Young Children's Ability to Differentiate Appearance-Reality and Level 2 Perspectives in the Tactile Modality

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FLAVELL, JOHN H.; GREEN, FRANCES L.; and FLAVELL, ELEANOR R. *Young Children's Ability to Differentiate Appearance-Reality and Level 2 Perspectives in the Tactile Modality.* CHILD DEVELOPMENT, 1989, **60**, 201–213. A key acquisition in the child's developing knowledge of the mind is the subjective-objective distinction, which includes a clear understanding that things may appear to be other than the way they really are (appearance-realilty distinction) and may present different appearances to self and others (Level 2 perspective-taking). Previous studies using tasks involving visual appearances have found that most children do not show such understanding until 4 or 5 years of age. However, a conceptual analysis of tactile as compared to visual and other perceptual experiences suggested the hypothesis that this understanding might appear earlier if the appearances the child must identify are tactile rather than visual. This hypothesis was supported by the results of 3 studies. In Studies 1 and 2, 3-year-old subjects could correctly indicate, for example, that an ice cube they were feeling with a heavily gloved finger did not feel cold to that finger (tactile appearance for the self), did feel cold to the experimenter's ungloved or thinly gloved finger (tactile appearance for another person), and was a cold ice cube, really and truly (reality). In contrast, and consistent with previous research findings, they were much poorer at distinguishing between real and visually apparent object identity, number, and color. Similarly, in Study 3 they tended to perform better on tactile appearance-reality tasks involving the properties of number, wetness, and intactness than on visual appearance-reality tasks that involved these same properties.

The development of children's knowledge about the mental world has been the subject of considerable research since Piaget's (1929) pioneering studies. This research is usually reviewed under the headings of children's developing metacognition and social cognition, and more recently, their developing "theory of mind" (e.g., Astington, Harris, & Olson, in press; Bretherton & Beeghly, 1982; Brown, Bransford, Ferrara, & Campione, 1983; Chandler & Boyes, 1982; Flavell, 1979, 1981, 1985, in press; Flavell & Ross, 1981; Hogrefe, Wimmer, & Perner, 1986; Selman, 1980; Shantz, 1983; Shatz, Wellman, & Silber, 1983; Wellman, 1985a, 1985b, in press). One of the most important things children must acquire in this area of cognitive development is a clear distinction between external objects (events, etc.) and internal representations and experiences of those objects. This acquisition entails both the understanding that an object can seem different to different people and the related insight that it can seem different from the way it really is. The former has been called Level 2 perceptual perspective-taking competence, the latter, competence with the appearance-reality distinction. Both competencies are absolutely essential for mature thought and understanding. We could not comprehend much about ourselves, other people, or the natural world without the concepts of perspective, appearance, and reality. To illustrate, understanding the notions of theory, belief, guess, misunderstanding, error, illusion, resemblance, deception, disagreement, and point of view requires these competencies.

There is considerable evidence that 3-year-olds tend to perform poorly on both Level 2 perspective-taking tasks and appearance-reality tasks (Flavell, 1986, in press; Flavell, Everett, Croft, & Flavell, 1981; Flavell, Flavell, & Green, 1983; Flavell, Flavell, Green, & Wilcox, 1980; Flavell, Green, & Flavell, 1986; Flavell, Green, Wahl, & Flavell, 1987; Liben, 1978; Taylor & Flavell, 1984). Performance on these two types of tasks has

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also been found to be positively correlated within this age group (Flavell et al., 1986; Gopnik & Astington, 1988), a further indication that these two conceptually related forms of understanding may also develop together. To illustrate the correlation, the same 3-year-old children (a minority) who correctly state that a straight object that they are viewing through a distorting lens presently looks bent to them but is really straight (appearance-reality task) also tend to say that the object looks straight to an experimenter who is viewing it from the opposite side, with no lens interposed (Level 2 perceptual perspective-taking task). Finally, the difficulties that the majority of 3-year-olds have with such tasks seem well-entrenched; for example, efforts to reduce them through brief training have so far proven unsuccessful (Flavell et al., 1981, 1986).

It may be significant, however, that almost all this evidence for 3-year-olds' difficulties with appearance-reality and Level 2 perspective-taking has come from tasks in which the appearances or perspectives are visual in nature. Our introspections about the phenomenology of perceptual experiences in different modalities suggest that tactile experiences might be easier than visual and other perceptual experiences for young children to reflect on and to differentiate from the external objects that cause them. Consider the following differences between, say, seeing with one's eyes that an object is blue and feeling with one's hand that it is cold.

1. In the tactile but not the visual case, one has the sense that the experience is taking place out there in one's hand rather than up here in the head region, the place where one senses that the seat of consciousness or "cognitive self" resides (Flavell, Shipstead, & Croft, 1980; Horowitz, 1935; Johnson & Wellman, 1982).

