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Memory and representation in young children with Down syndrome: Exploring deferred imitation and object permanence

MECHTHILD RAST AND ANDREW N. MELTZOFF
University of Washington

Abstract

Deferred imitation and object permanence (OP) were tested in 48 young children with Down syndrome (DS), ranging from 20 to 43 months of age. Deferred imitation and high-level OP (invisible displacements) have long been held to be synchronous developments during sensory-motor "Stage 6" (18–24 months of age in unimpaired children). The results of the current study demonstrate deferred imitation in young children with DS, showing they can learn novel behaviors from observation and retain multiple models in memory. This is the first demonstration of deferred imitation in young children with DS. The average OP level passed in this sample was A-not-B, a task passed at 8–12 months of age in normally developing infants. Analyses showed that individual children who failed high-level OP (invisible displacements) could still perform deferred imitation. This indicates that deferred imitation and OP invisible displacements are not synchronous developments in children with DS. This asynchrony is compatible with new data from unimpaired children suggesting that deferred imitation and high-level OP entail separate and distinctive kinds of memory and representation.

This study addressed the relationship between imitation from memory (deferred imitation) and object permanence in young children with Down syndrome. Although object permanence has been investigated numerous times in this population (Cicchetti & Mans-Wagener, 1987; Dunst, 1981, 1988, 1990; Dunst & Rheingrover, 1983; Kahn, 1978; Mervis & Cardoso-Martins, 1984; Morss, 1983, 1984; Pasnak & Pasnak, 1987; Sloper, Glenn, & Cunningham, 1986; Wishart, 1986, 1987; Wishart & Duffy, 1990), this is the first study designed to test deferred imitation in young children with Down syndrome.

In classic developmental theory, there is thought to be a deep kinship between deferred imitation and a high level of object permanence ("Stage 6" invisible displacements). Both provide a measure of recall not simply recognition memory: To succeed, infants must generate actions on the basis of stored representations of perceptually absent realities. Both are thought to derive from a common source, the emergence

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Address correspondence and reprint requests to: Andrew N. Meltzoff, Department of Psychology, Box 357920, University of Washington, Seattle, Washington 98195-7920.

of a representational intelligence (Piaget, 1952, 1954, 1962). It has long been held that deferred imitation and high-level object permanence (OP) emerge in tandem at about 18 to 24 months of age in unimpaired children.[1]

Recent data and theory have shown that some developmental synchronies described by Piagetian theory do not obtain, but that others certainly *do* (e.g., Astington & Gopnik, 1991; Bates & Snyder, 1987; Curcio & Houlihan, 1987; Fischer & Bidell, 1991; Flavell, 1982; Gopnik & Meltzoff, 1986, 1987, 1992; Hirschfeld & Gelman, 1994; Uzgiris, 1987). Although contemporary researchers now speak of "asynchrony across domains" and "synchrony within domains," predicting in advance of the data, where the "domain" boundaries are has proven to be a challenge.

Pending a new developmental theory that makes such predictions and provides explanations for them, experimental work is needed to uncover which particular abilities are empirically related in development. This paper focuses on the relation between high-level OP and deferred imitation. There is near-universal consensus that success on Stage 6 OP tasks (invisible displacements) requires memory and representation for absent objects and that deferred imitation requires memory and representation of absent acts. Are these both part and parcel of one domain or developmental level (representational vs. sensory-motor), and are they developmentally synchronous? Does one ability systematically emerge before another? Is there no systematic ordering between them and only individual variation? Does the relationship vary across different populations? These questions can begin to be addressed by testing OP and deferred imitation in the same individuals.

The first motivation for this study was to investigate deferred imitation in children with DS. Regardless of one's theoretical stance, it is acknowledged that deferred imitation is a powerful form of social learning, a kind of no-trial learning where the actions of the other are appropriated to the self. Because the imitative re-enactment takes place after a memory delay when the social act is no longer visible, deferred imitation also taps memory. A fuller understanding of the mental and social capacities of children with DS will be obtained by cataloging their capacity for deferred imitation. At present, this capacity is sometimes inferred from indications that young children with DS can learn sign language (Abrahamsen, Cavallo, & McCluer, 1985; Miller, 1992). Acquisition of sign language requires visual and gestural memory abilities. However, signs are taught using not only observational learning and imitation, but also a mixture of other training, shaping, and molding procedures. Thus, true observational learning and deferred imitation can be surmised but are not unequivocally demonstrated by reports of sign language. An organism could be taught to use signs through means other than imitation.

