three testing sessions conducted three weeks apart, while Schoemaker et al. (1994) reported no practice effect when testing children 3 months apart. Van Waelvelde et al. (2007) recommend avoiding frequent testing over short testing periods, so it was decided to allow two weeks between testing sessions.

3.2. Ethical Approval

Ethical approval for the study was granted by The Education and Health Sciences Research Ethics Committee (EHSREC). The study followed the procedures of The University of Limerick Child Protection Guidelines (2006) throughout.

3.3. Participants

One mainstream primary school was invited to take part in the study, and a letter sent to the principal of the school (p36), who approved the study. The school randomly selected one 2nd class (all boys) to participate (n=14) (Figure 3). Each child was given an information leaflet (p34) and consent form (p37) for a parent/guardian to sign. Informed written consent from a parent/guardian was required to take part in the study. Consent forms were returned for 11 of the 14 children. These children (n=11) were included in the study (Mean age 7.55yrs, SD 0.52yrs). All 11 children were present for both assessments.
3.4. Inclusion Criteria

- Primary school children aged between 7 and 10, currently enrolled in 2nd class for the academic year 2010/2011.
- Informed consent from caregiver.

3.5. Exclusion Criteria

- Non-English speaking subjects.
- Children with any known medical condition.
- Children with a known neurological, developmental, or learning disability (Van Waelvelde et al. 2007; Miyahara et al. 1998).
### 3.6. Outcome Measures

The outcome measure used in this study was the English version of the MABC-2. The test involves children completing a series of fine and gross motor tasks grouped into three categories: manual dexterity, aiming and catching, and balance. Raw scores (Figure 4) are converted into standard scores using the examiner’s manual. The total impairment score is the sum of the 8 standard scores. A higher score indicates a better performance and a lesser degree of motor impairment. All children participating in this study were aged 7-8 so the second age band of the MABC-2 for 7-10 year olds was used. The items contained in this band are:

<table>
<thead>
<tr>
<th>Manual dexterity</th>
<th>Placing pegs (preferred and non-preferred hands)</th>
<th>Time in seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Threading lace</td>
<td>Time in seconds</td>
</tr>
<tr>
<td></td>
<td>Drawing trail (Figure 5)</td>
<td>Number of errors made</td>
</tr>
<tr>
<td>Aiming and Catching</td>
<td>Catching with two hands (Figure 6)</td>
<td>Number of successful catches out of 10</td>
</tr>
<tr>
<td></td>
<td>Throwing at a target</td>
<td>Number of successful attempts out of 10</td>
</tr>
<tr>
<td>Balance</td>
<td>One-board balance (both legs)</td>
<td>Time in seconds</td>
</tr>
<tr>
<td></td>
<td>Walking heel-toe forwards</td>
<td>Number of successful steps</td>
</tr>
<tr>
<td></td>
<td>Hopping (dominant and non-dominant legs)</td>
<td>Number of consecutive hops</td>
</tr>
</tbody>
</table>

Figure 4 – Items in age band 2 (7-10yrs) of the MABC-2
Figure 5 – Drawing trail

Figure 6 – Catching with two hands
3.7. Procedure

- A letter was sent to the principal of a mainstream primary school inviting them to take part in the study (Appendix 8.2. p36).

- Having obtained consent from the school, each child was given an information sheet (Appendix 8.1. p34), and a consent form (Appendix 8.3. p37) for a parent or guardian to sign.

- The official MABC-2 kit (Figure 7) was used in accordance with the instructions in the examiner’s manual to test each child individually (Henderson et al 2007, p41-56).

![MABC-2 testing kit](source: pearsonassessments.com)

- One physiotherapy student (the author) rated each child’s performance while another student administered the test.
- Children were tested twice, with exactly two weeks between testing sessions. Testing was conducted at the same time on the same weekday for each child on both occasions.

- Children were instructed to wear their school tracksuit for each testing session.

- Administration of the test took 25-40 minutes per child.

- The first testing session took place in the children’s school, while the second testing session took place in a nearby physiotherapy clinic, a setting unfamiliar to all of the participating children.

- No child changed in age band during the study.

