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The Predictive Validity of the Test of Infant Motor Performance on School Age Motor Developmental Delay

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CRITICALLY APPRAISED TOPIC

Title: The Predictive Validity of the Test of Infant Motor Performance on School Age Motor Developmental Delay.

Clinical Scenario: Is the Test of Infant Motor Performance (TIMP) a valid assessment tool for infants less than 4 months of age and can scores on the TIMP predict school age motor development? Physical therapists in outpatient settings have been treating preterm infants as early as 3 weeks and are considering using the TIMP instead of the Peabody Development Motor Scale (PDMS) or the Bayley Scale of Infant Development (BSID) as an assessment tool for infant motor development. The PDMS is a valid assessment tool of children from birth to 60 months and the BSID is a valid assessment tool of children from 1 month to 42 months; however, both tests fail to predict school age motor development for infants less than 3 months of age.[1]

Introduction: Due to the advancements in prenatal, perinatal and neonatal medicine, survival rates for infants less than 32 weeks of age are greater than 85%.[1] Despite this, more than 50% of preterm infants develop neurological impairments including motor incoordination, cognitive impairment, attention deficits, or behavioral problems.[1] It is important to accurately identify preterm infants who are at risk for developmental delays since the research has shown that early preventative interventions can avert functional limitations later in life.[2] There are several motor assessment tools for infants less than 37 weeks gestation up to 4 months of age; however, no gold standard has been established.[3] The TIMP, created by Susan Campbell and associates[2], was developed to evaluate functional motor development of infants between 34 week post-conception up to 4 months of age. The research suggests that the TIMP is a reliable and valid test for assessing infants 34 weeks up to 4 months with strong intra-rater reliability and construct validity.[2,3] However, the predictability of the TIMP on determining an infant's motor development at school age is unknown. The purpose of this critically appraised topic is to investigate the current literature to determine the predictive validity of the TIMP compared to commonly used school aged motor development outcome measurements, in order to determine which infants would benefit from early physical therapy interventions to prevent future functional limitations.

My Clinical Question: Can the TIMP predict an infant's risk of motor developmental delay at school age, to determine which infants would benefit from early physical therapy interventions?

Clinical Question PICO:

Population – Infants 34 weeks post conception to 4 months of age

Intervention – Test of Infant of Motor Performance

Comparison – Bruininks-Oseretky Test of Motor Proficiency (BOTMP) and Peabody Developmental Motor Scales, 2nd edition (PDMS2)

Outcome – Sensitivity, specificity, positive predictive values, negative predictive values

Overall Clinical Bottom Line: Based on the results found by Flegel *et al.*[4] and Kolobe *et al.*[5] the Test of Infant Motor Performance accurately predicts school age motor development on the Bruininks-Oseretky Test of Motor Proficiency and the Peabody Developmental Motor Scales, 2nd edition. The TIMP can be used as an assessment tool to determine which infants would benefit from early physical therapy interventions.

Search Terms: Test of Infant Motor Performance AND Peabody; Test of Infant Motor Performance AND Bruininks-Oseretky. Databases used: MEDLINE - Ovid, CINAHL (EBSCOhost), PubMed.

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Rationale for Chosen Articles: Using the above search terms and search engines a total of 24 articles were found. Of the found articles, two articles match the clinical PICO. QUADAS scores were used to critique the diagnostic accuracy of both articles. Flegel *et al.* had a QUADAS score of 13/14 and Kolobe *et al.* had a QUADAS score of 14/14 (see table 1). Since both articles had high QUADAS scores and each matched the clinical PICO both articles were used in this critically appraised topic.

(1) Flegel J, Kolobe T. Predictive validity of the test of infant motor performance as measured by the bruininks-oseretsky test of motor proficiency at school age. *J Phys Ther*. 2002; 82(8): 762-773.
   a. QUADAS score: 13/14
   b. Patient: 35 school age children between 4 years 9 months to 7 years 3 months, tested on the TIMP between the ages of 32 weeks post conception to 3.5 months of age
   c. Intervention: TIMP
   d. Comparison: BOTMP and Problem-Oriented Perinatal Risk Assessment System (POPRAS)
   e. Outcome measures: Sensitivity, specificity, positive predictive value, negative predictive value, correlation coefficient

