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Reliability and Validity of the Revised Individualized Structured Mastery Tasks in Children with Developmental Delay

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Abstract

Objective: Mastery motivation is an under-assessed resiliency factor that helps all children achieves their potential; it impels children to strive to master skills and to solve challenging problems. Because children with developmental delay (DD) are perceived to have lower motivation than children with typical development, it is important to have good behavioural measures of mastery motivation. This research describes psychometric properties of the revised individualized structured mastery tasks (ISMT-R), a behavioral assessment, which was updated based on empirical and theoretical feedback. The purposes of this study were: to examine the test-retest, inter-rater and inter-coding reliabilities of the ISMT-R and the relationships between the ISMT-R and both the Dimensions of Mastery Questionnaire (DMQ 18) and developmental ability measured by a standardized developmental test.

Method: The design produced a cross-sectional study. Sixty-two mother-child dyads of children with DD aged 23-43 months were recruited. Children were tested with the ISMT-R (puzzles and cause-effect tasks) and the Comprehensive Developmental Inventory for Infants and Toddlers (CDIIT). DMQ 18 was filled out by mothers and produced scores for four persistence scales and mastery pleasure scale. Intraclass Correlation coefficient was used to examine reliabilities, and correlation analysis was used to estimate the validities (α=0.05; two-tailed).

Results: The ISMT-R had well to excellent test-retest, inter-rater and inter-coding reliabilities. Children's persistence at moderately difficult tasks positively correlated with the predicted dimensions of the maternal ratings of the child's persistence on the DMQ 18 and the child's development based on the CDIIT.

Conclusion: The ISMT-R has acceptable reliability and convergent validity, and can be a useful tool for assessing mastery motivation of children with DD. It also can be used in clinical settings to help clinicians distinguish between motivation and developmental ability for each child with DD.

Keywords: Mastery motivation; Individualized mastery task; Reliability and validity; Developmental disabilities; Child; Early intervention; Surveys and questionnaires

Introduction

Mastery motivation has been identified as one of the core aspects of child development [1]. Previous studies have found that mastery motivation predicted future adaptive performance and academic achievement in young children with developmental delay (DD) [2,3]. In addition, mastery motivation has predicted cognitive function better than standardized developmental quotients for typically developing children [4,5]. Pediatric physical therapists view childrens motivation as a determinant of improvement in basic motor abilities for children with cerebral palsy [6]. Children with DD have been perceived by parents to have lower mastery motivation than typically developing children [7-10]; however, they did not show significantly lower mastery motivation on individualized structured mastery tasks [8,10]. Thus, it is important for clinicians to have reliable and valid behavioral measures of mastery motivation.

Mastery motivation stimulates child's independent attempts to master tasks that are moderately challenging for him or her [11]. Mastery motivation focuses on the child's persistence, the process or motivation to master the task, rather than the child's ability to solve a problem [12]. The construct of mastery motivation has been assessed in two main ways: individualized structured behavioral tasks and maternal ratings of the child's motivation with the Dimensions of Mastery Questionnaire (DMQ 18) [12-14]. This paper focuses on evidence supporting the reliability and validity of the recently revised individualized structured mastery tasks, the ISMT-R.

The original individualized structured mastery task (ISMT) procedure has been commonly used for measuring mastery motivation and has acceptable psychometric properties [10,12]. Wang et al. used the ISMT, which was designed to provide one moderately challenging task (i.e., not too easy and not too hard) of one specific puzzle and one cause-effect toy to each individual child [10]. This procedure developed by Morgan et al. was used by Hauser-Cram, Gilmore et al., and others [3,7,8,13,15].

Several studies have shown that children were most motivated by tasks that were moderately difficult for them. Children had lower persistence at tasks that were too hard or perhaps too easy for them [16-18]. Tasks that is moderately difficult for typically-developing peers might be too hard for children with DD. Thus, if we want to have a valid test of mastery motivation, it is important to give children tasks that are moderately difficult for them personally.