3.8. Data Analysis

The raw scores obtained during testing were converted into standard scores using the examiner’s manual (Henderson et al. 2007, p79-82). Standard scores were used for the reliability analysis of the total test score (TTS) and the three components (Ellinoudis et al. 2011), and the individual test items (Smits-Engelsman et al. 2011). Statistical analysis was carried out using the Statistical Programme for the Social Sciences (SPSS) v18.0 software. Because the aim of the study was to investigate reliability and because of the small sample size, the intra-class correlation coefficient (ICC) and the Bland and Altman tests were chosen as the most appropriate measures for analysis (Rankin and Stokes 1998).

The ICC is a measure of reliability, and conveys the association between variables. An ICC value of 0 denotes no reliability, while a value of 1 denotes perfect reliability (Streiner and Norman 1995). ICCs however, do not give sufficient information to be interpreted in isolation. The coefficient is just a point estimate of reliability based on a selected sample. The ICC in isolation cannot give a true picture of reliability and should be complemented by hypothesis testing and/or confidence intervals (Eliasziw et al. 1994). Using a one-way random effects analysis of variance (ANOVA) model, ICCs along with 95% confidence intervals were calculated for intra-rater reliability.
Good reliability is defined as an ICC of 0.75 or higher, moderate as an ICC of 0.50-0.74, and poor as an ICC of less than 0.50 (Portney and Watkins 2000). For clinical measures, ICCs of between 0.91 and 1.0 indicate adequate reliability (Portney and Watkins 1993), but some would argue however, that there is no such thing as a minimum acceptable level of reliability that can be applied to all measures, as this will vary depending on the use of the test (Bruton et al. 2000).

Bland and Altman described a series of statistical methods for assessing agreement between two methods of clinical measurement (Bland and Altman 1986). Bland and Altman calculations of the mean difference (Mean diff), the 95% CI for the mean difference, the standard deviation of the differences (SD_{Diff}) and the standard error of the mean difference (SE of Diff) were used to complement the ICCs. The closer the mean difference to zero, and the narrower the 95% CI, the more reliable the measurement (Altman 1991). SE of Diff is a measure of how good the estimate of the mean difference is, and again, the closer this figure is to zero, the more reliable the measurement. Scatter plots were used to graphically represent the distribution of the data obtained (Rankin and Stokes 1998).
4. Results

Figure 8 summarises the results of the statistical analysis carried out on the data. The results of this study suggest that, overall, in terms of total test score, the MABC-2 (ICC 0.91, 95% CI 0.70-0.97) has good reliability. The Bland and Altman test results in Figure 8, and Figure 12 (p22), which shows most points contained within the 95% CI and few major outliers apart from one, support this agreement.

The ICC values for the three subsections of the test: manual dexterity (ICC 0.81), aiming and catching (ICC 0.76) and balance (ICC 0.79) also have good reliability, but many of the individual components have poor or moderate reliability.

The ICC of 0.81 for the manual dexterity section is good, though the 95% CI is wide (0.46-0.95). The distribution plot (Figure 9, p19) shows few outliers outside the 95% CI for the mean difference. These outliers do indicate however that there was a difference of 3-4 standard scores for manual dexterity for some children between the first and second testing sessions. Though the mean difference of -0.55 is relatively small, the SD\text{Diff} of 2.10 is large, indicating that this is not a very accurate estimate of the mean difference between test-retest scores.

Looking more closely at the items in manual dexterity, ICCs range from 0.37-0.61 with wide 95% CIs and large SD\text{Diff}. Placing pegs with the preferred hand (ICC 0.37) and threading lace (ICC 0.44) have poor reliability, while placing pegs with the non-preferred hand (ICC 0.61) and the drawing trail (ICC 0.55) have moderate reliability.

Similarly, the ICC value of 0.76 for the aiming and catching section is good, though the 95% CI is very wide (0.35-0.93). Figure 10 (p20) shows differences of 2-3 standard scores for several items between testing sessions. The mean difference of -0.36 is small, though the SD\text{Diff} of 1.80 is relatively high.

The individual components of the aiming and catching section, throwing (ICC 0.47) and catching (ICC 0.65) have poor and moderate reliability respectively. Again, the SD\text{Diff} is
large for both items, something which would be considerably smaller if the reliability was better.

