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Test of Ideational Praxis (TIP): Preliminary Findings and Interrater and Test–Retest Reliability With Preschoolers

Shelly J. Lane, Carole K. Ivey, Teresa A. May-Benson

MeSH TERMS

- apraxias
- motor skills
- psychomotor performance
- reproducibility of results
- child, preschool

Praxis is the ability of the brain to develop an idea for action and plan, organize, and execute unfamiliar motor actions. It enables purposeful interaction with people and things in the environment. Ideation is central to praxis but has been little researched. This study investigated the reliability of the Test of Ideational Praxis (TIP) and examined ideational praxis in typical preschoolers. TIP performance for 78 preschoolers ages 3, 4, and 5 yr was videotaped and scored by two trained raters. The TIP has strong interrater reliability, supporting earlier findings. Further, we documented test–retest stability over 2 wk. As a group, preschoolers identified 10.6 affordances (ideas) for action on the TIP; no age differences were found. Training is required for accurate scoring of the TIP; following training, clinicians and researchers may find the TIP a useful tool to screen motor ideational abilities in young children.

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*P*ra^rxis is the ability of the brain to conceive of, plan, organize, and carry out a sequence of unfamiliar motor actions and enables adaptive interaction with the environment (Ayres, 1985). The cognitive ability to conceptualize and generate motor actions is termed *ideation* and depends largely on the integration of sensory inputs and resultant knowledge of possible body actions. Ayres noted that a child’s knowledge of objects and their potential uses develops out of purposeful activity and engagement with the objects; Ayres and Cermak (2011) stated, “Before one can engage purposefully or adaptively with a physical object, large or small, one must first have the concept of possible object–person interaction and some idea as to what might take place during that interaction” (p. 67). Ideation, then, is a dynamic process that occurs throughout typical development, beginning in infancy, as the child learns about actions and object properties through exploratory behavior such as banging, squeezing, or touching (Gibson, 1988). Early efforts at ideation are likely to be slow, with limits in variability, if for no other reason than that infants and younger children have less experience from which to draw. Because experience drives knowledge of affordances of objects and person–object–environment interaction, young children are not expected to show complex motor praxis skills.

Children with praxis problems typically demonstrate a wide range of motor planning and motor coordination difficulties. They may have difficulties with motor skills related to dressing, eating, or sports; may seem clumsy and appear to use more effort than necessary to complete tasks; or may have difficulty generalizing motor skills to situations requiring motor planning outside of their motor repertoire (Schaaf et al., 2010). Many children with praxis problems also demonstrate difficulties generating ideas for actions. Difficulty translating ideas into action may result in apparent motor clumsiness and challenges completing movements based on visual or verbal directions or using tools to complete

a perceptual–motor task (Steinman, Mostofsky, & Denckla, 2010). Children with poor ideation tend to have difficulty knowing what to do or how to interact with novel objects in their environment. They may demonstrate fewer ideas than typical children in play, may use less language when describing possible activities, and may be more frustrated, inflexible, or rigid when presented with new or changed plans (May-Benson, 2005a).

Praxis skills have been examined in school-age children for many years but have rarely been examined in preschool children. Parham (1987) reported on assessment strategies for preschoolers with dyspraxia and recommended formal assessment when possible, observation in a clinical setting with therapeutic equipment, observation during spontaneous play, and parent interview. When assessing a preschool child for ideational abilities, she suggested observing the extent to which the child generates and organizes ideas for what to do with novel equipment, the extent to which the child's actions are goal directed and purposeful, and how the child anticipates the potential for whole body actions with equipment.

In formal assessment, two standardized tests are routinely used to evaluate praxis difficulties in preschoolers, the Sensory Integration and Praxis Tests (SIPT; Ayres, 1989) and the Miller Assessment for Preschoolers (MAP; Miller, 1988). The SIPT is standardized for children ages 4 yr to 8 yr, 11 mo, and assesses praxis components related to planning, sequencing, and completion of a variety of fine and gross motor tasks. However, it does not assess ideational abilities, and the standardized norms begin at the end of the preschool years. The MAP is standardized for children ages 2 yr, 9 mo, through 5 yr, 8 mo, and assesses coordination and gross, fine, and oral–motor skills. It has several items that assess praxis-related components that involve imitation, visual–motor skills, block design, ability to follow verbal directions, and sequencing skills, but not ideational skills. Other motor assessments such as the Movement Assessment Battery for Children (Henderson, Sugden, & Barnett, 2007) and the Bruininks–Oseretsky Test of Motor Proficiency (Bruininks & Bruininks, 2005) are available but do not explicitly assess praxis. Clinicians have therefore primarily relied on informal clinical observations to assess aspects of praxis, including ideation, in young children.