The second motivation was the opportunity for contributing to the debate about developmental synchronies/dissociations that has emerged in modern developmental theory, especially for infancy. Whereas unimpaired infants develop so quickly that two target skills may seem to co-occur, children with DS develop in a slower (but organizationally similar) manner (Beeghly & Cicchetti, 1987; Beeghly, Weiss-Perry, & Cicchetti, 1989, 1990; Cicchetti & Mans-Wagener, 1987; Dunst, 1990; Dunst & Rheingrover, 1983; Hill & McCune-Nicolich, 1981; Motti, Cicchetti, & Sroufe, 1983; Sigman & Ungerer, 1984). This potentially allows us to see dramatic dissociations between skills and abilities that are not tied by necessity but are only contingently related in normal development. There is the potential for discovering wide gaps, if they exist—gaps of months or years that would be more subtle in unimpaired children. Thus,

1. OP development consists of a series of levels. Piagetian theory makes a specific and powerful prediction: A certain level of OP understanding, invisible displacements, emerges in synchrony with deferred imitation. Other more primitive levels of OP are thought to emerge in conjunction with more primitive levels of imitation (e.g., Piaget, 1962; Uzgiris & Hunt, 1975).

claims about developmental universality and causal connectivity can be addressed by tests with this population.

The third motivation was more applied. It would be informative for teachers and parents if it could be demonstrated that children with DS have strengths in imitating from memory. A reason that deferred imitation has not been tested in young children with DS is that paradigms typically involve verbal directions or prompts such as, "Do you remember what I showed you? You do it." New procedures not relying on language have recently been developed to assess deferred imitation in preverbal infants (e.g., Meltzoff, 1985, 1988a, b, 1990). Thus the third goal was to adapt these infant tests for use with young children with DS and potentially other language-delayed populations.

Methods

Subjects

A total of 48 children with DS served as subjects. According to school records and parental reports of karyotyping, the sample was composed of 46 cases of the trisomy 21 type of DS and 2 cases of the translocation type. All children were home reared. The sample was composed of two subgroups used to test specific theoretical predictions (described later). The "young" group consisted of 24 children ranging from 20 to 24 months of age (M = 21.92 months; SD = 1.00). The "old" group consisted of 24 children ranging from 25 to 43 months of age (M = 32.32 months; SD = 6.10; Table 1). Five additional children were tested but dropped from the study: one because of procedural error and four because of lack of cooperation (usually they persisted in throwing the testing materials).

Subjects in both the younger and the older group were randomly assigned to an imitation (experimental) and a control group, each counterbalanced for sex. The control group was further subdivided into a baseline- and activity-control group (described in Procedures), each of which was again balanced for sex.

The subjects were recruited by contacting Early Intervention Programs in Washington, Texas, California, and British Columbia. The principal testing site was at the Child Development and Mental Retardation Center, University of Washington, Seattle, but some children were drawn from other sites because we sought a very large N within tightly prescribed age limits. Descriptive statistics for various subject characteristics and demographic factors are provided in Table 1, including the parent's socioeconomic status (SES; Hollingshead, 1975), the children's weekly hours of participation in intervention programs, birthweight, and number of younger and older siblings. Analyses revealed no significant differences on any of these characteristics between the imitation or control groups.

Materials

Six objects were used as test stimuli. All had been previously used by Meltzoff in tests of unimpaired infants (Hanna & Meltzoff, 1993; Meltzoff, 1988a, b). Four of the six objects had been specially constructed in this laboratory, and therefore were novel objects to the subjects.

1. The dumbbell object consisted of two wooden cubes (2.5 cm), which were connected by two plastic tubes (length 7.5 cm). The thinner tube fit inside the wider one. The target act was pulling apart the object.
2. The head-touch panel consisted of a flat wooden box with a nonreflecting, translucent orange plastic panel (4.3 cm × 19 cm × 26.7 cm). The target act was leaning forward and touching the orange panel with the forehead, which activated a bulb inside the box that illuminated the orange panel.
3. The buzzer box consisted of a black box (16 cm × 16.5 cm) tilted off the surface of the table so it faced the child. The top surface contained a small round hole (9 mm) with a slightly recessed button. The target act was pushing the button with