The ICC value of 0.79 for the balance section shows good reliability, but the 95% CI of 0.41-0.94 is very wide. The mean difference between test-retest scores was 1.18, with a SD\textsubscript{Diff} of 2.32, both of which are high, given that they refer to standard scores. Figure 11 (p21) shows few outliers apart from two which indicate differences of 4-5 standard scores.

Interestingly, some of the items in the balance section have good reliability, with ICCs ranging from 0.41-0.99. Hopping other leg has poor reliability (ICC 0.41), while one-board balance other has moderate reliability (ICC 0.52). The other three items, one board balance best, walking heel-toe forwards, and hopping best had ICCs of 0.81, 0.99 and 0.98 respectively, giving them good reliability. Walking heel-toe forwards (95% CI 0.98-1.00), and hopping best (95% CI 0.91-0.99) in particular had very narrow 95% CI.
<table>
<thead>
<tr>
<th>Intracell Correlation Coefficients</th>
<th>Bland and Altman</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICC</td>
<td>95% Confidence Interval</td>
</tr>
<tr>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>Placing pegs preferred</td>
<td>.37</td>
</tr>
<tr>
<td>Placing pegs non-preferred</td>
<td>.61</td>
</tr>
<tr>
<td>Threading lace</td>
<td>.44</td>
</tr>
<tr>
<td>Drawing trail</td>
<td>.55</td>
</tr>
<tr>
<td><strong>Manual dexterity</strong></td>
<td><strong>.81</strong></td>
</tr>
<tr>
<td>Catching with two hands</td>
<td>.65</td>
</tr>
<tr>
<td>Throwing</td>
<td>.47</td>
</tr>
<tr>
<td><strong>Aiming and catching</strong></td>
<td><strong>.76</strong></td>
</tr>
<tr>
<td>One board balance best</td>
<td>.81</td>
</tr>
<tr>
<td>One board balance other</td>
<td>.52</td>
</tr>
<tr>
<td>Walking heel-toe forwards</td>
<td>.99</td>
</tr>
<tr>
<td>Hopping best</td>
<td>.98</td>
</tr>
<tr>
<td>Hopping other</td>
<td>.41</td>
</tr>
<tr>
<td><strong>Balance</strong></td>
<td><strong>.79</strong></td>
</tr>
<tr>
<td>Total test score</td>
<td><strong>.91</strong></td>
</tr>
</tbody>
</table>

Mean diff = Mean difference
SE of Diff = Standard error of the mean difference
SD<sub>Diff</sub> = Standard deviation of the mean difference

Figure 8 – Results table
Figure 9

Bland and Altman (1986) distribution plot showing mean score between testing sessions against the difference between test-retest scores for MANUAL DEXTERTY

---

95% confidence interval of the mean difference

<table>
<thead>
<tr>
<th>Pegs preferred</th>
<th>Pegs non-preferred</th>
<th>Threading lace</th>
<th>Drawing trail</th>
<th>Manual Dexterity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICC</td>
<td>0.37</td>
<td>0.61</td>
<td>0.44</td>
<td>0.55</td>
</tr>
<tr>
<td>Upper bound</td>
<td>0.78</td>
<td>0.87</td>
<td>0.81</td>
<td>0.85</td>
</tr>
<tr>
<td>Lower bound</td>
<td>-0.24</td>
<td>0.07</td>
<td>-0.16</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

I CCs and 95% Confidence Intervals for Manual Dexterity
Bland and Altman (1986) distribution plot showing mean score between testing sessions against the difference between test-retest scores for Aiming and Catching.

95% confidence interval of the mean difference.
OBB = One board balance

Figure 11

Bland and Altman (1986) distribution plot showing mean score between testing sessions against the difference between test-retest scores for BALANCE

![Bland and Altman plot](image)

95% confidence interval of the mean difference

**ICCs and 95% Confidence Intervals for Balance**

<table>
<thead>
<tr>
<th></th>
<th>OBB best</th>
<th>OBB other</th>
<th>Walking heel-toe</th>
<th>Hopping best</th>
<th>Hopping other</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICC</td>
<td>0.81</td>
<td>0.52</td>
<td>0.99</td>
<td>0.98</td>
<td>0.41</td>
<td>0.79</td>
</tr>
<tr>
<td>Upper bound</td>
<td>0.94</td>
<td>0.84</td>
<td>1</td>
<td>0.99</td>
<td>0.79</td>
<td>0.94</td>
</tr>
<tr>
<td>Lower bound</td>
<td>0.46</td>
<td>-0.05</td>
<td>0.98</td>
<td>0.91</td>
<td>-0.2</td>
<td>0.41</td>
</tr>
</tbody>
</table>
Bland and Altman (1986) distribution plot showing mean score between testing sessions against the difference between test-retest scores for TOTAL TEST SCORE