2. Because the tactile experience is perceived as occurring away from the head region, one can see one's "subordinate experiencer" (the sensing hand) contact the object and one can witness, almost as if one were an outside observer, the resulting sensory experience. One's "executive experiencer," subjectively located up in the head region, can observe and reflect on the whole epistemic event and can easily distinguish among its three components—the object, the subordinate experiencer, and the latter's experience of the object. One cannot observe and reflect on one's own visual experiences in the same way, clearly differentiating object, experiencer, and experience while doing so, because visual experiences are subjectively located in the very same place their would-be observer, the executive experiencer, resides. I would want to say that the object feels cold to my *hand*, or my *hand* feels cold, but that the object looks blue to *me*, or *I* see a blue object.

3. In the tactile but not the visual case, two or more subordinate experiencers can have two or more experiences simultaneously. These experiences could be the same, opposite, or unrelated. For example, one object could feel cold to one hand at the same time that the same object or a different object feels cold (same), not cold (opposite), or wet (unrelated) to the other hand. As a consequence, it is possible in the case of touch to do a kind of Level 2 perceptual perspective-taking within the self, as well as between the self and another person. For instance, suppose one touches a piece of ice with one's ungloved left hand and with one's heavily gloved right hand at the same time that another person touches it with a heavily gloved hand; one could then be asked to identify one's own two contrasting perspectives (those of one's two subordinate experiencers) as well as that of the other person. The possibility of such within-self perspective-taking might also help one distinguish between objects and people's experiences of them. That is, the fact that one can simultaneously experience the same object as, say, cold and not cold should help make this object-experience distinction salient.

4. An object causes a tactile experience by making direct physical contact with the subordinate experiencer. The executive experiencer or cognitive self also sees this contact occur just before or just as the resulting sensation is experienced, as noted in 2. This is the prototypical causal sequence, familiar to us since infancy (Leslie, 1984; Piaget, 1954), in which object A causes effect B in object C by contacting C directly. In contrast, the way an object causes a visual experience of that object is decidedly more mysterious. Although one can by definition see the object, one cannot see either one's eyes or anything that makes direct physical contact with them; the visual experience seems to be produced by some sort of causal action-at-a-distance rather than by causal action through direct contact. This difference could also make the distinction between the nature of the object and the nature of one's experience of it easier to maintain in the tactile case than in the visual one.

Table 1 shows comparisons among five sensory modalities on these dimensions. Also included are bodily feelings, such as headaches, back pains, itches, feelings of hunger,

TABLE 1

PROPERTIES OF PERCEPTUAL EXPERIENCES THAT MAY FACILITATE THE DISTINCTION BETWEEN OBJECTS AND PEOPLE'S EXPERIENCES OF THEM

	TYPE OF EXPERIENCE					
FACILITATING PROPERTY	Visual	Auditory	Olfactory	Gustatory	Tactile	Bodily Feelings
1. Locus of experience can be distant from the head region (the subjective seat of consciousness and the cognitive self)	no	no	no	no	yes	yes
2. Locus of experience can be visible to the self	no	no	no	no	yes	yes
3. Different experiences at different loci can take place simultaneously	no	no	no	no	yes	yes
4. Object causes experiences of object by touching the experiencer	no	no	no	yes	yes	no object

thirst, muscle tension, etc., that have no presently perceptible cause or perceptual object (McGinn, 1982). Unlike percepts, they are not experiences of or about objects in the external world. Table 1 shows that, in this analysis, tactile experiences turn out to resemble objectless bodily feelings more than they resemble other perceptual experiences with respect to these dimensions. This resemblance may be significant. In fact, some tactile sensations are hybrids, sometimes experienced as perceptions of objects, sometimes as objectless feelings. For example, one's fingers can feel cold either because they are holding a cold object (perception that this object is cold) or because one has just come in from the cold (objectless feeling of coldness). The same is approximately true for wet, slippery, sticky, or painful fingers. The fact that children sometimes have these sensations when there is no object present should help them construe these sensations as essentially subjective rather than objective events—even on those occasions when an object does cause the sensation. That is, because they are used to their hands feeling cold, for instance, even when not touching a cold object, they may find it relatively easy, when they do touch one, to attend to the subjective experience of coldness and distinguish it from the objective coldness of the object. In contrast, visual experiences seldom occur in the absence of visual objects, except when one is dreaming. The same tight coupling of experience and object holds for auditory experiences and, to a lesser extent, olfactory and gustatory ones as well. Thus, this difference may also make it easier for the young child to construe certain tactile experiences as subjective experiences, distinguishable from objects, than to so construe visual, auditory, olfactory, and gustatory ones. Consistent with this possibility, Dunn, Bretherton, and Munn (1987) report that children as young as 24 months of age talk about objects and body parts feeling cold.

Two studies were carried out to test the hypothesis, based on the foregoing analysis that 3-year-olds would find tactile appearance-reality (AR) and level 2 perspective-taking (PT) tasks easier than visual ones. In Study 1, 3-year-olds were tested for their ability to distinguish between: (*a*) how an object (cold ice cube, wet hand towel) felt to one of their fingers that had an insulated glove on it (not cold, not wet) and how the object really and truly was (cold, wet) (AR tasks); (*b*) how the object felt to their ungloved hand and how it felt to the experimenter's gloved finger (PT Between tasks); (*c*) how it felt to their ungloved hand and how it felt to a gloved finger of their other hand (PT Within). Study 2 was similar but also included a needed control and a set of visual AR tasks for comparison purposes. A third study (Study 3) included additional controls and tested only the hypothesis that 3-year-olds would find tactile AR tasks easier than visual AR tasks; that is, no PT tasks were given in Study 3.