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The main advantage of the ISMT was that by identifying a moderately difficult task, it facilitated the separation of the child's ability or competence from his or her motivation. This method has important clinical implications because several previous studies found no significant differences in mastery motivation between children with and without developmental disabilities using the individualized method [7,8,10,15]. Some other advantages of the ISMT (and the ISMT-R) were: (a) they provided objective records of the child's behavior, and thus, the scores were less influenced by social desirability than those from questionnaires; (b) the individualized tasks controlled for the confounding effects of differences in developmental abilities; (c) because the tasks varied in difficulty level, they could be used with children that varied in age and also with children of the same age that varied in mental and fine motor ability.

Although the original ISMT method produced valuable results, we made some improvements to the method. For example, the ISMT-R allowed for the possibility of identifying two or even three moderately difficult tasks for a given child. The goal of the original ISMT was to find and score one moderately difficult level for each child; the tester would start with the presumed moderately difficulty level toy and continue until one moderately difficult level was found. Finding the moderately challenging level of task was partly based on trial and error because the initially presumed moderately challenging toy might turn out to be too hard or too easy. Thus, the identified moderately challenging tasks could be the first, the second or even occasionally the third task of that type. In the ISMT-R, the tester began the testing procedure with a presumed easy, then moderate, and finally one hard level of task; more than one of these tasks could turn out to be actually moderate difficulty for that child.

Several studies have found that the expected relationships between persistence on structured mastery tasks and maternal ratings of the childs persistence on the DMQ [19,20]. However, these findings especially for children with delays are not consistent. One study showed no significant correlation between task persistence and the DMQ in children with motor delay [10]; but another found that persistence at shape-sorter, but not puzzle tasks, positively correlated with DMQ object persistence rated by caregivers of children with Down syndrome [7].

A numbers of studies have shown that persistent goal-directed behaviors on the structured mastery tasks were moderately correlated with cognitive ability on standardized developmental tests [21-25]. Furthermore, other researchers found that early mastery motivation on structured tasks predicted later ability in children with delays [2,3,26].

We tested the following hypotheses: (1) the persistence scores of the ISMT-R would be highly correlated between two repeated tests, between two coders, and between two coding methods (face to face and video coding); (2) mastery motivation measured with the ISMT-R would be positively correlated with object persistence from the DMQ 18 but not be significantly correlated with other DMQ 18 scales; and (3) there would be significant but modest associations between mastery motivation measured with the ISMT-R and the child's fine motor and cognitive development on a standardized developmental test.

Method

Design

We conducted a cross-sectional study to examine reliabilities of the ISMT-R and its relations with the DMQ 18 as well as with a standardized developmental test.

Participants

Children with DD were recruited from clinics in the greater Taipei area. The inclusion criteria were: (1) child age between 24 to 43 months; (2) the child had received a doctor's diagnosis related to developmental delay; (3) developmental ages of both the cognitive and fine motor domains were ≧ 15 months (e.g., able to play with a car sliding back and forth, able to identify at least 5 body parts, able to build 2-block tower, etc.); (4) the mother was the primary caregiver and took care of the child for at least 4 hours per day; and (5) mother's educational level was at least junior high school, so she could read and rate the questionnaire appropriately. The exclusion criteria were: (1) child had neuromotor disorders (e.g., cerebral palsy, spinal bifida, etc.), progressive diseases (e.g., neuromuscular dystrophy, brain tumor, etc.), autism spectrum disorder, or attention deficit hyperactivity disorder; (2) child had a unstable medical condition (e.g., epilepsy), severe heart disease (e.g., Tetralogy of Fallot), frequent hospitalization, or received a surgical operation in the past 6 months; and (3) visual or hearing function impairments even with assistive devices.

To calculate the sample size, the Gilmore et al (2003) study, which investigated the correlations between ISMT and DMQ, was used as a reference. They reported that the correlation coefficient between the structured tasks and the DMQ was around 0.40. When we set α as 0.05 and power as 0.80, the estimated sample size was 62 [27]. A convenience sample of 62 Taiwanese children with DD was recruited from hospitals and clinics in the Taipei area.