Table 1. *Subject characteristics and demographic information*

	All Subjects	Imitation Group	Control Group
CA (years)	2.27 ± 0.57	2.19 ± 0.50	2.34 ± 0.63
Young	1.83 ± 0.08	1.82 ± 0.08	1.84 ± 0.09
Old	2.70 ± 0.51	2.56 ± 0.45	2.84 ± 0.54
Birthweight (kg)	3.14 ± 0.64	3.28 ± 0.73	2.99 ± 0.52
Young	3.17 ± 0.57	3.23 ± 0.68	3.11 ± 0.46
Old	3.11 ± 0.71	3.34 ± 0.80	2.88 ± 0.56
SES	42.60 ± 12.97	43.15 ± 12.03	42.06 ± 14.05
Young	43.41 ± 13.64	44.27 ± 13.56	42.63 ± 14.27
Old	41.81 ± 12.54	42.13 ± 10.96	41.50 ± 14.44
Program hours	7.40 ± 7.76	7.71 ± 8.35	7.08 ± 7.29
Young	4.33 ± 4.42	3.42 ± 2.58	5.25 ± 5.69
Old	10.46 ± 9.17	12.00 ± 9.95	8.92 ± 8.45
Older siblings	1.33 ± 1.26	1.29 ± 0.91	1.38 ± 1.56
Young	1.33 ± 0.92	1.50 ± 0.91	1.17 ± 0.94
Old	1.33 ± 1.55	1.08 ± 0.90	1.58 ± 2.02
Younger siblings	0.19 ± 0.45	0.17 ± 0.48	0.21 ± 0.42
Young	0.04 ± 0.20	0.00 ± 0.00	0.08 ± 0.29
Old	0.33 ± 0.57	0.33 ± 0.65	0.33 ± 0.49

Note: Values are mean ± 1*SD*. CA = chronological age; Young = 20–24 months old; Old = 25–43 months old; Program hours = weekly hours in intervention program.

the index finger to produce a buzzing sound.

4. The hinged object consisted of two pieces of wood, a base (2 cm × 15.3 cm × 23.5 cm), and a vertical board (2 cm × 9.2 cm × 10 cm), connected by a hinge. The target act was folding down the vertical board. The hinge had enough resistance to prevent the flap from falling over when moved partially through the arc.

5. The collapsible cup (6.5 cm × 5.8 cm) was composed of graduated bands of plastic. The target act was pressing down the top surface with the palm of the hand so that it collapsed. The cup had enough resistance to avoid collapsing if continuous pressure was not applied.

6. The orange plastic egg (4.5 cm × 6.4 cm) was mounted on a small black base. The egg had been filled with a couple of metal nuts. The target act was shaking the egg, which resulted in a rattling sound.

Six test sequences were used, assuring that each test object occurred in each position at least once. Equal numbers of children within both the experimental and control groups were randomly assigned to each test sequence.

Testing environment and apparatus

All children were tested in centers located in their own geographic regions by the same experimenter in highly uniform test conditions set up in advance of the test session. The parents and children were accompanied to a waiting room that was separate from the test room. They also returned to the waiting room during the 5-min memory delay period used for deferred imitation. The testing rooms varied somewhat in size, but were quiet and contained a table at which two adults could sit comfortably facing each other. The size of the table was at least 76 cm × 122 cm so that three cloths (for OP testing) could be spread in front of the subject without touching each other. The subject was held on the parent's lap facing the table. The parent's chair was on coasters allowing the parent to roll back and approach the table during the administration of OP tasks. The height of the table was such that it did not interfere with the children's forward flexion of the trunk, which was required in the test of head-touch imitation (the top edge of the table was at about the infant's lower chest). Infants who were too short when sitting on the parent's lap were raised by placing a foam rubber pad on the parent's thighs. A black cloth was taped to the underside of the table, acting as a curtain that hid the testing materials from view. A video camera was placed slightly laterally and behind one of the experimenter's shoulders. It was focused on the child and included a portion of the table top in front of the child. In sum, all important aspects of the test room itself were kept constant across the different testing sites.

Procedure

All children were tested in one session lasting approximately 45 min. The parents received a $12.00 participation fee and a certificate acknowledging participation.

Acclimation and spontaneous play with objects. In the waiting room the parents completed a consent form describing the study. They were informed about the procedures and advised not to assist their child through language, gestures, or movements during the session. After answering questions about the procedure, the experimenter escorted the parent and child to the test room. All subjects were presented with small plastic and rubber warm-up toys to become accustomed to the test situation. The toys did not resemble those used for the experiment. When the subjects appeared comfortable, the spontaneous play session began. For this, the experimenter handed the subject the six test objects one at a time. The children were allowed to interact with each object for 20 s, and their behavior was videotaped for subsequent analysis. The details of the next step differed according to the experimental group assignment (imitation vs. control).

Imitation group. This group assessed whether children would reproduce target acts after seeing them demonstrated. The experimenter demonstrated a specific target act (three repetitions in succession) with each of the six test objects. The child's attention was attracted and maintained by calling the child's name or by saying "look at this" or "watch what I am doing now." The names of the objects or the target acts were never mentioned. Each test stimulus was removed from the child's visual field before the next one was presented. After demonstrations with the six test objects, the memory delay was imposed. Importantly, the children were not given the opportunity to touch or play with the objects during the stimulus-presentation periods. Therefore they had no immediate motor practice before the delay was imposed, which provides a strong test of deferred imitation (Meltzoff, 1985, 1988a, b, 1995).