Study 1

METHOD

Subjects

The subjects were 36 nursery school children (26 girls, 10 boys) drawn mostly from upper middle-class families. They ranged in age from 2-10 to 3-11, with a mean of 3-6. Three other children were excluded from the sample because they were unwilling to put on a finger glove. One child was excluded from Study 2 for the same reason. The same female experimenter tested all of the children in the three studies.

Procedure

Prior to administration of tasks involving coldness, the children were asked to ascertain whether four different objects felt cold to their fingers. A similar warm-up preceded the tasks involving wetness. Two of these objects did indeed feel cold (or wet) and two did not. The purpose of these warm-ups was to give the children some practice in attending to their tactile sensations and to forestall an anticipated yes bias in responding to our yes-no task questions.

All children were given a block of three tasks (PT Within, PT Between, and AR) involving coldness that was either followed (half the sample) or preceded (the other half) by a similar block of three tasks involving wetness. The ordering of the tasks within blocks was counterbalanced across subjects. Each child was given the same task order for Cold tasks as for Wet tasks. Within each task questions were administered in the fixed order described below.

The stimulus for the Cold tasks was an ice cube and for the Wet tasks a hand towel that the child had seen the experimenter dip into a bowl of water. The items were placed in a pie pan and the child was asked either "Is this ice cube cold?" or "Is this cloth wet?" before each block of tasks were given. Most of the children spontaneously touched the object before answering this question. While each question was asked on the six tasks that followed the child simultaneously touched the object with one hand and with a finger of his or her other hand on which a brown insulated finger glove had been placed. Finger gloves were changed after each task, and the hand on which the glove was placed was varied unsystematically by the experimenter. For the PT Between tasks the experimenter also donned a finger glove and touched the object with that finger while the child was maintaining contact with both gloved finger and ungloved hand. The procedure for Cold and Wet tasks was identical and therefore is described below only for Cold tasks.

PT Within.—"Here's a glove for you to put on. Can you touch the ice cube with this finger and this hand? Good." The test questions were: "Does this ice cube *feel* cold to *this* hand?" (the experimenter touched the ungloved hand) and "Does this ice cube *feel* cold to *this* finger?" (the experimenter touched the gloved finger).

PT Between.—"Here's a glove for you to put on. I'll put a glove on. Can you touch the ice cube with this finger and this hand? I'll touch the ice cube too." The test questions were: "Does this ice cube *feel* cold to *your* hand?" (the experimenter touched the child's ungloved hand) and "Does this ice cube *feel* cold to *my* finger?" (the experimenter touched her gloved finger).

AR.—"Here's a glove for you to put on. Can you touch the ice cube with this finger and this hand?" The test questions were: "*Really* and *truly*, is this a cold ice cube?" and "Does this ice cube *feel* cold to *this* finger?" (the experimenter touched the child's gloved finger).

Results and Discussion

Children were scored as having passed a task if they correctly answered both of the task's two questions. Of the 36 children, 29 (81%), 28 (78%), and 29 (81%) passed the PT Within, PT Between, and AR Cold tasks, respectively. The figures for the corresponding three Wet tasks were 30 (83%), 29 (81%), and 29 (81%). Twenty-eight (78%) of the children passed five of the six tasks and 23 (64%) passed them all. This is much better performance than 3-year-olds have shown on visual AR and Level 2 PT tasks in previous studies. In the case of visual tasks involving object properties, for example, the mean percentages of subjects passing each kind of task (thus, comparable to the 78%–83% figures given above) are: 19%–42% for size AR (Flavell et al., 1983, Studies 2 and 3); 39%–48% for shape AR (Flavell et al., 1983, Study 3; Flavell et al., 1986, Study 4); 32%–54% for color AR (Flavell et al., 1983, Studies 2 and 3; Flavell et al., 1986, Studies 1, 2, and 4; Flavell et al., 1987, Study 1); 42% for shape PT and 55% for color PT (Flavell et al., 1986, Study 4; Liben, 1978). Although comparisons of percentages across different studies are of course somewhat problematic, these consistent differences over a number of studies provide preliminary support for the hypothesis that tactile AR and PT tasks are easier for young children than visual ones.

As had been found previously for visual AR and PT tasks (Flavell et al., 1986, Study 4), the 3-year-olds in this study performed about equally well on the tactile AR and Between PT tasks. Performance on the Within PT tasks was also similar. In summary, the children found it quite easy, and about equally so, to differentiate how an object felt to their gloved finger and how it really was, how it felt to their gloved finger and to their ungloved hand, and how it felt to their ungloved hand and to another person's gloved finger.