Measures

Revised Individualized Structured Mastery Tasks (ISMT-R)

Two sets of revised individualized structured mastery tasks (ISMT-R) for 15- to 48-month old children were used to examine cognitive/object-oriented mastery motivation behaviours. Eight puzzle toys and 7 cause-effect toys, varying in assumed difficulty level from easy for children of 1.5-years developmental age too difficult for children of 4-years developmental age, were used. The actual or observed difficulty level of tasks during each 3 minute trial of each level was defined as follows: (1) easy task: a child completed all solutions within 1.5 minutes; (2) moderate challenge task: a child completed at least 2 solutions but not all solutions within 1.5 minutes; (3) hard task: a child completed less than 2 solutions (none or only one) within 1.5 minutes. Using Table 1, the tester administered specific puzzle and cause-effect toys for each of the three assumed difficulty levels (easy, moderately challenging, and hard) to each individual child. The tester based the presented toys on the average of the child's cognitive and fine motor developmental age from a standardized developmental test, the Comprehensive Developmental Inventory for infant and Children (CDIIT) [28].

One camera was set in front of the child and another camera was set at a 45° deviation from the horizontal line in order to collect videos of each child's behaviour. The assumed easy, then moderate, and then hard puzzle tasks were presented first; then the cause-effect tasks were administrated. Specific rules were followed for when to provide prompts and when to terminate a task.

Based on the child's success in completing parts of the task, each trial or level was observed to be actually easy, actually moderate, or actually hard. For each individual child, at least one actually moderately difficult level was identified for both puzzle and cause-effect tasks.

The Dimensions of Mastery Questionnaire (DMQ 18)

DMQ 18 was used for caregivers to rate perceptions of their

Assumed Level of Difficulty – Puzzle Task			
Mental and FM Age	Easy	Moderate	Hard
15–19 months	Level 1	Level 2	Level 3 and/or 4
20–24 months	Level 2	Level 3	Level 4 and/or 5
25–29 months	Level 3	Level 4	Level 5 and/or 6
30–36 months	Level 4	Level 5	Level 6 and/or 7
37-42 months	Level 5	Level 6	Level 7 and/or 8
42-48 months	Level 6	Level 7	Level 8
Assumed Level of Difficulty – Cause and fect Tasks			
	Easy	Moderate	Hard
15-24 months	Level 1	Level 3	Level 4 and/or 5
25-36 months	Level 2	Level 4	Level 5 and/or 6
37-42 months	Level 3	Level 5	Level 6 and/or 7
42-48 months	Level 4	Level 6	Level 7

Note. If the assumed easy level turned out to be actually moderate, the tester presented the next assumed moderate and hard levels. If the assumed easy level turned out to be actually hard, the tester presented an easier level if possible. If the first two levels presented turned out to be actually easy, both of the presumed hard levels were presented. The goal was to have at least one level that turned out to meet the definition of a moderately challenging task and probably one task that turned out to be very challenging/hard.

Table 1: Three assumed levels of difficulty for two types of task based on the average of the mental and fine motor (FM) developmental ages of each child

children's motivation [14]. The DMQ 18 pre-schooler version contains 39 items, each rated on a five-point Likert scale from 1=not typical at all to 5=very typical. Our team translated the DMQ 18 for children aged 1.5-5 years into Chinese. A back translation by two bilingual persons unfamiliar with the DMQ 18 was approved by Morgan (the DMQ developer) after adjustments were made in both the Chinese and English based on pilot testing. Morgan et al. (2015) compared results from English and Chinese parents and reported evidence for reliability and validity in both languages [14]. Five DMQ 18 scales are used to assess mastery motivation. Four persistence scales include: cognitive/object persistence (5 items; e.g., tries to complete toys like puzzles even if they are hard); (b) gross motor persistence (5 items; e.g., tries to do well in physical activities even when they are challenging); social persistence with adults (5 items; e.g., tries to get adults to understand him or her); and (d) social persistence with children/peers (6 items; e.g., tries to say and do things that keep other kids interested). One expressive scale is mastery pleasure (5 items; e.g., gets excited when he or she figures something out) [14]. Scores on each scale were obtained by averaging item scores, with a range of 1-5. A higher score indicates higher mastery motivation.