The child and parent returned to the waiting room for the 5-min delay. The children often had a small snack or played with toys. At the end of the delay, the children and parents returned to the test room. The experimenter handed the objects to the child following the same test order as before. The subject was allowed to interact with each test object for 20 s, starting from the moment the child first touched the toy. No verbal or physical directions concerning the target acts were provided; the child was simply presented with the objects, and if there was hesitation they were encouraged by saying, "this is for you" or "it's your turn, it's OK."

Baseline control group. The subjects were treated similarly to the experimental group, save that they were not exposed to the demonstrations. The subjects were brought into the test room and allowed to play with the objects during the spontaneous play period but were not shown the target acts by the experimenter. The children were then removed from the test room for the 5-min delay before returning for the response period. Upon returning to the test room, the procedure was identical to the imitation group. This baseline group assessed the children's likelihood of spontaneously producing the target acts in the absence of seeing them modeled.

Activity control group. In addition to the baseline control, a second control group was used. This group assessed whether merely seeing the adult pick up and handle the test objects might elevate subjects' tendency to perform the target acts after the delay, even in the absence of seeing the specific target acts modeled. The overall procedure was the same as in the experimental group except that the specific target acts were not demonstrated. The adult picked up and manipulated the test objects for the same length of time and over the same spatial extent of movement as in the imitation group, but refrained from demonstrating the particular target acts under test. The experimenter instead handled the objects in other ways, each toy for approximately 20 s (see Meltzoff, 1988a, b for details). Following this, the subjects were treated identically to the other groups: They left the room and the delay was imposed, after which they returned to the test room for the six 20-s response periods. Previous research with unimpaired children did not reveal any significant difference between the baseline and activity control groups; the two control groups together provide a rigorous assessment of the children's tendency to produce the target acts "on their own" in the absence of modeling.

Object permanence. All groups received the same test of OP. Small objects were hidden under cloths in the manner originally described by Piaget (1954) and used by Uzgiris and Hunt (1975). The particular hiding procedures used here derived from the work of Moore (1975) and Moore and Meltzoff (1978) with some adaptation for atypical populations.

A particular level of OP was deemed "passed" if the child successfully found the object in three of four hidings at that particular task level. Following Piaget and the Uzgiris–Hunt procedure, a trial was sometimes readministered if the child refused to watch or was uninterested in a toy; such trials were not counted against the child's criterion four trials. Testing continued up the scale until the child failed two consecutive levels or refused to maintain attention to the disappearances despite repeated attempts to re-engage him/her (often a sign of cognitive conflict with tasks the subject finds difficult to solve). The specific tasks used are described below (with Piagetian stage equivalents in parentheses). Unless otherwise noted, there were two cloths on the table for each hiding.

Task 1. Partial hiding: The toy is put on the table, and the child watches as two cloths are moved so that one of them is covering about 75% of the toy (Stage 3).

Task 2. Simple visible hiding: Complete occlusion in one place. The toy is put on the table. As the child watches, both cloths are moved forward so that one fully covers the toy (Stage 4).

Task 3. A-not-B: Complete occlusion in alternating places. Same as Task 2 except after two successful recoveries at one place the toy is moved to the other place for the hiding (early Stage 5).

Task 4. Serial visible displacement: A toy is transported by hand under two hiding places. The toy is put in the experimenter's flat open palm and the open hand is slid under the first and then the second cloth. The toy is either deposited under the last cloth or under the first one (late Stage 5).

Task 5. Simple invisible displacement: An invisible displacement at one place. The toy is put on the table and then covered by the experimenter's hand so that the child finds it there several times. The toy is then covered by the hand, and the hand is slid under one of the cloths where the toy is deposited unbeknownst to the child. Then, the hand is slid out again for the child to search (early Stage 6).

Task 6. Serial invisible displacement: A series of invisible displacements. After hiding the toy in the hand (as in Task 5), the hand is moved under three cloths, and the toy is deposited under one of them unbeknownst to the child. The hand emerges from the last cloth and is put in a spot in front of the child for search (late Stage 6).