Some recent findings by Arnold and colleagues seem at first glance to be inconsistent with these results (Arnold, Moye, & Winer, 1986; Arnold, Winer, & Wickens, 1982). Their subjects experienced an illusion caused by temperature adaptation that was first described by the philosopher John Locke. The subjects simultaneously placed their right hand in cool water and their left hand in warm water for a brief adaptation period. Next they put both hands in a pan containing water at physiological zero. The result was that the water in the pan felt cool to their left hand and warm to their right. Then they were asked whether the water in contact with the right hand "just feels warmer or is it really warmer?" and finally, after removal of hands and 180° rotation of the pan, "If you put your hands in the water, which hand would feel warmer now or would they both feel the same?" In contrast to the excellent performance of 3-year-olds in the present study, many 8-year-olds in the Arnold et al. (1986) study answered these questions incorrectly. However, in our tasks the child was easily able both to see and feel that the ice cube was really cold and the cloth really wet before the questions were asked, and could also directly perceive that they did not feel cold or wet to the gloved finger. In the Arnold et al. (1986) tasks, on the other hand, whereas the appearance was of course directly perceptible, considerable knowledge and inference were required to determine the reality.

Study 2

The children in Study 1 might have passed the appearance-reality and perspective-taking tasks, not by attending to tactile experiences but simply by applying their knowledge that gloves can keep hands from feeling wet and cold. To control for that possibility, the subjects in Study 2 were questioned while wearing two finger gloves, one on each hand. One glove was of the insulated type used in Study 1. The other was made of aluminum foil. The former prevented the finger from feeling the coldness of cold objects, while the latter did not.

In Study 1, performance on tactile tasks was compared to performance on visual tasks given in previous studies, using different subjects. This problem was partly remedied in Study 2 by giving the children visual appearance-reality tasks as well as tactile appearance-reality and perspective-taking tasks. We would have added visual perspective-taking tasks as well except that it would have made the testing session too long.

METHOD

Subjects

The subjects were 32 nursery school children (21 girls and 11 boys) drawn mostly from upper middle-class families. They ranged in age from 2-11 to 4-0, with a mean of 3-7. Of the 32 children, 23 had served as subjects in Study 1 about a month previously. We retested these subjects because we wanted to compare performance on tactile tasks that involved only a normal, protective glove (Study 1) to performance on tactile tasks that used both a normal and an atypical, cold-transmitting glove (Study 2).

Procedure

There were five tactile tasks and four visual tasks. Half of the sample experienced the tactile tasks first, and half the visual ones first. The first three tactile tasks given were designed to assess both appearance-reality (AR) and within-person perspective-taking (PT Within) competencies within the same task; the last two were designed to measure between-person perspective-taking (PT Between) competencies. The PT Between tasks had to be given after the AR and PT Within tasks because subjects needed to know how the object felt to them when wearing each type of glove before being asked, in the PT Between tasks, how it felt to the experimenter when wearing these gloves. Unlike the tactile tasks, the four visual AR tasks were given in randomized order. All of the tactile tasks involved the sensation of coldness. The visual ones were of four different types.

Tactile Tasks

AR and PT Within.—The procedure to be described was administered three times in an identical fashion. A different color ice cube was used on each task (blue, red, or yellow) and the experimenter alternated the hands on which the insulated and noninsulated (aluminum foil) gloves were placed from task to task. Following the reality question, always asked first, the experimenter asked how the cube felt to each differently gloved finger, alternating from task to task which finger was asked about first. As in Study 1, new gloves were selected for each task. The experimenter said: "Here's a [blue] ice cube. Touch it. Here are two little gloves. Let's put one on this finger and one on this finger. Can you touch the ice cube with both fingers? Good." The experimenter then gently held both of the child's fingers to the ice cube as she asked the following questions: "*Really* and *truly*, is this a cold ice cube?" and then "Right now, does the ice cube *feel* cold to this finger?" (asked about each gloved finger). The experimenter touched each finger as she asked about it.

PT Between.—On both of these tasks the child touched an ice cube with one glove type while the experimenter wore the contrasting glove type. On the second task the child and experimenter switched glove types (although new gloves were selected). The experimenter introduced each task by saying: "Here's a [green] ice cube. Touch it. This time you can wear this glove. I'll wear this glove. Let's both touch the ice cube with our fingers." The test questions were: "Does the ice cube *feel* cold to *your* finger?" (the experimenter touched the child's finger) and "Does the ice cube *feel* cold to *my* finger?" (the experimenter touched her finger). The child's experience was always asked for first. Half the sample was given the first of these tasks wearing an insulated glove and half given the first task wearing a noninsulated glove.

Visual Tasks

As in the tactile AR tasks, the reality question always preceded the appearance question in these visual AR tasks.

Color.—A cutout of a red bird appears black when viewed through a green filter. The experimenter said, "Here's a bird. Watch." She slowly slid the filter over the bird, away from it, and then over it again. The test questions were: "*Really* and *truly*, is this a red bird?" followed by "Right now, does this bird *look* red to your eyes?" A pretest had previously established that all the children could identify red and black colors by pointing or labeling.

Number.—A single pencil appears to be two pencils when held behind a prism. The experimenter held a pencil vertically saying: "Here's something. Watch." The pencil was moved slowly behind the prism, away from the prism, then behind the prism again. The test questions were, "*Really* and *truly*, am I holding just one pencil?" and "Right now, does it *look* to your eyes like I'm holding just one pencil?"