(2) Kolobe T, Bulanda M, Susman L. Predicting motor outcome at preschool age for infants tested at 7, 30, 60, 90 days after term age using the test of infant motor performance. *J Phy Ther*. 2004; 84(12): 114-127.
   a. QUADAS score: 14/14
   b. Patient: 61 children between 4 to 5 years of age, tested on the TIMP weekly between 34 weeks gestational age to 4 months postterm
   c. Intervention: TIMP
   d. Comparison: PDMS2 and POPRAS
   e. Outcome measures: Sensitivity, specificity, positive predictive value, negative predictive, correlation coefficient

Table 1. Comparison of QUADAS scores

Item	Flegel *et al.*	Kolobe *et al.*
Was the spectrum of patients representative of the patients who will receive the test in practice?	Y	Y
Were selection criteria clearly described?	Y	Y
Is the reference standard likely to correctly classify the target condition?	Y	Y
Is the time period between reference standard and index test short enough to be reasonably sure that the target condition did not change between the two tests?	Y	Y
Did the whole sample or a random selection of the sample, receive verification using a reference standard of diagnosis?	Y	Y

Did patients receive the same reference standard regardless of the index test result?	Y	Y
Was the reference standard independent of the index test	Y	Y
Was the execution of the index test described in sufficient detail to permit replication of the test?	Y	Y
Was the execution of the reference standard described in sufficient detail to permit its replication?	Y	Y
Were the index test results interpreted without knowledge of the results of the reference standard?	N	Y
Total Score	13/14	14/14

Based on the above comparisons, I have chosen to write this critically appraised paper on the articles by Flegel *et al*. and Kolobe *et al*.

Article 1: Flegel *et al.*, 2002.

Clinical Bottom Line: Based on this article, infants between 32 weeks post-conception and 4 months of age who score -1.6 standard deviations from the mean on the TIMP will have a low motor performance on BOTMP, indicated by a score -1.5 standard deviations away from the mean. Therefore, infants identified on the TIMP as having atypical motor development would benefit from early physical therapy services to avert functional limitations at school age as evident by the high specificity (1.0) and positive predicative value (1.00) results. However, due to lower sensitivity (0.5) and negative predictive value (0.87) therapists who use the TIMP need to be aware of false negatives. The study had good internal and external validity and is easy to administer during a physical therapy evaluation.

Article PICO:

P – Children between 4 years 9 months to 7 years 3 months who had been tested on the TIMP between 32 weeks post conception to 3.5 months of age. Exclusion criteria included infants with congenital malformations. Inclusion criteria included preterm infants less than 37 weeks gestation and full term more than 37 weeks gestation with varying degrees of medical complications.

I – Test of Infant Motor Performance

C – Bruininks-Oseretky Test of Motor Proficiency and Problem-Oriented Perinatal Risk Assessment System

O – Sensitivity, specificity, positive predictive value, negative predictive value, correlation coefficient, percent correct

Representative Sample: The spectrum of child ages in the study was representative of infants in the clinic who would be assessed on the TIMP.

Blind Comparison: Physical therapists who administered the BOTMP were blinded to the results of the TIMP and the POPRAS prior to testing participants on the BOTMP.

Independent Reference Standard: The TIMP and the BOTMP are separate tests with no overlap in testing items.

Reliability of Clinical Test and Reference Standard: The authors cite two articles that established the TIMP as having a strong intra-rater reliability (r= 0.89) among experienced examiners. The test-retest reliability was cited by the author's as strong (r=0.89) when tested over a three-day period. Physical and occupational therapists were trained on how to administer and score the TIMP prior to the study; however, the authors did not determine their own TIMP intra-rater or test-retest reliability. The authors reported reliability of the BOTMP based on results determined by administering the BOTMP to 6 children, not included in the study with similar age range to the participants. One author administered 4 BOTMP and scored the corresponding tests while another experienced therapist observed the 4 tests and scored the corresponding tests. The therapists switch and the experienced therapist administered 2 BOTMP and scored the test while the author observed and scored the corresponding test. From this testing, the intra-rater reliability was calculated r=0.97, suggesting the BOTMP has strong intra-rater reliability. The authors did not report BOTMP test-retest reliability.

Ascertainment: All participants that remained in the study were administered both the TIMP and the BOTMP.

Validation in Second Independent Sample: A second independent sample was not used in this study.