The above descriptions outline the Moore–Meltzoff OP test battery used in this study. There are also four procedural points that are part of the battery. Several of these procedural points were recommended in Piaget's original descriptions, and they have been incorporated into the Moore–Meltzoff battery because they were found to be critical for obtaining reliable OP scores (they are sometimes overlooked in other OP assessment instruments). First, searching in the wrong location resulted in the experimenter's prompt removal of cloths and toy. This meant that the child was not given the opportunity to learn about the toy's location through trial and error, which might lead to "magical procedure" cloth-pulling strategies in later trials and thus invalidate results. Second, care was taken at the disappearance and reappearance transitions such that the toy and cloths were moved only if the child was closely attending. Third, the toys could be changed between but not within task levels. For example, the logic of the A-not-B test demands that the same object that was found at A is the one that is hidden at B; switching objects within task would undermine the logic of the test. Thus if a child became bored with a toy within a task, the task was readministered in its entirety using a new toy. Fourth, in the invisible displacement tasks, the object was first hidden under the hand until the child found it there two times. This is necessary to pose a valid test of invisible displacements (where the object is invisibly moved from the hand to the cloth). A critical aspect of invisible displacements is whether the child can change his or her hypothesis about where the object is while it is out of sight. The child must have the belief that the object exists hidden under the first occluder (the hand) before the invisible displacement problem can be posed. It is this failure of the child's first prediction (the hand is empty) that induces the conceptual problem.

Scoring

Imitation and OP were coded by independent scorers from videotaped response periods. Each scorer remained unaware of the subjects' performance on the other test (OP vs. imitation), thus the relation between these tests could be validly assessed. To assure that deferred imitation was scored blind to test conditions (control vs. imitation), an edited videotape was made that only contained the 20-s response periods. There was no artificial way of knowing what group the child was in because for all groups the children had a series of 20-s response periods. The scorers were provided with the following operational definitions for success on the tests administered.

Deferred imitation: Operational definitions. A dichotomous (yes/no) score was assigned according to whether the child did or did not perform the target act in the 20-s response period (timed from when the subject first touched the test object). The scorer often used slow motion or replayed a trial to determine whether criterion was met. For the dumbbell, a "yes" was scored if the child pulled the object apart. For the buzzer box, the child obtained a yes score for poking the recessed button and activating the buzzer. For the hinged object, a yes was scored if the subject folded down the vertical piece through an arc of at least 45°. For the cup, a yes was scored if the child pushed the cup flat with his/her hand. For the egg, a yes was scored if the child shook the object. Shaking was defined as a rapid bidirectional movement in which the trajectory was reversed. For the head-touch panel, a yes was scored if the child leaned forward and touched it with the head (or if the subject leaned all the way down, but missed slightly because, for example, bulky clothing preventing him/her from making contact). The children frequently approached this flat panel with their mouth for the purpose of oral exploration. To avoid giving credit for such mouthing behavior, the scorers were trained (based on pilot tapes) to distinguish between approaches to the panel for oral explorative purposes versus head touching. Only the latter were counted.

Object permanence: Operational definitions. Children were assigned the highest

Table 2. *Number of subjects succeeding on different levels (and stages) of object permanence*

	Simple Visible (Stage 4)	A-not-B (Early Stage 5)	Serial Visible (Late Stage 5)	Simple Invisible (Early Stage 6)	Serial Invisible (Late Stage 6)
Number of subjects	12	16	12	7	1

Note: The Piagetian stage equivalents for the OP tasks are shown in parentheses.

OP level passed. An OP level was scored as having been passed if the subject found the object three out of four times at a given task level. The child was given credit for finding the object if he/she lifted the appropriate cloth and looked at the object. If subjects made bimanual responses (lifting two cloths virtually simultaneously), the subject's visual attention was the determinant of which location was being searched. For Task 6 (serial invisible displacement), the subject had to search systematically from the first to the third cloth or in the reverse direction; random searches of all cloths were not scored as a success (as also suggested by Piaget, 1954 and Uzgiris & Hunt, 1975).

Scoring agreement. There was high inter- and intraobserver scoring agreement. For both assessments coders rescored 25% of the data. The samples were randomly selected with the restriction that they were balanced for equal numbers of subjects from the young/old groups, the imitation/control groups, and male/female subjects. Agreement was evaluated both by using the Pearson r and the kappa statistic (κ corrects for chance agreements and is a conservative measure). For deferred imitation, the dependent measure consisted of the number of target acts performed, ranging from zero to six because there were six objects. The intraobserver agreement was Pearson r = .98 and weighted κ = .94; the interobserver agreement was Pearson r = .96 and weighted κ = .88. For OP, the dependent measure consisted of the highest task level passed. Intraobserver agreement was perfect, interobserver agreement was Pearson r = .93 and weighted κ = .86.