Object.—A pen which appears to be a tube of toothpaste is shown to the child with much of its appearance hidden. The experimenter said, "Here's something you can write with. [The experimenter wrote and then squeezed the tube.] There's nothing in here but ink. Want to try it?" After the child wrote, the experimenter replaced the cap and asked, "*Really* and *truly*, is this a pen?" and "Right now, does this *look* like a pen to your eyes?"

Distance.—A very small (0.5 cm) pencil-drawn picture of a face appears to be other than a face when held at a distance of 3.25 m from the child. ("Dot," "spot," and "circle" were some of the labels children used to describe its appearance from that distance.) Standing next to the child, the experimenter displayed the picture saying: "Here's a little picture. Can you see the nose and the eyes? Okay. Now I'm going to move over here." The test questions were, "*Really* and *truly*, is this a picture of face?" and "Right now, does it *look* like a face to your eyes?"

RESULTS AND DISCUSSION

As in Study 1, children were scored as having passed a task if they correctly answered both of the task's questions. These questions asked about real temperature (cold) and perceived temperature in the insulated glove (not cold) for the three Tactile AR tasks; perceived temperature in the insulated glove (not cold) and in the aluminum foil glove (cold) for the three Tactile PT Within tasks; perceived temperature for the child (cold, not cold) versus for the experimenter (not cold, cold) for the two Tactile PT Between tasks; and apparent versus real properties or object identities for the four Visual AR tasks.

Tables 2 and 3 show, respectively, the percentage of subjects passing each task and the percentage of subjects answering each individual question correctly. It is evident from these tables that the results of Study 2 closely replicate those of Study 1 and previous investigations. As in Study 1, children performed well on all three tactile tasks. Similar to Study 1 results, percentages passing were in the 80s, 78% of the children answered at least 12 of the 13 tactile questions correctly, and 63% answered all of them correctly. This high level of performance was not due to previous experience with Study 1 tasks: the 23 children who had also served as subjects in Study 1 did not perform any better than the nine who had not. The children proved to be as skilled at judging that the ice cube felt cold to fingers clad in noninsulated gloves as they did at judging that it did not feel cold to fingers clad

TABLE 2

PERCENTAGE OF SUBJECTS PASSING EACH TASK

TYPE OF TASK	SPECIFIC TASK 1	2	3		MEAN
Tactile:					
AR	91	84	84		86
PT Within	88	81	81		83
PT Between	75	84	...		80
	Color	Number	Object	Distance	
Visual:					
AR	38	50	53	38	45

in insulated gloves (see Table 3, I and NI columns). This shows that they could not have based their judgments on the simple rule that feeling objects through gloves prevents them from feeling cold.

In contrast, performance on the four visual AR tasks was much poorer (Tables 2 and 3). Percentages of subjects passing ranged from 38% to 53%, only 38% of the children answered at least seven of the eight questions correctly, and only 22% answered all of them correctly. This level of performance on visual AR tasks is similar to those observed in previous investigations, as described in Study 1. A 2 (type of task) × 2 (order of administration) ANOVA was performed on the number of AR tasks passed. Both main effects proved significant; there was no significant interaction effect. The children performed significantly better on tactile tasks than on visual tasks: $F(1,30) = 40.84$, $p < .001$. In addition, the subjects who were given the tactile tasks first performed significantly better on both types of tasks than the subjects who were given the visual tasks first: $F(1,30) = 4.72$, $p < .05$. We also found this order effect in Study 3 and will discuss it there. Of the 32 subjects, 23 performed better on the tactile tasks than on the visual ones, eight performed equally well on both, and only one performed better on the visual tasks ($p < .001$ by Sign test). The results of these two studies, taken together with previous ones, thus support the hypothesis

TABLE 3

PERCENTAGE OF SUBJECTS ANSWERING EACH QUESTION CORRECTLY

TACTILE AR AND PT WITHIN

Task 1			Task 2			Task 3		
R	I	NI	R	I	NI	R	I	NI
97	94	94	97	88	91	97	88	91

TACTILE PT BETWEEN

Task 1		Task 2	
S	O	S	C
88	88	97	88

VISUAL AR

Color		Number		Object		Distance	
R	A	R	A	R	A	R	A
50	72	78	72	84	59	84	50

NOTE.—R = reality, I = feeling inside insulated glove, NI = feeling inside noninsulated glove, S = child's feeling, O = experimenter's feeling, A = visual appearance.

that 3-year-olds find tactile appearance-reality and Level 2 perspective-taking problems easier than visual ones.

Finally, and also consistent with the results of Study 1 and Flavell et al. (1986, Study 4), Tables 2 and 3 show that the children found tactile AR and PT Between tasks to be of roughly equal difficulty. Likewise, they performed similarly well on the PT Within tasks.