Comprehensive Developmental Inventory for Infants and Toddlers (CDIIT)

The CDIIT is a diagnostic developmental test that was standardized on a norm sample of 3703 Taiwanese children, aged 3-72 months; it has six developmental subtests (cognition, language, gross motor, fine motor, social, and self-help). The cognitive subtest is used to assess child's mental capacity; the language subtest consists of comprehension and expression. The gross motor subtest includes items to assess antigravity, locomotion and body-movement coordination, and the fine motor subtest includes items for basic hand use and visual-motor coordination. The social subtest is used to assess social interaction and self-help contains items dealing with feeding, dressing and hygiene skills. The tester administers all the cognitive and motor items and some items of the language subtests; other items of the language subtest plus the social and self-help subtests are reported by the main caregiver [28]. Developmental ages and developmental quotients for all subtests and the whole test were obtained according to norms [28]. A developmental quotient of less than 85 (1 SD below the mean) on a subtest was used to indicate developmental delay in this study. The CDIIT has acceptable psychometric properties, including test-retest reliability; construct validity, and concurrent validity [29-31].

Procedure

The study was approved by the Human Subjects Review Committee of one university hospital. A home visit (or sometimes laboratory visit) with a pediatric physical therapist was arranged to assess children's development using the CDIIT. At the same visit, mothers were asked to fill out basic demographic information. After the home visit, mothers and children who met the inclusion criteria were invited to the laboratory for a 90-min session. After a warm up period (with interesting toys other than the testing materials), a mother-child teaching interaction observation was conducted (not reported in this paper). The child was then tested using the ISMT-R method, and at the same time, the mother filled out the DMQ 18. The tester used live-coding methods to administer the ISMT-R, and each child's performance also was videotaped to obtain inter-rater reliability and inter-coding reliability. Two professionals with different clinical experiences watched videos to code children's task-directed persistence in order to examine inter-rater reliability. Children were tested again within 2-week interval to examine the test-retest reliability of ISMT-R. To assess reliability of live versus video coding, children's task-directed persistence scores coded live by the tester and coded from videos were correlated to examine inter-coding reliability.

Data reduction and analysis

for the ISMT-R, the toddler's most prevalent behavior was coded for every interval of each level or trial of the task, which lasted up to 3 minutes. For live coding, there were up to 12 to 15 sec intervals, and for the video recording there were up to 36 to 5 sec intervals. In the present study, task-directed persistence at moderate tasks (both puzzle and cause-effect toys) was calculated from the number of intervals in which the child showed mostly task-directed behavior; i.e., trying to fit a puzzle piece. For persistence at moderately challenging tasks, the child completed two but not all predefined solutions in the first 1.5 min. If the child completed all the remaining predefined solutions after 1.5 min. but before 3 min., an adjusted persistence score at moderate tasks was calculated from the number of 15 sec (or 5 sec) intervals in which the child showed mostly task-directed behavior before completing all the predefined solutions divided by the actual numbers of intervals before the child finished the task.

If more than one level of puzzle or cause-effect task turned out to be actually moderate, the persistence score for that task was the average of the adjusted scores for each level identified as moderate. The total persistence score was the average persistence score of the moderate puzzle and cause-effect tasks. Each variable was examined for normality and analyzed using SPSS software (SPSS Inc, Chicago, Illinois). Descriptive statistics presented basic information about the children and the various measures.

For analysis of test-retest and inter-rater reliabilities, intraclass correlation coefficients (ICC) were used. The inter-coding reliability and relations between ISMT-R persistence scores and five DMQ 18 scales were analyzed using Pearson correlations. Partial correlations were used to analyze the relationships of ISMT-R persistence with developmental age of the CDIIT controlling for children's chronological age.

Results

Participants characteristics

The characteristics of the children with DD and their mothers are presented in Table 2. The whole sample was used for validity, with partial samples used for the three reliabilities. There were 47 boys and 15 girls. In addition to the medical diagnosis of developmental delay, 30 children had other main diagnoses: psychomotor retardation (n=3); prematurity (n=4); chromosome disease (n=4); failure to thrive (n=3); developmental language disorder (n=12); hydrocephalus (n=1); other genetic diseases (n=3). The distribution of severity levels of developmental delay was 45 mild and 17 moderate. Test-retest reliability for ISMT-R was collected from 18 children with different severity levels: 12 mild and 6 moderate. Twenty one trials from six children (3 mild and 3 moderate) were used for inter-rater reliability. Thirty one children (25 mild and 6 moderate) were scored for inter-coding reliability. The distribution of social economic status levels of families of the 62 children was 7%, 61%, 25%, and 7% for level I to IV respectively. Level I represent the highest social economic status, and level III represents middle class [32]. Thus, 86% of the participants of this study were middle to upper middle class.