ICCs and 95% Confidence Intervals for Section scores and Total test score

<table>
<thead>
<tr>
<th></th>
<th>ICC</th>
<th>Upper bound</th>
<th>Lower bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual dexterity</td>
<td>0.81</td>
<td>0.95</td>
<td>0.46</td>
</tr>
<tr>
<td>Aiming and Catching</td>
<td>0.76</td>
<td>0.93</td>
<td>0.35</td>
</tr>
<tr>
<td>Balance</td>
<td>0.79</td>
<td>0.94</td>
<td>0.41</td>
</tr>
<tr>
<td>Total test score</td>
<td>0.91</td>
<td>0.97</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Figure 12
5. Discussion

At the time of this study, no other study could be found investigating the influence of the environment on the performance of children on the MABC-2, or its predecessor, the MABC. The environment plays a significant role in activity performance in children (Simeonsson et al. 2003), and the results of this study add to the evidence on the reliability of the MABC-2 in this regard. The ICC for total test score (TTS) was very good (ICC 0.91, 95% CI 0.70-0.97), but reliability for the component scores, and particularly the individual items was considerably less. This is similar to the findings of Leemrijse et al. (1999), who concluded that the TTS of the MABC was reliable, but the individual scores were not.

Walking heel-toe forwards (ICC 0.99, 95% CI 0.98-1.00), and hopping best (ICC 0.98, 95% CI 0.91-0.99) were found in this study to have excellent reliability. It is interesting to note that ceiling effects have been observed in heel-toe walking (Miyahara et al. 1998) and hopping in squares (Van Waelvelde et al. 2004, Miyahara et al. 1998) in previous studies of the MABC, so the excellent reliability demonstrated in this study should be interpreted with this in mind.

Few studies on the reliability of the MABC-2 are available for comparison, but an earlier small study (n=60) of all age bands demonstrated good reliability for component scores (r = 0.73-0.84) and TTS (r = 0.80) (Henderson et al. 2007). This is similar to the results of this study, although the reliability of the individual items is not mentioned, as the sample was deemed too small to do so. Equally, the results of this study must be interpreted with caution due to the small sample size (n=11).

This study was conducted on age band 2, so the applicability of the results of some other studies to this study is arguable. In a study carried out by the authors of the MABC-2 on 20 children in age band 1, Pearson Product Moment correlations of 0.91, 0.86 and 0.89 were achieved for the three manual dexterity items (pegs preferred and non-preferred counted as one item) respectively, above the 0.70 criterion for adequacy described by the authors. The aiming and catching tasks were less reliable, with coefficients of 0.48 and 0.68 respectively (Henderson et al 2007, p135). Ellinoudis et al. (2011) (ICC 0.61, 95% CI
0.43-0.75) and Smits-Engelsman et al. (2011) (ICC 0.74) also found the aiming and catching section of age band 1 to be the least reliable. Similarly, this study found the aiming and catching section to be the least reliable of the components (ICC 0.76). Comparing the raw data between testing sessions, significant variability was evident in this section, particularly on the throwing task. With the MABC-2, children are not required to maintain performance, but rather to produce single or limited movements. Thus, children may be able to score well with a “one off” achievement using the MABC (Rodger et al. 2010). Since variability is a hallmark of performance in both young children (Woollacott et al. 1989) and those with DCD (Hadders-Algara 2002), this makes it difficult to definitively say that variability in results is due to the measure itself. Stability or instability of test scores is usually interpreted as a quality of the measurement instrument, whereas in reality the subjects may have changed between test and retest (Leemrijse et al. 1999).

Chow et al. (2002) assessed 31 teenagers in age band 3 of the MABC-2, with individual item ICCs for test-retest reliability ranging from 0.62 to 0.92. The drawing trail (ICC 0.62, 95% CI 0.21-0.82) and the two-board balance (ICC 0.73, 95% CI 0.44-0.87) were the only tasks that did not meet the 0.70 criterion for good reliability (Portney and Watkins 2000). This study found similar low levels of reliability for the drawing trail task (ICC 0.55, 95% CI -0.02-0.85).