Results

All subjects succeeded on the lowest level of OP, the partial hiding task, indicating that they had the motor skills and means–ends understanding to lift cloths to retrieve objects. The distribution of subjects as a function of different OP levels is provided in Table 2. The results show that the modal level was A-not-B. As expected through the random assignment of subjects, the level of OP was nearly identical as a function of experimental groups (imitation vs. control), Mann-Whitney, $p > .50$ (also see Table 3).

The measure used to assess deferred imitation was the percent of novel target acts performed. For example, if a subject performed one of the six target acts during the spontaneous play period, he/she had five possible new acts that could be imitated at test. If this subject then performed four of the five target acts at test, the percent novel act score equalled 80%. This measure (hereafter referred to as the "imitation score") allowed us to examine imitation of nonhabitual acts for individual children. Preliminary analyses indicated that the two types of controls (baseline and activity control) did not significantly differ from each other (replicating similar findings with unimpaired children, Meltzoff, 1985, 1988a, b). The data from the two control groups were therefore collapsed for the subsequent analyses.

As shown in Table 3, the imitation score was significantly greater in the imitation

Table 3. *Scores for deferred imitation and object permanence (OP) as a function of group*

	Imitation Group					Control Group				
	All	Young	Old	Low OP	High OP	All	Young	Old	Low OP	High OP
Deferred imitation scores										
M	50.28	35.69	64.86	42.67	62.96	10.21	6.39	14.03	12.18	7.88
Median	55.00	32.50	67.50	40.00	66.66	0.00	0.00	8.33	16.66	0.00
SD	31.78	32.37	24.50	30.70	31.06	13.35	9.48	15.85	13.10	13.93
Range	0–100	0–80	25–100	0–80	0–100	0–40	0–20	0–40	0–40	0–33
OP scores										
M	3.25	3.17	3.33			3.46	3.25	3.67		
Median	3.00	3.00	3.50			3.00	3.00	3.50		
SD	0.99	0.84	1.16			1.18	1.14	1.23		
Range	2–5	2–5	2–5			2–6	2–5	2–6		

Note: The young group (n = 24) ranged in age from 20–24 months and the old group (n = 24) from 25–43 months. The low-OP group (n = 28) consisted of children who passed the A-not-B hiding or below. The high-OP group (n = 20) consisted of those children who passed OP tasks higher than A-not-B. The imitation scores were the percent novel acts performed.

group (M = 50.28%, SD = 31.78) than in the control group (M = 10.21%, SD = 13.35), z = 4.33, p < .0001, Mann–Whitney *U*. The imitation score was analyzed separately for the young and the old group. The results showed deferred imitation within each age group considered individually. For the young group, children in the imitation group scored significantly higher (M = 35.69%, SD = 32.37) than the controls (M = 6.39%, SD = 9.48), z = 2.38, p < .05, Mann–Whitney *U*. For the old group, the imitation group (M = 64.86%, SD = 24.50) scored significantly higher than the controls (M = 14.03%, SD = 15.85), z = 3.85, p < .001, Mann–Whitney *U*.

On theoretical grounds it was of interest to examine imitative performance for children of different levels of cognitive functioning. OP is a measure that has been used to assess mental functioning in both preverbal infants and very young children with DS (Cardoso-Martins, Mervis, & Mervis, 1985; Curcio & Houlihan, 1987; Dunst, 1990; Uzgiris, 1987; Uzgiris & Hunt, 1975). (Other assessments such as the Bayley scales or maternal reports such as the Vineland were not available on the current sample.) The children were divided into those who were functioning at "high" versus "low" levels of OP, and the existence of deferred imitation was assessed in each subgroup. There were 28 subjects who only succeeded on simple visible hiding or the A-not-B hiding tasks (termed low OP). This OP level corresponds approximately to the functioning of 8- to 12-month-old unimpaired infants (Butterworth, 1977; Butterworth, Jarrett, & Hicks, 1982; Diamond, 1985; Fox, Kagan, & Weiskopf, 1979; Moore & Meltzoff, 1978; Piaget, 1954; Uzgiris & Hunt, 1975; Wishart & Bower, 1984). The results showed that there was significant deferred imitation among these children. The imitation score was significantly greater in the imitation group (M = 42.67%, SD = 30.70) than in the controls (M = 12.18%, SD = 13.10), z = 2.80, p < .01, Mann–Whitney *U*. Deferred imitation was also assessed in the 20 subjects with higher functioning according to the OP test (serial visible, simple invisible, or serial invisible displacements—indicative of a cognitive level between 1 to 2 years of age in unimpaired infants). The imitation score was greater in the imitation group (M = 62.96%, SD = 31.06) than in the controls (M = 7.88%, SD = 13.93), z = 3.39, p < .001, Mann–Whitney *U*. There was not a significant difference in imitative performance for the low- versus high-OP subjects ($p = .187$), although the means (42.67% vs. 62.96%) were in the direction of more deferred imitation in the high-OP group. It is possible that with a broader range of OP levels represented in the sample, the findings would show a significant association between OP level and imitation. We are not suggesting that OP level and deferred imitation are wholly unrelated (one would expect that at some level of cognitive immaturity deferred imitation would fall to chance, and conversely at high cognitive levels these simple deferred imitation tasks would reach ceiling). The principal point is that there was significant deferred imitation even among the low-OP group taken in isolation (none of whom solved invisible displacements), which was a key question under test and is informative for theory.