Reliabilities of the revised individualized structured mastery tasks

The analyses of test-retest, inter-rater, and inter-coding reliabilities for mastery motivation measured by the ISMT-R are shown in Table 3. Good test-retest reliability was found for the total persistence score and also for persistence scores at puzzle and cause-effect tasks (ICC=0.80 to 0.86), and there were no significant differences between the first and second testing sessions (F=0.0 to 3.46, p>0.05). Inter-rater reliability for the persistence scores at puzzle and cause-effect tasks were excellent (ICC= 0.95 to 0.98), and there were no significant differences between

	Validity (n=62)		Test-retest reliabilities (n=18)		Inter-rater reliabilities (n=6)		Inter-coding reliability (n=31)	
Child variables	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Age, months	32.5 (5.1)	23.5 ~ 42.6	32.0 (4.7)	23.5 ~ 42.6	30.2 (4.2)	26.3 ~ 36.5	32.5 (4.9)	24.6 ~ 42.0
CDIIT DQ (whole test)	63 (9)	39 ~ 76	63 (9)	46 ~ 75	66 (9)	54 ~ 75	65 (7)	45 ~ 76
CDIIT DA (subtest score, months)								
Whole test	19.6 (3.8)	13.2 ~ 29.1	19.6 (2.7)	13.9 ~ 23.9	19.3 (2.0)	15.7 ~ 21.0	20.4 (4.3)	13.2 ~ 29.1
Cognitive	21.2 (4.7)	15.0 ~ 33.1	21.4 (3.3)	16.0 ~ 30.7	20.0 (2.0)	16.0 ~ 21.0	22.1 (5.3)	15.0 ~ 33.1
Gross motor	19.0 (3.2)	11.5 ~ 25.9	18.3 (3.0)	11.5 ~ 23.9	18.3 (1.3)	17.3 ~ 19.9	19.5 (3.3)	12.7 ~ 25.9
Fine motor	22.3 (5.1)	15.0 ~ 33.8	24.0 (4.3)	16.3 ~ 31.4	23.9 (4.0)	18.3 ~ 28.5	21.9 (5.0)	15.0 ~ 33.8
Language	21.3 (6.0)	10.3 ~ 40.7	21.6 (4.5)	10.7 ~ 31.6	20.3 (3.2)	16.1 ~ 25.0	22.4 (6.9)	12.8 ~ 36.4
Social	20.2 (7.5)	9.0 ~ 44.2	18.6 (5.7)	10.3 ~ 34.3	17.8 (5.3)	10.3 ~ 22.2	23.0 (8.2)	9.0 ~ 44.2
Self-Help	20.0 (4.9)	10.3 ~ 40.7	20.5 (3.3)	14.7 ~ 26.2	22.2 (3.2)	18.2 ~ 26.2	20.0 (5.8)	10.3 ~ 40.7
ISMT-R persistence scores								
Total	24.5 (5.8)	12.3 ~ 36.0	25.8 (5.4)	13.1 ~ 35.0	25.2 (3.3)	21.1 ~ 29.9	24.1 (5.4)	15.3 ~ 35.8
Puzzle tasks	17.5 (9.6)	2.0 ~ 36.0	19.9 (8.6)	2.0 ~ 35.8	20.0 (6.6)	12.3 ~ 30.3	16.2 (10.0)	3.0 ~ 36.0
Cause-effect tasks	29.3 (5.9)	13.0 ~ 36.0	30.2 (5.6)	14.5 ~ 36.0	30.2 (4.9)	21.0 ~ 34.1	29.4 (5.9)	13.0 ~ 36.0
DMQ 18								
Object/cognitive persistence	2.7 (0.9)	1.7 ~ 4.6	2.9 (0.8)	1.6 ~ 4.6	2.5 (0.7)	1.6 ~ 3.4	2.9 (0.8)	1.2 ~ 4.6
Maternal variables								
Age (years)	36.0 (5.5)	23.0 ~ 50.0	36.1 (5.3)	24.0 ~ 46.0	35.2 (3.9)	30.0 ~ 42.0	34.8 (4.9)	23.0 ~ 42.0
Education (≧college), n, %	46, 74%		13, 72%		6, 100%		23, 74%	

Note: Abbreviation: CDIIT=Comprehensive Developmental Inventory for Infants and Toddlers; DA=developmental age; DQ=developmental quotient.