Faber and Nijhuis-Van der Sanden (2004) obtained an intra-rater reliability ICC for TTS of 0.79 when assessing 64 young adults in age band 3 of the MABC-2. However, this paper is an unpublished manuscript, thus has not been peer-reviewed and must be interpreted accordingly (Brown and Lalor 2009).

In parallel with the main UK standardisation study, another small study was carried out on 60 children, 20 from each age band. Children were tested twice with a minimum of one week between testing sessions, and a maximum of 2 weeks. Using the standard scores to calculate reliability, Pearson’s Product Moment correlations of 0.77, 0.84, 0.73 and 0.80 were obtained for the manual dexterity, aiming & catching, balance and TTS sections respectively (Henderson et al 2007, p136).
It is important to note when interpreting the results of this study that standard scores were used throughout to evaluate reliability. Though this approach has been used by other authors (Ellinoudis et al. 2011; Smits-Engelsman 2011), it is important to establish what data has been used for the reliability analysis before making comparisons between studies. Clearly, there is more variance when using raw data than there is when using standard scores, so the results of this study may suggest that the reliability of the MABC-2 is higher than it would be had raw scores been used. This also explains the improved reliability for component and TTS compared to individual item scores, due to the repeated standardisation of scores. As raw data, component scores and TTS are converted to standard scores, there is far less variance, as the standard scores are based on a far smaller scale than the raw scores. Hence, the repeated standardisation of scores makes it difficult for there to be a significant deviation in component and TTS between testing sessions.

Certain limitations must be taken into account when interpreting the results of this study. The rater was not trained in the administration of the test, and had only familiarised himself with the MABC-2 in so far as was possible before the study. To successfully administer the test, examiners must be familiar with the general procedures of standardised testing and should have some experience of working with children, particularly with movement difficulties. Examiners should also have comprehensive knowledge of the item instructions and practice the administration and demonstration of each item until the mechanics have been mastered (Henderson et al. 2007, p13). Thus, this may have affected the consistency of the commands or demonstrations given and affected repeatability in this manner.

While this study was carried out by a physiotherapy student, relatively unfamiliar with the MABC-2, previous studies assessing the reliability of the MABC-2 have used assessors trained in the administration of the test (Smits-Engelsman 2011). As a result, caution is advised when applying these results to assessors that are more familiar with guiding motor performance in children. Rankin and Stokes (1998) suggest that the larger population of raters needs to be defined, as this will suggest who will demonstrate similar reliability to the raters in the study. For example, this could be all physiotherapists of all abilities working in all areas, only physiotherapy students, or only senior physiotherapists in a
particular area (Rankin and Stokes 1998). Therefore, the results of this study may only be generalisable to physiotherapy students.

Another limitation of this study is that children with a developmental, neurological or learning disability were excluded from the study. As a result, no conclusions can be made regarding the reliability of the MABC-2 in children with motor impairments or co-occurring conditions. Until further research is done, the results of this study are only applicable to children with no known developmental, neurological or learning disability.

When any child is repeatedly tested by the same examiner, three possible sources of variability can arise. Firstly, there is incidental instability of performance, which means that a child’s performance can vary on any given day, regardless of who is doing the testing. Although research tends to neglect such fluctuations, it is the common experience of paediatric therapists that the degree to which a child suffers from functional limitations may vary from day to day (Van Geert 1994, Leemrijse et al. 1999). This is likely to contribute to random error variance. Secondly, there is the tester’s rating on the day, which could be affected by things such as how the rater felt on each day. This could introduce a systematic bias into the results. Thirdly, the idea of a practice effect, whereby a child’s performance improves due to repeated testing could also affect the repeatability of the test. Though two weeks were allowed between testing sessions to try and account for the practice effect, the optimal gap between test-retest sessions in not yet known, thus the possibility of a practice effect cannot be ignored.