Study 3

The purpose of Study 3 was to provide a better controlled test of the hypothesis that 3-year-olds find tactile AR tasks easier than visual AR tasks. There were two controls. First, the same properties (number, wetness, and intactness) were used in both kinds of tasks. Second, the reality was initially established both visually and tactually in both kinds of tasks; then, only illusory tactile information was perceptually available on tactile tasks when the tactile-appearance and reality questions were asked, and only illusory visual information was perceptually available on visual tasks when the visual-appearance and reality questions were asked. (We decided against using a design in which the reality on tactile tasks would be established only tactually and the reality on visual tasks only visually because we found young children to be unwilling to touch unknown objects they could not see.) Neither of these two controls was present in the Study 2 comparison of tactile and visual AR tasks. The children were given 12 AR tasks, six tactile and six visual. Prior to the study, we administered these same tasks to 12 college students to make sure that the visual and tactile stimuli had the intended illusory appearance. All 12 reported the intended appearance on seven of the tasks, and 11 did so on the remaining five. In addition, all students answered all reality questions correctly.

METHOD

Subjects

The subjects were 24 nursery school children (13 girls, 11 boys) drawn mostly from upper middle-class families. They ranged in age from 2-11 to 4-1, with a mean of 3-6. One additional child was excluded from the study because of attentional difficulties and another because of experimenter error.

Procedure

Prior to testing, all subjects were first given practice in attending to tactile and visual sensations of number, wetness, and intactness and then were briefly trained on tactile and visual AR distinctions for the property of bumpiness. To illustrate the nature of the practice using the property of intactness, in the visual practice task the subject was shown a broken crayon and an intact crayon. The experimenter said, "This crayon looks broken. This crayon doesn't look broken." For each object, the child was then asked, "Does this crayon look broken?" The other pairs of visual practice stimuli were two pennies versus one penny, and a wet versus a dry paper towel. For the tactile practice tasks the procedure was to present two objects or pairs of objects hidden under a cloth. The experimenter told the child what object(s) was under the cloth and asked him or her to feel the top(s). In the case of intactness, the child was told, "There is a straw under here. Feel it. This straw feels broken to your finger. Here is the place where it feels broken. There is a different straw under here. Feel it. This straw does not feel broken to your finger." When necessary, the experimenter guided the child's finger. The question for each object was, "Does this straw feel broken to your finger?" The other tactile practice stimuli were two hidden boxes versus one hidden box and a stick hidden under a dry cloth versus a stick hidden under a wet cloth. Only two children erred on one of these practice tasks, both on tactile number. They were corrected and the questions were repeated before the experimenter began the appearance-reality training.

A yellow Lego block with a bumpy top was the stimulus used for both visual and tactile AR training. In the visual case, the block was viewed on a white background through a blue filter which made the shape but not the bumps visible. In the tactile case, the block was covered with a plastic table mat that prevented the child from feeling the bumps. The sequence of events in the training was similar to that in the subsequent testing. That is, first the reality was established visually and tactually, with the experimenter saying, "Is the block rough or bumpy? That's right, the block is rough and bumpy." Then the stimulus was either covered by the filter (visual case) or the table mat (tactile case) and the reality question was asked: "*Really* and *truly*, is the block rough and bumpy?" In the tactile case, the subject was asked to move his or her finger over the top of the block just before this question was asked. In the training, but not the testing, the experimenter next uncovered the block and said, "That's right [actually], the block is *really* and *truly* rough and bumpy." The block was then covered again and the experimenter concluded with the appearance question: "Right now, does the block *look* [*feel*] rough and bumpy to your eyes [to your finger]? That's right [actually], the block doesn't *look* [*feel*] rough and bumpy to your eyes [to your finger] because you can't see [feel] the bumps. It doesn't *look* [*feel*] rough and bumpy but it *really* and *truly* is rough and bumpy."

In the testing that followed, half of the subjects experienced the six visual AR tasks first, and half the six tactile AR tasks first. The tasks were blocked by the property being studied with two tasks of each type, for example, two visual number tasks. Task orders and specific tasks within blocks were counterbalanced across subjects. Each child was given the same task order for visual tasks as for tactile tasks.

Tactile Tasks

The stimuli for the tactile intactness tasks were a broken pencil taped to a card with its broken ends .6 cm apart and an 18 cm long broken green block taped to a card with its broken and splintered ends overlapping in part and separated in part by .6 cm. When the tops of these objects were subsequently felt through four layers of construction paper covered by black felt, the object did not feel broken. In similar fashion, the stimuli for the number tasks were aligned and taped to cards and subsequently felt through the construction paper and felt cover just described. These stimuli were two 4.5 × 4.5-cm blue blocks separated by .6 cm and two differently colored 3.8-cm crayon ends separated by 1 cm. When covered, these objects felt like one rather than two objects. For the wetness tasks, a rock and a cassette tape case were immersed in a bowl of water. When subsequently removed and covered by an insulated white cloth, they did not feel wet.

The procedure was identical for the six tasks and will be illustrated for intactness. "Here's a pencil. Look at it. Feel it. Is this pencil broken? That's right. It's broken." (Pencil is then covered.) "Okay, move your finger over the top. *Really* and *truly,* is the pencil broken? Let's touch the top again. Right now, does the pencil *feel* broken to your finger?" The three questions were asked in this same fixed order for each object. If the subject erred on the first question (five subjects each made a total of one such error over the six tactile tasks) he or she was corrected and the question was asked again before the examiner proceeded to cover the object. We used this procedure in an attempt to underscore for the subject the real state of the object.