Recently, *ideation in praxis* has been operationally defined as the “ability to demonstrate various actions with and on specified objects that indicate recognition of the specific affordances offered by the individual objects”

(May-Benson, 2005b, p. 2). This operational definition was used to develop the Test of Ideational Praxis (TIP; May-Benson, 2005a), an individually administered test that assesses the ideational aspects of praxis in children. The TIP is a reliable, objective assessment of ideational praxis, and preliminary evidence has indicated that it can detect developmental differences among children ages 5–8 yr. In addition, limited normative data are available for children ages 5–8 yr (May-Benson & Cermak, 2007). However, no information on age norms or developmental trends is available for the preschool age range, and test–retest reliability has not been established. The purpose of this study was to examine the ideational abilities of typical preschoolers ages 3–5 yr using the TIP and to examine both test–retest and interrater reliability for this instrument.

Method

Research Design

This study was an observational quantitative study aimed at examining ideational abilities in typical preschool children ages 3–5 yr. We also examined interrater reliability and test–retest stability for the TIP. We obtained approval from the institutional review board at Virginia Commonwealth University and parental informed consent for all participating children. This study was conducted as part of a larger study on assessment of praxis in preschoolers.

Participants

Eighty-five typically developing preschoolers (52 boys, 33 girls) ages 3–5 yr were recruited from three Richmond, Virginia, metropolitan area preschools. Preschools were selected for convenience, because the authors had contacts at the schools, and because the schools represented a variety of approaches to learning (one is Reggio Emilia, one is Montessori, and one is a standard developmental preschool). The recruited group consisted of 67 White, 5 African American, 1 Native Hawaiian or Pacific Islander, 1 Arab American, and 9 mixed-race children; two parents did not report race. Race distribution was approximately equal between genders. Four families indicated they were of Hispanic or Latino culture, 80 were not, and 1 did not report. Inclusion criteria stated that no child was to be excluded on the basis of race, ethnicity, health or medical condition, or education level; children with limited English proficiency were excluded because they needed to understand the directions of the assessment, which were given only in English. All children at each site whose parents consented to testing were included in the study.

Instrument

The TIP was designed by author Teresa A. May-Benson to examine the ability of a child to recognize and act on object affordances (May-Benson, 2005a). As used in this study, the TIP consisted of a single item, a 36-in. shoestring. The string item was initially part of a larger group of six test items, which included a hoop, the string, a tube, a box, and two items that involved object combinations (May-Benson & Cermak, 2007). Although this assessment was shown to be reliable and valid, it was too lengthy to be clinically useful. Internal consistency using Cronbach's α coefficient for the total test score of all six test items was .74. Although nearly all items contributed approximately equally to the total score, with correlations between .36 and .65, careful examination of both the α coefficient and the discriminative ability of each item identified the string and the hoop as having the best individual discrimination.

The string was chosen over the hoop for practical reasons; it was easily available and inexpensive. Analysis of variance indicated that the string item was able to detect significant differences between 5- and 8-yr-old children with ideational dyspraxia and children with dyspraxia not considered ideational in nature (other dyspraxia) and typically developing peers ($p < .000$). No significant differences were found between children with other dyspraxia and typically developing peers ($p = .824$). The string item alone was able to classify 64%–83% of cases among children with ideational problems, other dyspraxia, and typical peers accurately when divided by age. The age trends identified by the full six-item test were maintained with the string item.

The TIP is relatively easy to administer, with simple directions for the child. However, scoring is more challenging and requires training. May-Benson trained authors Lane and Ivey and research assistants (occupational therapy students) in TIP administration and scoring. Interrater reliability of at least .80 was established with the scoring provided by May-Benson before any testing was begun.