Table 2: Characteristics of children with developmental delay and their mothers

ISMT-R Persistence scores	Mean (SD)	Range	Mean (SD)	Range	*F* (*P* value)[a]	*ICC* (95% CI)[b]
Test-retest reliability (n=18)	First session		Second session			
Total	24.9 (6.1)	12.0 ~ 35.3	26.5 (5.5)	14.3 ~ 35.8	3.46 (0.08)	0.88 (0.68 ~ 0.96)***
Puzzle tasks	19.5 (9.8)	3.0 ~ 36.0	19.8 (9.6)	1.0 ~ 35.5	0.00 (1.00)	0.80 (0.46 ~ 0.93)**
Cause-Effect tasks	29.8 (6.7)	14.3 ~ 36.0	30.8 (5.4)	14.7 ~ 36.0	1.19 (0.29)	0.86 (0.63 ~ 0.95)***
Inter-rater reliability (n=6)	First rater		Second rater			
Total (21 trials)	28.4 (5.6)	15.5 ~ 35.1	28.8 (5.8)	17.0 ~ 34.6	1.16 (0.32)	0.97 (0.90 ~ 0.99)***
Puzzle task (10 trials)	24.4 (7.6)	16.0 ~ 34.2	24.7 (8.8)	12.0 ~ 34.2	0.14 (0.71)	0.95 (0.83 ~ 0.99)***
Cause-Effect task (11 trials)	31.8 (6.2)	15.0 ~ 36.0	32.3 (5.9)	16.0 ~ 36.0	1.60 (0.24)	0.98 (0.91 ~ 0.99)***
Inter-coding reliability (n=31)	Live coding		Video coding		Correlation coefficients	
Total	8.6 (1.9)	5.7~12.0	24.1 (5.4)	15.3 ~ 35.8	0.85**	
Puzzle tasks	6.5 (3.2)	2.0~ 12.0	16.2 (10.0)	3.0 ~ 36.0	0.90**	
Cause-Effect tasks	10.0 (1.9)	5.5 ~ 12.0	29.4 (5.9)	13.0 ~ 36.0	0.88**	

Note: **p<.01; ***p<.001 (two-tailed); [a]: Comparison of differences on mean persistence scores between first session/tester and second session/tester by repeated ANOVA; [b]: ICC: Intraclass Correlation coefficient between first session/rater and second session/rater; Abbreviation: CI=confidence interval.

Table 3: Descriptive data and reliabilities of persistence scores at puzzle and cause-effect tasks on the revised individualized structured mastery tasks (ISMT-R)

	ISMT-R Persistence scores		
DMQ 18	Total	Puzzle tasks	Cause-Effect tasks
Object/cognitive Persistence	0.34**	0.46***	0.06
Gross Motor Persistence	0.18	0.15	0.13
Social with Adult Persistence	0.11	0.12	-0.01
Social with Children Persistence	-0.08	-0.09	-0.13
Mastery Pleasure	0.02	0.11	-0.19

Note: **p<.01; ***p<.001 (two-tailed) by Pearson correlation analyses; Abbreviation: ISMT-R=revised individualized structured mastery tasks; DMQ 18=the revised Dimensions of Mastery Questionnaire.