Visual Tasks

The stimuli for the intactness and number tasks were also taped to backgrounds and their ends aligned. The visual illusions for these tasks were created by covering the center of the object(s) with heavy white paper of varying sizes. The stimuli for the intactness tasks were a 16 cm long broken dowel with its broken ends separated by 2.6 cm, subsequently covered by a 5 cm wide strip of paper and a 15 cm long broken pen with its broken ends separated by .6 cm, subsequently covered by a 2 cm wide paper. When covered, neither object appeared broken. The stimuli for number were two identical 13 cm long red candles positioned so that the wick of one nearly touched the end of the other, subsequently covered with a 7.7 cm wide paper and two identical 3.8 cm long bottles positioned .6 cm apart, subsequently covered by a 3.8 cm wide paper. When covered, there appeared to be just one object present rather than two. For the wetness tasks, two dark blue socks were the stimuli, one of which had been rolled into a ball and was termed a ball by the experimenter. Each one was dipped into water, taken out dripping wet, wrung out, and then handed to the subject to verify that it was wet. Then it was placed on a yellow cafeteria tray and a green colored filter was placed directly over but not touching it. The filter removed textural but not shape cues. When under the filter, the object did not look wet.

The subjects were acquainted with the reality of each object by looking at it and feeling it, just as in the tactile case. The visual task questions were identical to the tactile for all but the third (appearance) question: "Right now, does this [pencil] *look* [broken] to your eyes?" In contrast to the tactile tasks, no error was made by a subject on the first question prior to the illusory transformation.

Results and Discussion

As in the first two studies, children were scored as having passed a task if they correctly answered both its appearance question and its reality question. A 2 (modality: tactile, visual) × 2 (order of administration: tactile first, visual first) × 3 (property: number, intactness, wetness) ANOVA was performed on the number of tasks passed. This analysis yielded significant or near-significant main effects for modality, $F(1,22) = 4.02$, $p < .058$, order of administration, $F(1,22) = 7.35$, $p < .02$, and property, $F(2,44) = 5.18$, $p < .01$. The two-way interaction between modality and property also reached significance ($p < .05$), the other two did not reach significance ($p <$

TABLE 4

PERCENTAGE OF SUBJECTS PASSING EACH TASK

MODALITY	PROPERTY: Number	Intactness	Wetness
Tactile (first)	50	83	83
Visual (first)	25	33	17
Tactile (second)	17	38	29
Visual (second)	46	50	58
Tactile (either)	33	60	56
Visual (either)	35	42	38

NOTE.—"Tactile (first)" refers to the performance on the tactile tasks of the 12 subjects who experienced these tasks first, that is, prior to the visual task (similarly for "Visual [first]" etc.). "Tactile (either)" refers to the performance of all 24 subjects on the tactile tasks, whether experienced first or second.

.14), and the three-way interaction did not approach significance ($p < .58$).

Table 4 reports the mean percentages of subjects passing each task. (Because the percentages tended to be quite similar for the two tasks of each specific type, only the means of each such pair of percentages are given in Table 4). The meaning of the various ANOVA effects is shown in the table. If we consider only what the children did on their first six tasks (rows 1 and 2 of Table 4), the data suggest that tactile AR tasks are easier than visual ones, as hypothesized; the difference is most pronounced in the case of the intactness and wetness tasks. Thus, the 12 children who were given the tactile tasks first performed significantly better on these tactile tasks than the 12 who were given the visual tasks first performed on those visual tasks ($p < .002$ by t test). The tactile-first subjects also performed near significantly ($p < .08$) better on these initial tactile tasks than they did on the visual tasks that followed (rows 1 and 4), again especially in the case of the intactness and wetness tasks. Although it looks from Table 4 as if performance on tactile tasks when given second was poorer than performance on visual tasks when given second (rows 3 and 4), this difference is not significant ($p < .26$). However, the subjects who were given the tactile tasks after the visual ones performed significantly ($p < .009$) more poorly on these tactile tasks than those who were given them first (rows 1 and 3). Similarly, there is a near-significant ($p < .09$) trend for performance on visual tasks given second to exceed performance on visual tasks given first (rows 2 and 4).

Our interpretation of these results is that at least the intactness and wetness tactile tasks were easier for the children than their visual counterparts (rows 5 and 6). The finding that the children performed better on both tactile and visual tasks if they were exposed to tactile ones first (rows 1 and 4 vs. rows 2 and 3) also supports this interpretation. Recall that we obtained a similar finding in Study 2. A plausible explanation for both findings is that the children's initial experience in successfully differentiating appearance and reality on the easier tactile tasks helped them to do the same on the subsequent visual tasks, whereas initial experience in failing to make this differentiation on the more difficult visual tasks dampened performance on subsequent tactile tasks. In our experience, it is fairly common for young children to persist through a series of tasks with their initial solution strategy, especially when, as here, the same properties are presented in both halves of the testing session. Thus, although the results of this study are not as clear cut as those of the first two, we believe that they also support the hypothesis that 3-year-olds find tactile AR tasks easier than visual ones.