Study: A total of 137 participants between 32 weeks post conception to 3.5 months of age, were recruited from 3 nurseries in the Chicago metro area for the initial Campbell and associates study on the TIMP. All participants were stratified into 7 age groups based on the participant's age when the TIMP was administered. Within each group participants were categorized into 3 subgroups based on their medical risk as measured by POPRAS scores, prior to being tested on the TIMP. All 137 participants were assessed on the POPRAS by trained nurses and the TIMP by occupational and physical therapists who were trained on how to administer the TIMP. Very young infants were feed one hour prior to the administration of the TIMP.

Of the 137 original participants, in the Campbell and associates study, only 65 participants were located for the follow-up study. The authors randomly selected two participants within each age and risk group to be assessed on the BOTMP. In several of the age and risk groups only one participant was located for the follow-up study. In this circumstance, the one participant was the only participant assessed on the BOTMP for that group. A total of 35 participants, which included 19 males and 16 females, were assessed on the BOTMP, 32 at home and 3 in an outpatient therapy classroom. The BOTMP was administered according to the standardized instructions in the testing manual. Two of the participants were uncooperative and the BOTMP had to be completed over two sessions within an eight day time period. The other 33 participants were assessed on the BOTMP during one session. A questionnaire was filled about by the participant's parent or guardian after the BOTMP test. The questionnaire included demographics, medications and child's development to determine if there were any medical complications between the administration of the TIMP and the BOTMP that would alter motor development and disability.

Summary of Internal Validity: This study had good internal validity. Although the scores on the TIMP were of participants from another study, the authors used the same participants for the BOTMP assessment. The BOTMP assessors were blinded to the participant's results on the TIMP and there were more than 34 participants in the study, which was above necessary sample size, determined by a power analysis, in order to determine statistical significance. Participants were representative of patients seen in the clinical setting, and the tests were administered over an appropriate amount of time. In addition, items on the TIMP and the BOTMP were independent with no overlap; all participants were assessed on both the TIMP and BOTMP, and both the TIMP and BOTMP possess strong validity and reliability as measurements of motor development. Threats to internal validity include 1) having different assessors for the TIMP and the BOTMP, 2) small sample size, and 3) environmental and geographical factors contributing to an infant's development. The threats to internal validity are not significant since the variability in the participants was similar to infants seen at this outpatient pediatric setting.

Evidence: Sensitivity, specificity, positive predicative values, and negative predictive values between the TIMP and the BOTMP were calculated after the participants were assessed on the BOTMP between the ages of 4 years 9 months and 7 years 3 months.

At the time of the study standardized norms had not been developed yet for the TIMP; therefore, there was not a cutoff point to determine a score on the TIMP that would indicative atypical motor development. Due to the lack of standardized norms, the authors used several cutoff points on the TIMP to predict motor development on the BOTMP. For the BOTMP there are standardized norms and the author's use a z-score of -1.5 as the cutoff for low motor performance for all participants at their respective age.

Based on the results, the TIMP cutoff z-score of -1.6 had the greatest overall accuracy by correctly predicating motor performance on the BOTMP compared to TIMP scores 89% of the time. Since the author's identified -1.6 as the value of interest they did not provide additional 95% confidence intervals for the other TIMP z-scores.

Overall, when using the cutoff score of -1.6 standard deviations from the mean on the TIMP, the TIMP had a sensitivity of 0.5, specificity of 1.0, positive predicative value of 1.00 and negative predictive value of 0.87 compared to BOTMP scores. (See tables 2a, 2b, 2c,2d)

Table 2a. Mean, standard deviation, range of scores on the TIMP and BOTMP

	Mean	Standard Deviation	Range of Score

TIMP (n=35)	82.7	30.7	16 to 157
BOTMP (n=35)	43.9	11.6	20 to 65

The authors reported the mean, standard deviation and range scores of the 35 participants who were assessed on both TIMP and BOTMP. The range of TIMP scores is large which can affect the statistical significance of the data; however, clinically physical therapists will treat a wide range of infants with varying scores on both the TIMP and BOTMP. Higher scores on both the TIMP and BOTMP indicate higher levels of motor performance.

Table 2b. Sensitivity, specificity, positive predicative values, negative predictive values and percent correct of the TIMP sores compared to the BOTMP scores.