Table 4: Correlation coefficients between the ISMT-R persistence scores and the DMQ18 subscale scores in children with developmental delay

	CDIIT development ages						
ISMT-R Persistence score	Whole	Cognitive	Gross Motor	Fine Motor	Language	Social	Self-help
Total	0.44***	0.29*	0.29*	0.61***	0.24	0.27*	0.42***
Puzzle tasks	0.41***	0.32*	0.28*	0.56***	0.26*	0.30*	0.28*
Cause-effect tasks	0.23	0.13	0.18	0.38***	0.10	0.05	0.30*

Note:p<.05; **p <.01;*** p<.001 (two-tailed); partial correlation coefficient between persistence score and development age controlling for children's chronological age; Abbreviation: ISMT-R=revised individualized structured mastery tasks; CDIIT=Comprehensive Developmental Inventory for Infants and Toddlers.

Table 5: Correlation coefficients between the ISMT-R persistence scores and the CDIIT development ages in children with developmental delay.

the two raters. The reliabilities of live versus video coding of persistence scores at puzzle and cause-effect tasks were good (r=0.85 to 0.90).

Validity of the Revised Individualized Structured Mastery Tasks

Results for convergent validity of the ISMT-R, is provided by significant correlations with the cognitive/object scales of the DMQ 18. As shown in Table 4, the cognitive/object persistence scale of the DMQ 18 was positively correlated with total persistence and persistence at puzzle tasks (r=0.34, p<0.05; r=0.46, p<0.01) but was not correlated with persistence at cause-effect tasks (p>0.05). Evidence supporting divergent validity is that there were no significant associations between ISMT-R persistence at task scores and other DMQ 18 scales (r= –0.19 – 0.18, p>0.05).

The correlations of ISMT-R with developmental age are presented in Table 5. The CDIIT fine motor and cognitive developmental ages were significantly related to total persistence on the mastery tasks (r=0.61 and 0.29, p<0.001). In addition, the CDIIT self-help, gross motor and social developmental ages were associated with total persistence on the mastery tasks (r=0.27 to 0.42). Specifically, CDIIT fine motor developmental age significantly correlated to persistence at puzzle and cause-effect tasks (r=0.56 and 0.30). The CDIIT cognitive developmental age was associated with persistence at puzzle tasks (r=0.32, p<0.05), but it was not significantly related to persistence at cause-effect tasks (r=0.13).

Discussion

The key finding of this study was that reliabilities of the revised individualized structured mastery tasks (ISMT-R) were good to excellent. The ISMT-R total persistence and persistence at puzzle tasks were significantly correlated with maternal ratings of the child's object/cognitive persistence on the DMQ 18, but as hypothesized, there were no significant associations between task persistence scores and the other DMQ 18 scales, supporting adequate convergent and divergent validity of the ISMT-R. As hypothesized, total persistence at moderate tasks was positively correlated with fine motor and cognitive developmental age.

Differences between the Original and Revised Individualized Mastery Tasks

With the ISMT-R procedure, it was possible for each child to have more than one actual moderately challenging puzzle task and cause-effect task. In fact, we found most children had two or more cause-effect tasks of moderate difficulty (81%); and about half the children had two or more puzzle tasks of moderate difficulty (45%) using the ISMT-R. This increased the range of difficulty level found to be moderate and produced more stable and reliable persistence measures without additional testing time.

Another difference was that we used an adjusted scoring method for persistence at moderate tasks if the child completed all predefined solutions after 1.5 min. and did not continue. This procedure eliminated the need with the previous ISMT to require the child to repeat completed tasks in order to achieve a high task persistence score. We believe this lead to more valid scores.

Correlation between ISMT-R and the DMQ 18

In the current study, total persistence and persistence at puzzle tasks on the revised ISMT were positively correlated with object/cognitive persistence from the DMQ 18. This finding was similar to several previous studies in children with and without disabilities [7,20,33]. The item descriptions of the DMQ 18 object/cognitive persistence assess mother's ratings of children's persistence at objects or toys which are similar to the persistence scores on the toys used for the individualized mastery tasks. A possible reason for low correlations of DMQ persistence with the cause-effect tasks was that they had a ceiling effect and less variability than persistence on puzzle tasks.

Correlation between ISMT-R and developmental age

Our findings indicate that total persistence and persistence at puzzle tasks positively correlated with developmental abilities. The results are similar to previous studies of children with disabilities indicating some overlap with most developmental subtests [2,3].