Discussion

This is the first study assessing deferred imitation in young children with DS. Overall, children produced about 50% of the novel acts they saw demonstrated versus about 10% in the controls. This comparison clearly shows that the children remembered and were influenced by what they had seen before the delay. The children were reenacting a display that was briefly shown, following a delay in which they left the test room and engaged in other visual and motor tasks. The findings demonstrate an ability to organize actions based on the stored representation of absent events in the absence of any extrinsic reinforcement for doing so. Moreover, the test of deferred imitation was an extremely stringent one. The children were not allowed to touch or handle the objects during the display; the experimenter simply demonstrated the target act while keeping the test object out of reach. The delay was then imposed and deferred imitation assessed. Detailed analyses demonstrated deferred imitation even among the subset of children ($N = 28$) who were functioning at or below the 1-year age level as assessed by OP.

Children were randomly assigned to the experimental and control groups. A measure of nonverbal cognitive functioning was obtained on all children. The results confirmed that the imitation and control groups were virtually identical on this measure as well as on demographic characteristics, which adds weight to the finding of a significant difference in the imitation score as a function of experimental treatment.

Although deferred imitation was demonstrated, imitative performance was not near ceiling, and some interesting errors were observed. The cup was frequently put to the mouth as if enacting drinking behaviors instead of imitating the target act itself. This suggests that young children with DS may have difficulty in overcoming or inhibiting routinized behaviors with familiar objects (Krakow & Kopp, 1983), which could be mistaken as a fundamental deficit in imitation or memory per se if tests were not designed with care. Several children pushed the ends of the dumbbell inwards instead of pulling them outwards. This suggests that in some cases they retained a more global description of the target act (perhaps "lateral movement of the ends") and failed to remember the fine-grained information about details of the event. The nature of these errors and a fuller examination of how memory degrades over time in children with DS as compared to normally developing children would be worth pursuing in future research.

The typical OP performance of this sample (assessed by mean, median, and mode) was at the A-not-B level. This manifests a marked cognitive delay, inasmuch as unimpaired children reach this level of understanding at about 8 to 12 months of age (e.g., Butterworth, 1977; Diamond, 1985; Piaget, 1954; Uzgiris & Hunt, 1975), and this DS sample ranged from 20 to 43 months of age. Such delays on OP in young children with DS are in line with previous findings (Dunst, 1988, 1990; Dunst & Rheingrover, 1983; Kahn, 1978; Mervis & Cardoso-Martins, 1984; Morss, 1983, 1984). It is probable that the few studies reporting little or no delay in OP for children with DS (Cicchetti & Mans-Wagener, 1987; Wishart, 1988) provided training by testing the infants repeatedly. This suspicion is supported by the finding that positive outcomes were not maintained after termination of the regular testing schedule (Wishart, 1988).

In addition to the delay (a quantitative measure), a qualitative difference in the OP behavior of children with DS was noted as compared to the more than 500 normally developing children we have tested. This qualitative difference is captured by the notion of "competence motivation" (White, 1959). Normally developing children are cognitively motivated to work on OP problems. They sometimes become bored with easy hidings and are impelled to search when the tasks begin to become difficult for them. They are not seeking the object as an extrinsic reward, indeed they often give the object back to the experimenter or put it down immediately after finding it. They show signs (affective, motivational, etc.) of being taken in by the conundrum of where the toy is. Adults show the same cognitive curiosity when a magician makes an object disappear: We don't want the object as such, but we want to understand. This type of "epistemic curiosity," seems dampened in children with DS. It is difficult to find OP tasks that draw them in for systematic cognitive work. It is not that OP tasks do not command their attention, but there seems to be less "cognitive capture." This observation is offered with recognition that it is a clinical impression and not a statistical result. It is provided because future studies could codify it more carefully, and also investigate whether it is limited to OP tasks, or applies to other problem-solving tasks. The notion that there may be a dampened epistemic curiosity in young children with DS is compatible with other work (Ruskin, Mundy, Kasari, & Sigman, 1994; Wishart, 1993; Zigler, 1969).