TIMP Cutoff Z-Scores	Sensitivity	Specificity	Positive Predicative Values	Negative Predicative Values	% Correct
-0.5	.75	.63	.38	.89	66%
-0.75	.63	.74	.42	.87	71%
-1.0	.50	.81	.44	.85	74%
-1.5	.50	.96	.8	.87	86%
-1.6	.50	1.00	1.00	.87	89%
-2.0	.25	1.00	1.00	.82	83%

Sensitivity represents participants with typical motor development scores on the TIMP that had typical motor performance scores on the BOTMP and therefore these participants would not need early physical therapy services. Specificity represents participants with atypical motor development scores on the TIMP (scores -1.6 standard deviations away from the mean) that had atypical motor performance scores on the BOTMP (scores -1.5 standard deviations away from the mean) and therefore these participants would benefit from early physical therapy services. The closer the sensitivity and specificity values are to 1.0 the more accurate the TIMP score is at identifying the need for therapy services. The highest sensitivity was 0.75 at TIMP cutoff z-score of -0.5 and the highest specificity was 1.00 at -1.6 and -2.0 TIMP cutoff z-scores.

The negative predictive values represent the participants with typical motor development scores on the TIMP that were accurately identified as not having a low motor performance on the BOTMP. Positive predictive values represent the participants with atypical motor development scores on TIMP that were accurately identified as having a low motor performance on the BOTMP. The closer the predicative value is to 1.0, the more accurate a high or low score on the TIMP is at predicating motor development performance on the BOTMP. The highest negative predictive value was 0.89 at the -0.5 TIMP cutoff z-score and highest positive predictive value was 1.00 at -1.6 and -2.0 TIMP cutoff z-scores.

The percent correct was determined by the number of participants in each age and risk group, based on TIMP cut off z-score, that were correctly identified on the TIMP as having or not having a low motor performance score on the BOTMP. The highest correct percentage 89% was at a z-score of -1.6.

Table 2c. 95% confidence interval for sensitivity and negative predictive values of the TIMP compared to the BOTMP.

TIMP Cutoff Z-Score	Sensitivity	Negative Predicative Values
-1.6	.50 (.33 to .67)	.87 (.76 to 9.8)

The only 95% confidence internals reported in the study were of sensitivity and negative predicative values at the TIMP cutoff z-score of -1.6. Unfortunately it was not possible to calculate additional 95% confidence internals due to lack of the raw data. The 95% confidence intervals help to determine the reliability of the results. Since the reported confidence interval values are positive, the interval values did not go infinity, and interval ranges were small the reliability sensitivity and negative predicative values were reliable at the TIMP cutoff z-score of -1.6.

Table 2d. Positive likelihood ratio, negative likelihood ratio, positive post-test probability percentage, negative post-test probability percentage of the TIMP compared to the BOTMP.

TIMP cutoff z-score	Positive Likelihood Ratio	Negative Likelihood Ratio	Positive Post-Test Probability %	Negative Post-Test Probability %
-1.6	-	.50	100%	33%

Likelihood ratios and post-test probability percentages were calculated using raw data reported in the study at TIMP cutoff z-score of -1.6. Since the specificity of the

TIMP compared to the BOTMP was 1.0, it is mathematically impossible to calculate the positive likelihood ratio. In other terms, there were zero false positive or atypical TIMP scores compared to atypical BOTMP scores. A negative likelihood ratio of 0.50 denotes a small change in the likelihood of a participant with atypical motor development score on the TIMP as having an atypical motor development performance score on the BOTMP.

The 100% positive post-test probability means that infants identified on the TIMP as having delay motor development ended up having a low motor performance score on the BOTMP 100% of the time. The 33% negative post-test probability represents the probability of an infant not having a motor development delay on the TIMP who ended up having a low motor performance on the BOTMP. Since the negative post-test probability percentage is low, the TIMP has a high percentage of false negatives, meaning infants with low motor performance on the BOTMP are not identified on the TIMP and therefore, would not have received early physical therapy interventions, when there was a probability of that infant having an atypical motor development at school age.

Applicability of Study Results:

Clinical test available, affordable, accurate, and precise in our setting: The TIMP is available online at http://thetimp.com/. It costs $700 a year for an institution and $300 a year for individual use. For 100 TIMP forms it costs $65. The TIMP takes on average 36 minutes to administer making it an easy assessment tool to use during an evaluation. Due to the cost and the limited number of patients between 32 weeks post conception to 4 months being treated at this outpatient location, it might not be worth purchasing. Although, the TIMP accurately identifies infants with motor developmental delays who would benefit from physical therapy services, the test is expense for the clinic only that evaluates 1-2 infants that meet the TIMP criteria per month.