General Discussion

The results of these studies together with those of previous investigations support the hypothesis that 3-year-olds find tactile appearance-reality (AR) and Level 2 perspective-taking (PT) tasks easier than visual ones. In addition, the finding that children performed similarly on tactile AR and tactile PT tasks is at least consistent with previous theory and research suggesting that these two conceptually related competencies may develop concurrently and interdependently.

The children's performance on the tactile AR and PT tasks in Studies 1 and 2 was particularly impressive. On the AR tasks they were able to attend selectively to and report the not-wet or not-cold feeling in their gloved finger, despite highly salient visual and tactile evidence that the object was in reality decidedly cold or wet. To do this they had to realize that "feel" referred only to the way the object felt to their finger, whereas "really and truly is" referred only to the nature of the object. On the Study 2 PT Within tasks they were able to recognize that the ice cube felt cold to one finger wearing an aluminum foil glove but did not feel cold to another finger wearing an insulated glove. They neither automatically assumed that the ice cube would feel cold because it really was cold nor that it would not feel cold because it was felt through a glove. Instead, they simply attended to how it actually felt and correctly reported that feeling. On the PT Between tasks they were able to infer that the object felt different to the experimenter than it felt to them. In Study 2 the children's perspective and the experimenter's perspective on the PT Between tasks were similar in two respects: both felt the same ice cube and both felt it with a gloved finger. Despite these similarities, the children were usually able to differentiate the two perspectives correctly. In sum, young preschoolers were able to differentiate how the object really was; how it felt to them without a glove, with an insulated glove, and with a noninsulated glove; and how it felt to another person with an insulated glove and with a noninsulated glove. They were clearly able to correctly distinguish appearance and reality and to discriminate accurately one appearance from another, both within the self and between the self and another person. Nothing in the previous developmental literature on appearance-reality and Level 2 perspective-taking would have predicted such abilities.

Subjects generally performed better on the Study 1 and 2 tactile AR tasks than on the Study 3 tactile AR tasks (e.g., compare Tables 2 and 4). This may be partly explained by the fact that in the former but not the latter tasks both the appearance and the reality continued to be perceptible to the subjects when the appearance and reality questions were asked. That is, in Studies 1 and 2, the children continued to see and feel that the ice cube was cold at the same time that they were experiencing it as not feeling cold to their insulated-gloved finger. In contrast, in Study 3, they had to recall rather than perceive that, for example, the pencil under the construction paper was broken. Such recall was also necessary for the visual tasks of Studies 2 and 3 and previous studies. This difference in performance is consistent with previous research showing somewhat better performance by 3-year-olds on AR tasks in which the reality remains perceptually available (Flavell et al., 1986, Study 2; Flavell et al., 1987).

It is important to note, however, that task differences in perceptual availability of the reality cannot explain all the tactile-visual differences predicted and found in these three studies. First, they cannot explain the differences between tactile and visual AR task performance observed in Study 3 because the reality did not remain perceptually available in either task. Second, they cannot explain the superiority of tactile PT (Studies 1 and 2) over visual PT (previous studies) performance because the other person's perceptual experience was likewise not perceptually available to the children in either type of PT task. Finally, recall that in all AR tasks in Studies 2 and 3 children were always asked the reality question first and the appearance question second. If we consider only the children in each task who correctly answered the reality question, it is still the case that the subsequent appearance question tended to be harder if the task was visual than if it was tactile. In Study 2, the percentages of correct responses to appearance questions on visual tasks, given correct responses to the immediately preceding reality questions, were 75% (color), 68% (number), 59% (object), and 44% (distance); the corresponding percentages for the three tactile tasks in Study 2 were 94%, 87%, and 87%. The corresponding percentages for the Study 3 tasks were 49% visual versus 44% tactual for the number tasks, 56% versus 71% (intactness), and 56% versus 73% (wetness). Thus, even when the reality was cognitively available (i.e., when it had just been correctly reported), children were better at reporting tactile than visual appearances in all tasks except the Study 3 number tasks.

Two of the most important questions to ask about any developing cognitive competency are (*a*) when and where does it first appear, and (*b*) why does it first appear when and where it does? As to (*a*), these studies suggest that, contrary to previous evidence on appearance-reality and Level 2 perspective-taking skills, many 3-year-olds may possess some nascent capacity to differentiate realities, appearances for self, and appearances for others. However, like most capacities when they first appear, this one is fragile and severely limited in its expression. That is, it seems to be expressible primarily in tasks involving tactile appearances, particularly in those—different from what life usually presents—in which the reality as well as the appearance remains perceptible.

Why is it expressible so early in tactile tasks (question *b*)? We argue that the answer may partly lie in "the phenomenological 'feels' of different cognitive experiences" (Wellman, 1985a, p. 199; see also Flavell, 1972; Johnson, in press; Samuels, 1986; Stern, 1985). That is, as described in the Introduction and Table 1, tactile experiences may simply present themselves or "come on" to the experiencer in ways that facilitate an early differentiation between object experiences and objects experienced.

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