Procedure

Testing was conducted between February and April 2012 and 2013. Children whose parents had provided consent to participate were brought individually to a quiet, distraction-free room and asked to stand in a defined 6- × 8-ft testing area. Researchers conducted all sessions in pairs consisting of either two research assistants or a research assistant and a lead researcher (Ivey or Lane). For testing, one researcher interacted with the child while the other videotaped the session for later scoring. Each child

was given the instruction "Show me everything you can think of to do with this string" and had 5 min to demonstrate the actions.

The TIPs were scored from videotapes; the scoring procedure was consistent with that defined by May-Benson and Cermak (2007). Scoring involved observing the child interacting with and acting on the string. The child was awarded a point for each affordance demonstrated or when the intent to demonstrate the affordance was clear. *Affordances* were defined as actions that demonstrate knowledge of what the string can do or what actions may be used on the object. For instance, the child might demonstrate that the string was *throw-able* by throwing it or *wrap-able* by wrapping the string around his waist. Children did not need to be successful in their action to receive a point, but they had to clearly indicate the intent to act. A child who verbally indicated that she could, for instance, tie the string in her hair was asked to show the examiner what she meant. If she did not attempt to demonstrate the action, no point was awarded.

Affordance categories were identified by analysis of object–action affordances in an earlier study (May-Benson & Cermak, 2007) and included actions such as *bite-able*, *go-over-able*, *hand-on-able*, *swing-able*, and *whip-able*. Several affordance categories were sufficiently complex to allow for variations in actions. For instance, a child might demonstrate *tie-able* by tying the string around his head or his body or by tying the ends of the string together, either in the air or around the neck like a necklace. Each of these tie affordances was awarded 1 point. Other affordances, such as stretching the string between two hands, did not offer variations, so this affordance was counted only once, irrespective of the number of times it was repeated. The TIP Total score, which was derived by adding up all the points for each affordance category, was used in this study; in prior work, it was shown to have the best discriminative validity (May-Benson, 2005a).

Initially, lead researchers and research assistants conducted the scoring, but after discussion about distinguishing between affordances and review of previously scored tapes, we clarified the initial affordance definitions to allow for greater consistency, and Lane and Ivey rescored all tapes. Results are based on these revised scores.

Results

Participant Demographics

Children who did not have a diagnosis were considered typically developing for the purposes of this study. Of the initial 85 participants, 1 was omitted from analysis because

parent report indicated he had a diagnosis of language delay; 5 participants refused to participate in this part of the study (three 5-yr-olds, one 4-yr-old, one 3-yr-old); and 1 participant's data were omitted because exploratory stem and leaf analysis identified him as an outlier. The final sample size for this part of the study was 78. Of this sample, one 3-yr-old did not have date of birth data but was included in the sample of 3-yr-olds for analysis. Demographic information on the final sample is available in Table 1.

Age and Gender Performance

Table 2 presents the mean TIP Total score for each age group. Although 4-yr-olds performed on average slightly more actions on the string than 3- or 5-yr-olds, TIP Total scores did not differ across age brackets, $F(2, 73) = 1.29$, $p = .28$. Univariate analysis of variance indicated no difference by gender for the total group, $F(1, 77) = 1.4$, $p = .23$, or for the interaction of gender and year, $F(2, 77) = 1.63$, $p = .20$.

Reliability Analyses

We examined interrater reliability between authors Lane and Ivey. TIP Total scores for 19 children (approximately 24% of the testable population) yielded Cronbach's $\alpha = .94$, indicating excellent interrater reliability. Test-retest reliability was calculated on 16 children (approximately 20%) and yielded Cronbach's $\alpha = .80$, indicating acceptable to good test-retest stability over 2 wk.

Discussion

Praxis is a multifaceted concept that includes ideation, planning, and execution (Ayres, 1979). Both function and dysfunction in praxis play central roles in sensory integration theory. The motor performance aspect of praxis, execution of action, is easy to see, and therefore it can readily be assessed. A wealth of information is available on assessment of execution of action in the sensory integration literature (e.g., Ayres, 1989) and in other bodies of literature, such as the literature on developmental co-

ordination disorder (e.g., Bruininks & Bruininks, 2005; Hay, Hawes, & Faught, 2004; Henderson et al., 2007; Rihtman, Wilson, & Parush, 2011; Schoemaker, Flapper, Reinders-Messelink, & de Kloet, 2008).