Summary of external Validity: There were minimal threats to the internal validity of this study. The participants were similar to patients at the clinic. The TIMP can identify the majority of infants with low motor performance, between the 32 weeks post conception to 4 months of age who would benefit from early therapy interventions to minimize school age functional limitations.

Article 2: Kolobe *et al.*, 2004.

Clinical Bottom Line: Based on the results from this article, atypical motor development scores on the TIMP, identified as -0.5 standard deviations from the mean, at 90 days of age can predict school age atypical motor development delay on the PDMS2 at -1.0 standard deviations away from the mean and at -2.0 standard deviations away from the mean.

Article PICO:

P – Children between 4 and 5 years of age with varying levels of developmental disability. All participants had been tested weekly on the TIMP between 33 weeks post conception to 4 months of age. All infants were included into the study if his or her parent/guardian signed them up.

I – Test of Infant Motor Performance

C – Peabody Developmental Motor Scales, 2nd edition, Early Childhood Home Observation for Measurement of the Environment Inventory and Problem-Oriented Perinatal Risk Assessment System

O – Sensitivity, specificity, positive predictive values, negative predictive values, correlation coefficient

Representative Sample: Children who participated in the study were representative of infants who would be evaluated and treated in this outpatient pediatric setting.

Blind Comparison: The therapists who administered the PDMS2 were blinded to participant scores on the TIMP and POPRAS prior to administering the PDMS2.

Independent Reference Standard: The TIMP and the PDMS2 are separate tests with no overlap in testing items.

Reliability of Clinical Test and Reference Standard: The authors cite several studies[6,7,8,9] to support the reliability of the TIMP as an assessment tool for infant motor development. One cited study reported the TIMP had strong intra-rater reliability as evident by less than 5% misfitting of items between the assessors. In addition, the TIMP demonstrated a strong test-retest reliability (r=0.89). The authors determined the intra-rater reliability of the PDMS2 by administering the test to six preschool aged children. After taking a six-hour course on the PDMS2, three testers administered and scored one test, as well as, reviewed one videotaped test and scored that corresponding test. The intra-rater reliability ranged from 0.91 to .96. Additional citations in the study showed an intra-rater reliability of composite scores on the PDMS2 ranging from 0.96 to 0.98.

Ascertainment: All of the participants who were tested on the PDMS2 were tested by on the TIMP.

Validation in Second Independent Sample: A second independent sample was not used in this study.

Study: 90 infants were recruited for this longitudinal study from 3 nurseries in the Chicago metro area. Participants were stratified into 5 subgroups based on risk of developmental disability and ethnicity. Following the standardized procedures in the TIMP manual, the TIMP was administered to all participants weekly, between 33 weeks post conception to 4 months of age. Participants were scored on the TIMP according to the standardized instructions in the TIMP manual.

Of the original 90 infants, 73 were located and 61 children, 31 males and 30 females, between 4 and 5 years of age were available and willing to participate in the follow-up study. Using the standardized guidelines in the PDMS2 manual, the test was administered to all 61 participants in the participant's home. 2 participants were uncooperative. The tester followed the PDMS2 standardized procedures and tested the two participants out of order or during another session. Participants were scored on the PDMS2 based on the standardized instructions in the manual. The Early Childhood Home Observation for Measurement of the Environment Inventory (EC-HOME) was administered after the PMDS2 in less than 45 minutes. After both PDMS2 and EC-HOME were tested, the parent or guardian completed a questionnaire that included demographic, medical and motor development information.

Summary of Internal Validity: The study had good internal validity. Although several participants dropped out of the longitudinal study, they were accounted for through an intention to treat statistical analysis. In addition, there were enough participants to determine statistical significance. Participants in the sample were representative of the infants physical therapists would treat in this clinical setting. The testers were blind to TIMP scores prior to administering the PMDS2. Both the TIMP and PMSD2 had strong intra-rater and test-retest reliability. The authors cited several studies that validated both the TIMP and the PDMS2 as being the standardized assessment tests for motor development within each tests validated age range. The TIMP was administered in the appropriate age range, as well as, the PDMS2. The biggest threat to interval validity was the small sample size. Environmental and medical factors that can contribute to changes in motor development were only minor threats to internal validity.