When testing children, it is important to be aware of the factors that can affect the reproducibility of outcomes i.e. motivation, concentration, fatigue, emotional state, time of the test and relationship with the tester (Geldhof et al. 2006). The MABC-2 handbook advises examiners to attempt to convey enthusiasm and give frequent praise for effort to prevent discouragement (Henderson et al 2007, p16), but differences in this encouragement between testing sessions could affect a child’s performance. As the same tester carried out both testing sessions, and testing took place on the same weekday at the same time, every effort was made to minimise the effect of external factors on reproducibility. Considering the testing location changed between day 1 and day 2, the poorer performance of the children on certain items may be attributable to the effect of the
location on performance, or the intrinsic factors outlined above, or a combination of the two.

In a Schellenberg et al. (2007) study on exposure to music in children, the authors speculated that the unfamiliarity of the testing environment may have interfered with the effects of the music on the children. Conversely, in a study of getting data from children through interview techniques, Parkinson (2001) noted that the children seemed relaxed in a familiar setting, which allowed them to give the task their full attention. In this study, in the unfamiliar environment on the second testing day, the children’s performance was worse on certain items, particularly those involving use of the non-dominant side i.e. hopping and one-board balance, and the drawing trail. Perhaps the fact that the children had to deal with an unfamiliar environment meant that they could not devote as much of their attention to the task at hand as they did on the first occasion, and this adversely affected their performance.

If this is true, it may mean that children who are tested in unfamiliar locations, who under normal circumstances would not exhibit motor difficulties, may score poorly on certain items of the MABC-2. As the MABC-2 can be used for intervention planning (Henderson et al. 2007), this may lead a therapist to think that an intervention is indicated, when in reality, it may not be. Consequently, this may have significant implications for the current practice of assessing motor skills in children, and undoubtedly warrants further investigation.
6. Conclusion

Though the reliability of the individual test items is variable, the TTS of the 2nd age band of the MABC-2 appears to have good test-retest reliability between familiar and unfamiliar locations, when comparing standard scores.

An unfamiliar setting seems to adversely affect performance, particularly on tasks requiring more concentration i.e. use of the non-dominant side. This is possibly due to the fact that the children cannot devote their full attention to the task at hand because of the unfamiliar setting.

The American Academy of Pediatrics’ Committee on Children with Disabilities (2001) highlighted the need for screening tools that are simple, valid, standardised and reliable. The results of this study highlight the need for further research in this area. Further research is required to determine whether the testing location affects motor performance in children using a larger sample size. Future testing should evaluate the effects of location on all age bands of the MABC-2, and should include those with a known motor impairment.

Although it seems that the MABC-2 has good reliability regarding total test and component scores, until the psychometric properties of the MABC-2 are further investigated concerning the influence of the testing location, it should be borne in mind that the choice of testing location may affect a child’s performance. Hence, where possible, children should be tested in the same location, and ideally, this location should be familiar to them.
7. References


Corporation.


8. Appendices

8.1. Subject Information Leaflet

What is the study about?

There are many measures currently being used to assess motor skills/co-ordination in children. This study aims to assess how reliable one of these measures, the Movement Assessment Battery for Children-2 is.

Where and when?

Testing will take place during school hours, once in the school, and once in a clinical setting 1 week later, with as little disruption to class time as possible. Your child will be accompanied to the clinical setting by the project investigators and will be supervised at all times.

What will I have to do?

If you wish for your child to participate in the study, please sign the attached consent form. You will then be notified when the testing sessions will take place.

Your child will have to complete a series of simple tasks in the categories of dexterity, aiming and catching, and balance. Such tasks will include placing pegs, throwing bean bags onto a mat, and hopping. Your child’s performance in these tasks will be recorded on the M-ABC-2 scale and you may request information about your child’s performance when the study is completed.

The tasks will include:

Manual Dexterity
1.) Placing pegs
2.) Threading lace
3.) Drawing a trail

Balance
4.) Catching with two hands
5.) Throwing a bean bag onto a mat

Aiming and catching
6.) One-board balance
7.) Walking heel-to-toe forwards
8.) Hopping on mats

What are the benefits?

Your child will be providing valuable information about the reliability of the M-ABC2.

Should your child display any difficulties with the tasks, these will be brought to your attention and can be dealt with.

What are the risks?

Testing involves simple tasks, no different from playtime activities in school and is non-invasive and should therefore have no serious risks associated with it.

Should your child wish at any point to discontinue the testing, he/she is fully entitled to withdraw without giving a reason.

What if I do not want to take part?