In contrast, ideational praxis is not well understood, and empirical literature is lacking. Adequate tools to assess ideation, particularly in young children, have been unavailable. Nonetheless, Ayres (1985) identified ideation as a central aspect of praxis, referring to it as "knowing what to do," a cognitive aspect of praxis that develops on the basis of knowledge of self, knowledge of objects, and knowledge of self-object interaction. Because it is a cognitive function, the emergence of ideation likely follows a typical developmental sequence, unfolding along with cognitive abilities as children gain experience acting on and interacting with the environment.

May-Benson (2001), drawing on the work of Ayres, provided a model of praxis in which ideation is the link between language, sensory perception, limbic and frontal lobe functions, and motor action planning and execution. May-Benson explained that ideation includes conceptualization of the goal for action along with the intention to act. Intention to act is dependent on prior experiences and an understanding of object functions; ideation is a bridge between understanding objects and action and planning action. May-Benson developed the TIP to examine this step in the praxis process. Her original work provided age guidelines for performance in children ages 5–8 yr (May-Benson, 2005a). The study described in this article extends these findings and provides guidelines for children ages 3–5 yr.

Our finding of no significant differences among children ages 3, 4, and 5 yr was not unexpected. In fact, it is consistent with other early assessments of motor performance concerns linked with dyspraxia, which also found little difference among preschool-age children (Rihtman et al., 2011). Although the lack of age differences could be attributable to our small sample sizes at each age, preschool is a time when children are trying things out, exploring the environment, and conceptualizing how to interact within it. Ayres (1972) stated, "The

Table 1. Study Sample Demographics

Age Group	Mean Age, mo	Gender, <i>n</i> (%)		Handedness, <i>n</i> (%)		
		Male	Female	Right	Left	None
3-yr-olds (<i>n</i> = 31)	42 ± 3.1 ^a	17 (54.8)	14 (45.2)	21 (67.7)	3 (9.7)	7 (22.6)
4-yr-olds (<i>n</i> = 28)	54.6 ± 4.0	18 (64.3)	10 (35.7)	25 (89.3)	1 (3.6)	2 (7.1)
5-yr-olds (<i>n</i> = 19)	63.7 ± 2.5	13 (68.4)	6 (31.6)	16 (84.2)	1 (5.3)	2 (10.5)
Total (<i>N</i> = 78)	NA	48 (61.2)	30 (38.5)	62 (79.5)	5 (6.4)	11 (14.1)

Note. NA = not applicable.

^aDate of birth was not given for 1 child in the 3-yr-old group.

Table 2. Mean Test of Ideational Praxis Total Scores, by Age

Age Group, mo	<i>N</i>	Mean Total Score	Standard Deviation
36–47	31	9.68	5.653
48–59	28	12.18	6.504
60–71	19	9.68	8.028
Total	78	10.58	6.619

pre-school child is usually on the move, exploring the various ways in which his body will perform, manipulating objects, learning about things through touch and movement” (p. 170). It is a time when children can be expected to generate ideas about how to interact with people and things in the environment but also a time when children repeat the same action again and again. Younger children have limited motor experience and have just begun developing and experimenting with cognitive flexibility as they interact with people and things in the environment.

We did see some qualitative differences across the three ages in this study, but our observations are anecdotal at this time. For instance, the 3-yr-olds often repeated their actions and sometimes were awarded points for variations on a strategy, boosting their TIP scores. In contrast, many of the 5-yr-olds spent time trying to tie the string, as in tying a shoelace. They identified other affordances as well and received points for these, but their go-to action was often tying, and they ended up with scores very similar to those of the 3-yr-olds. The 4-yr-olds, however, were more inventive; they seemed to have greater cognitive flexibility and were not bound by a need to use the string “right,” as in tying. These are casual observations at this point that require further investigation to determine whether they are meaningful.