Evidence: TIMP scores at 30, 60, and 90 days were compared to PDMS2 scores at 4 to 5 years of age using sensitivity, specificity, positive predictive values, negative predictive values, and percent correct.

The z-score of -0.5 has been validated as the TIMP cutoff number for standard deviations away mean that identify atypical infant motor development. PDMS2 scores -1.0 and -2.0 standard deviations below the mean are cutoff points that determine eligibility for government services; therefore, the authors analyzed PDMS2 scores using both cutoff points.

Based on the results, scores on the TIMP at 90 days of age had the highest sensitivity specificity, positive predictive value, negative predictive value, and percent correct when compared to PDMS2 scores at both -1.0 and -2.0 cutoff z-scores. The correlation coefficient (r=0.69) was calculated between scores on the TIMP at 90 days of age and scores on PDMS2 at 4 and 5 years of age. Likelihood ratios, pre and post test probability were not reported and I am unable to calculate these values due to the lack of raw data. (See tables 3a,3b).

Table 3a. Sensitivity, specificity, positive predictive values, negative predictive values and percent correct of the TIMP compared to the PDMS2 (cutoff z-score of -2.0) at 30, 60 and 90 days of age.

Age (days)	Sensitivity	Specificity	Positive Predictive Values	Negative Predictive Values	% Correct
30	.33(.19-.47)	.94(.87-1.0)	.60(.45-.75)	.83(.72-.94)	80%
60	.50(.35-.65)	.86(.76-.96)	.55(.40-.70)	.84(.73-.95)	79%
90	.72(.59-.83)	.91(.83-.99)	.75(.63-.88)	.91(.83-.99)	87%

-TIMP cutoff z-score -0.5
-95% confidence internal in parentheses

Table 3b. Sensitivity, specificity, positive predictive values, negative predictive values and percent correct of the TIMP compared to the PDMS2 (cutoff z-score of -1.0) at 30, 60 and 90 days of age.

Age (days)	Sensitivity	Specificity	Positive Predictive Values	Negative Predictive Values	% Correct
30	.29(.15-.43)	.92(.84-1.0)	.80(.68-.92)	.72(.59-.85)	73%
60	.44(.30-.58)	.97(.92-1.0)	.89(.80-.98)	.74(.61-.87)	77%
90	.62(.48-.76)	.97(.92-1.0)	.92(.84-1.0)	.82(.71-9.3)	85%

-TIMP cutoff z-score -0.5
-95% confidence internal in parentheses

Sensitivity identified participants with typical motor development scores on the TIMP that ended up having typical motor development scores on the PDMS2. These participants would not have benefited from early physical therapy services. Specificity identified participants with atypical motor development scores on the TIMP (scores -0.5 standard deviations away from the mean) that ended up having atypical motor development scores on the PDMS2 (scores -1.0 and -2.0 standard deviations away from the mean). These participants would have benefited from early physical therapy intervention. TIMP scores tested at 90 days of age had both the highest sensitivity (0.72) and specificity (0.91) with PDMS2 cutoff score of -2.0; sensitivity (0.62) and specificity (0.97) with PDMS2 cutoff score of -1.0.

Positive predictive value predicted that a participant with an atypical motor development score on the TIMP would have ended up having an atypical motor development score on the PDMS2 at school age. Negative predictive value predicted that a participant with a typical motor development score on the TIMP would have ended up having a typical motor development score on the PDMS at school age. TIMP scores tested at 90 days of age had the highest positive predictive value (0.75) and negative predictive value (0.91) with PDMS2 cutoff score of -2.0; predictive value (0.92) and negative predictive value (0.82) with PDMS2 cutoff score of -2.0.

All of the 95% confidence interval values were positive, the interval values did not go infinity, and interval ranges were small which strengthens the reliability of the data. In addition, percent correct was also the highest at TIMP scores at 90 days of age, 87% with PDMS2 cutoff score of -2.0 and 85% with PDMS2 cutoff score of -1.0.

Applicability of Study Results:

<u>Clinical test available, affordable, accurate, and precise in out setting</u>: Refer to article 1, Flegel *et al.*, 2002.

<u>Summary of external Validity</u>: Similar to article 1, there were minimal threats to the internal validity of this study. The participants were similar to patients at the clinic. The TIMP can predict school aged motor development on the PMDS2 based on TIMP scores at 3 months of age.

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