Classical development theory holds that deferred imitation and a particular level of OP (invisible displacements) develop in synchrony. The study reported here demonstrates that these developmental achievements are not tied by necessity. Children with DS can fail completely on OP invisible displacements and still perform deferred imitation (none of the children in the low-OP group succeeded at invisible displacements and significant deferred imitation was demonstrated).

These results from children with DS showing a decoupling between deferred imitation and OP invisible displacements are compatible with newly emerging findings in unimpaired infants. Meltzoff (1988b) reported deferred imitation in unimpaired infants as young as 9 months of age. Other recent experimental work confirmed the existence of deferred imitation before the standard age of 18 months (e.g., Bauer & Hertsgaard, 1993; Heimann & Meltzoff, in press; Mandler, 1990; Meltzoff & Moore, 1994). Although none of these studies tested OP in the same individuals, there is consensus from both the experimental literature and the normative scales that normally developing 9-month-olds cannot solve OP search tasks involving invisible displacements (e.g., Gopnik & Meltzoff, 1986, 1987; Harris, 1987; Piaget, 1954; Uzgiris & Hunt, 1975). A new goal then is to try to account for why these two behaviors, long thought to be synchronous developments, do not emerge contemporaneously either in children with DS (as empirically demonstrated here) or in unimpaired children (as inferred from the age norms).

Two possibilities bear consideration. First, deferred imitation requires remembering another person's actions and OP requires remembering the location of an object. There are important differences in infants' notions of persons versus things (Meltzoff, in press; Meltzoff & Moore, 1995). Social cognition can be measured by a variety of behaviors. Depending on the selected behavior and the comparison group, children with DS have been found to have strengths or deficits in the social domain broadly defined (Beeghly, Weiss–Perry, & Cicchetti, 1989; Cornwell & Birch, 1969; Dykens, Hodapp, & Evans, 1994; Krakow & Kopp, 1983; Loveland & Kelley, 1991; Mundy, Sigman, Kasari, & Yirmiya, 1988; Sigman & Ungerer, 1984; Sinson & Wetherick, 1986). Is there a cluster of tasks tapping social cognition and the understanding of persons, including imitation, that tend to interrelate? How do children with DS compare to normally developing children (and to children with autism) on such a constellation? Answering such questions is relevant to current theorizing and would necessitate a larger study testing a range of person- and thing-oriented tasks to ferret out potential relationships.

Second, within the cognitive realm itself, it can be suggested that deferred imitation and high-level OP differ in the kind of memory and representation involved (Meltzoff, 1990; Meltzoff & Gopnik, 1993; Meltzoff & Moore, 1995). Classical theory was struck by two similarities: (a) in both deferred imitation and serial invisible displacements there is representation of the *nonvisible;* and (b) in both cases there is the formulation of an *action* plan, based on a stored representation (vs. purely visual recognition). However, close analysis (aided by the present data) suggests that the content of the representations may differ in interesting ways. Deferred imitation requires a representation of what actually was. OP invisible displacements require a deduction of what must have been. The OP task demands representation, not solely of a seen event, but of an unseen transformation of reality. The children must reason about a change of location that occurred during visual occlusion. In the invisible displacement task, the place where the toy was supposed to be (the hand) is found to be empty. The empty hand forces children to change their initial beliefs and hypothesize something that must have happened in the invisible world.

This distinction has been called "empirical" versus "hypothetical" representation (Meltzoff, 1990; Meltzoff & Gopnik, 1989). The first is the representation of what was seen; the second entails changing one's beliefs and using deductive thinking about what must have happened in the absence of direct sensory evidence. The results of the experiment reported here suggest that children with DS access the kind of representation underlying deferred imitation (empirical representations) with greater ease than hypothetical representations. It would be of interest to investigate whether these two are mediated by different brain structures, which might help explain why they do not develop in synchrony despite both involving the control of action based on stored representations of invisible realities.

The present findings suggest that imitation and OP can be differentiated in ways that were not suspected by traditional theory. If they are differentiable, this has implications beyond Down syndrome. Might there be a population with the reverse profile of the one found here—children who manifest high-level OP without a facility at deferred imitation? It has been suggested that children with autism (at least a subgroup of them) present just this unusual case, with consequences for their later impairments in understanding persons (Meltzoff & Gopnik, 1993; Rogers & Pennington, 1991). A. Meltzoff and G. Dawson (University of Washington) are currently investigating the relation between deferred imitation and OP in children with autism, and related work is being conducted in other laboratories (e.g., Charman & Baron-Cohen, 1994; Rogers, McEvoy, Pennington, & Bennetto, 1995). The present research procedures and data may prove useful for the larger enterprise of comparing developmental profiles across populations.

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