Your child may only take part in this project with your permission.

Participation is completely voluntary and you are under no obligation to take part.

Parents/Children can withdraw from the study at any stage without giving a reason.

What happens to the information?

Any information gathered during the study will remain confidential and anonymous. Participants will not be referred to by name anywhere in the study. At the end of the study information gathered will be used as part of a Final Year Physiotherapy project in the University of Limerick. Upon completion of the study, the information will be stored in a locked cabinet in an office in the Health Sciences Building in the University of Limerick for 7 years in accordance with research ethics.
Parents may request information pertaining to their child from the researchers following completion of the study.

Who else is taking part?

Approximately 10-20 primary school children, aged 7 to 10 years will be recruited from the school.

What if I have more questions or do not understand something?

If you require any further information or do not understand something you can at any point contact the project investigators through the contact details below or ask the project investigators on the day of testing.

What happens if I change my mind during the study?

As participation is voluntary you are free to withdraw from the study at any time for any reason with no explanation required.

What to do?

If you would like your child to participate in the study, please fill out the adjoining consent form and return it to the school as soon as possible.

Thank you for taking the time to read this leaflet

Contact name and number of Project Investigators.

Amanda Connell  Amanda.Connell@ul.ie

Eanna Clifford  0753726@studentmail.ul.ie

Conor Martin  0725927@studentmail.ul.ie

'If you have concerns about this study and wish to contact someone independent, you may contact'

The Chairman of the University of Limerick Research Ethics Committee,

C/o Vice President Academic and Registrar’s Office,

University of Limerick,

Limerick.

Tel: (061) 202022
8.2. Letter to Principal

To whom it may concern,

My name is Éanna Clifford and I am a fourth year physiotherapy student in the University of Limerick. As part of final year, students are required to undertake a project relating to an area of their choice. My chosen area is paediatrics and the title of my project is, ‘To assess the reliability of the Movement Assessment Battery for Children-2 when used in different settings, the school and the clinic’. The aim of the study is to ascertain whether environment has a role to play in a child’s motor performance, thus influencing the degree to which results obtained on a measure of motor skills are transferable between these settings. In order to conduct this project I am looking to recruit ten to twenty pupils from your school aged between 7 and 10 years. It would be greatly appreciated if you were prepared to facilitate the undertaking of this project in your school.

Children will be required to complete the following tasks: 1.) Placing pegs  2.) Threading lace 3.) Drawing a trail  4.) Catching with two hands  5.) Throwing a bean bag onto a mat  6.) One-board balance  7.) Walking heel-to-toe forward  8.) Hopping on mats. Children would be tested once in the school, and once in a clinical setting close to your school one week later. Testing should take no longer than 40 minutes per child on each occasion and children will be accompanied by myself and one other investigator to the clinical setting. At all times testing will be carried out under the supervision of Dr. Amanda Connell (PhD, MSc, MCSP, MISCP), a lecturer from the Physiotherapy Department in the University of Limerick. The data collected will remain anonymous and be stored in a locked drawer in the Health Sciences Building in the University of Limerick when testing is completed. Participation is entirely voluntary and informed consent will be sought from each student and their respective parent/guardian(s) – please find enclosed the information sheet. If at any stage the student or their parent/guardian(s) wishes to withdraw they will be allowed to do so immediately. Ethical approval has been obtained from The University of Limerick Research Ethics Committee allowing the project to take place.

Should you wish your school to partake in this project, I would propose conducting testing sometime in December or at a date convenient for you. Please feel free to contact me or my supervisor at any stage with any queries you may have.

Yours sincerely,

Éanna Clifford

Éanna Clifford  Conor Martin  Amanda Connell

Email: 0753726@studentmail.ul.ie  0725927@studentmail.ul.ie  amanda.connell@ul.ie
8.3. Informed Consent Form

- I have read and understood the subject information leaflet.

- I understand what the project is about, and what the results will be used for.

- I am fully aware of all of the procedures involving my child, and of any risks and benefits associated with the study.

- I know that my child’s participation is voluntary and that he/she can withdraw from the project at any stage without giving any reason.

- I am aware that my child’s results will be kept confidential.

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Signed: ________________________________

Date: ________________

Tester Signature: ________________________________

Print Name: ________________________________

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Day 2 (Standard scores in brackets)