It is interesting that the 5-yr-olds in this study identified many fewer affordances than the 5-yr-olds in May-Benson’s (2005b) study as reported in the TIP manual. Several possible explanations exist for this finding. The scores presented in the manual were generated in May-Benson’s initial study, which included a total of six items. The string was not the first item presented. It is feasible, then, that once children had some experience with the concept of “show me everything you can do with . . .” on the initial objects, they were able to generate more ideas with subsequent objects. An alternate explanation is time of year; in the current study, data were collected in the spring, and the 5-yr-olds had been practicing shoe tying. Because we used a shoestring for this assessment, it is possible that they did what was most recent in their minds, tying a lace. One important difference between this group and May-Benson’s original

group is that the current 5-yr-olds were preschoolers, whereas May-Benson’s 5-yr-olds were in kindergarten. Perhaps the difference in educational experience and exposure to older children in the school environment allowed May-Benson’s original group to generate a wider range of ideas. Although the groups shared the feature of being primarily White, the current group came from regional preschools, whereas May-Benson’s normative sample was drawn largely from a middle-class public school system. Further investigation is warranted to examine these differences.

Our findings of very high interrater reliability parallel and support those May-Benson (2005b) obtained with children ages 5–8 yr. Development of skilled scoring requires training and time and is essential, as May-Benson (2005b) clearly stated in the manual. In this study, authors Lane and Ivey periodically rescored tapes that the research assistants had scored and were able to identify consistent errors made by newer research assistants. As a result, in preparation for this article, Lane and Ivey rescored all tapes. We recommend that after training scorers and establishing interrater reliability with the training tapes, clinical users assess their scoring consistency by having another trained scorer periodically rescore some of their tapes. Discrepancies can be discussed to keep scoring on target. If the TIP is to be used for research, we strongly recommend consistent score checks to ensure adequate reliability.

This study was the first time test–retest reliability has been examined in the TIP. Because this tool relies on cognitive flexibility and understanding of objects and actions, we did not expect to have a learning effect within the 2-wk time frame. We had hypothesized that giving a child a string for only 5 min and requesting that he or she generate as many ideas for action as possible would not lend itself to a practice effect. This hypothesis was largely supported. With our population of preschoolers, the TIP showed adequate to good test–retest stability.

Limitations and Future Directions

Limitations in this study include a relatively small, ethnically and racially homogeneous sample of convenience. Sample limitations restrict generalizability, and additional normative data are needed on the TIP. Additionally, training to achieve rater consistency was time intensive; scoring needs to be done carefully, and we found videotaping to be essential. Although training demands will not limit the use of the TIP in research, these demands may limit its use clinically at this time.

Understanding praxis and its components is essential to understanding and treating developmental dyspraxia. Ayres (1985) and researchers before her, such as Paillard (1982) and Poeck (1983, 1986), identified ideation as a critical step in praxis; Ayres specifically indicated that ideation was central to the theory of dyspraxia. Moreover, Ayres postulated that ideation might serve a more general function in support of both praxis and behavioral organization. Improving ideation, she hypothesized, might also improve the child's ability to organize his or her own behavior. Being able to objectively assess ideation is a means to better understanding both praxis and dyspraxia.

The research presented in this article adds to the understanding of ideation in young children. Ideation is measurable in the preschool years, and this preliminary evidence indicates that the TIP provides a simple yet reliable tool that can provide insight into early typical development of this aspect of praxis. Additional normative data are needed for both preschool-age and school-age children using a larger and more heterogeneous sample. Previous research has demonstrated that the TIP accurately differentiates between typical school-age children and children with dyspraxia (May-Benson, 2005a), but future research is needed to determine whether it can do so in the preschool-age group.

Implications for Occupational Therapy Practice

Assessment tools that are easy to administer and score yet provide useful information on function and dysfunction are crucial to occupational therapy practice. The results of this study have the following implications for occupational therapy practice:

- This study provides preliminary scoring guidelines for the TIP, which can be used in examining ideational praxis in preschool-age children.
- After adequate training, practitioners can use the TIP to screen young children for ideational praxis as part of an overall motor screening.
- In addition, practitioners can use the TIP to track changes in ideational praxis over time. ▲

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