White (1959) hypothesized that young children have an intrinsic drive to interact effectively with their environment to facilitate competence through the learning experiences of success and failure [34]. Therefore, their acquisition of skill provided a sense of satisfaction that promoted further developmental abilities. Seifer & Vaughn (1995) also suggested that higher levels of mastery motivation, through focused exploration in early life, will increase interactions with the environment and repetitive practice, which then leads to better future developmental outcomes for toddlers [35].

Specifically, we found that there were medium to high significant partial correlations of persistence at mastery tasks with the fine motor developmental age. It is necessary for children to have good visual-motor coordination and hand use in order to master puzzle and cause-effect tasks. However, the partial correlations between persistence and cognitive developmental age were lower, indicating some overlap but that the concepts of mastery motivation and cognitive competence are distinct.

Clinical Application

Reliable and valid behavioural measures of mastery motivation for children with delays are important for clinicians and researchers in the

early intervention system. The ISMT-R has demonstrated acceptable reliabilities and validities and could be used for clinic or research purposes. A benefit of this measure is that it could be used for both the clinic or research purposes. The mastery tasks are presented in a room without other toys or activities to distract the child. Usually, the test is conducted in a research laboratory room for study purposes, but measures could be conducted in a quiet room at home and other settings, such as therapeutic room. The scoring could be live coding for clinic use or video coding for research purposes. This study demonstrated high correlations between live coding and video coding.

There are several ways for clinicians to choose moderate challenge or adjust the motor task difficulty in order to facilitate mastery motivation for each child. First, clinicians could use developmental tests to know the average developmental age of each child, which could help them to select tasks of appropriate difficultly for each child. Then task selection principles based on ISMT-R methods could be used to identify moderately difficult tasks for each child. Second, clinicians also can adjust task difficulty through task requirement analysis and modification [36], such as modifying the amount and type of feedback, modifying practice conditions or context [37], and modifying tasks based on Gentile's taxonomy [38], which is commonly used for clinicians to adjust the difficulty of motor tasks by requiring whole body motion or object manipulation. For example, the child could be asked to throw a ball in a static standing position or standing on an unstable floor. Another example of such an adjustment of difficulty level would be asking the child to walk either carrying a toy or not.

Clinicians can use the DMQ 18 to understand caregivers' perception of their children's motivation and administer the ISMT-R method to assess children's mastery motivation at same time. Thus, they can coach parents of children with DD about how to distinguish the differences between mastery motivation and child developmental ability. They can also instruct parents how to observe and supported children's mastery attempts and how to be sensitive to the child's needs and respond appropriately. Parents can also be instructed to delay providing assistance in order to provide the children with the opportunity to try and cope to find solutions independently. Furthermore, therapists can instruct parents to use the "one-step ahead" approach, encourage children's autonomy, offer cognitively stimulating activities and a variety of toys or activities in various settings, and give emotional support [39]. The concept of the one-step ahead approach is similar to Vygotsky's zone of proximal development in which adults only provided appropriate and necessary assistance to help the child to attain the next level of performance [40]. What's more, parents should be educated to provide positive feedback to their child while their child is trying independently to solve problems rather than wait until the child actually solves problems. This modified verbal reinforcement supports children's engagement in activities and play for the sake of the pleasure derived from the process [41]. Parents could also be educated to select the task depends on their child's preference, for example, to practice dressing with the child's favorite clothes [42].

Limitations

Some limitations of this study were as follows: (1) there was sample homogeneity because almost all participants in this study had middle to upper middle social economic status; (2) several children might have been influenced by the unfamiliar structured environment, even after the warm-up.

Conclusion

The findings of this study reveal that ISMT-R has well to excellent test-retest, inter-rater and inter-coding reliabilities in children with DD. It also has acceptable convergent and divergent validity with maternal ratings of the child's mastery motivation in daily life based on DMQ, and adequate convergent validity with children's developmental ages in cognition and fine motor domains. Therefore, we conclude that ISMT-R is a useful measure of children's mastery motivation, and can be used in clinical settings to help clinicians distinguish between motivation and developmental ability for each child with DD. This assessment can help clinicians and researchers promote the motivation of children with delays, so that they can reach maximum developmental potential to optimize their participation in daily life.

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