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The Effect of Movement on Children's Perception of Animacy

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ABSTRACT

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The main objective of this research is to investigate the role of movement in the development of the animate-inanimate distinction. Thirty children were studied at each of the following age levels: 3, 5, 7 and 9 years as well as adults. Subjects were required to answer 13 questions concerning familiar animate and inanimate objects. They were also asked to answer the same questions concerning an artificial stimulus presented as either stationary or moving on a computer screen. Two types of movement were manipulated: animate-type movement (spontaneous, goal-oriented or angular) and inanimate-type movement (elicited, random or linear). Three year olds were excluded from analyses since they did not understand basic life properties of familiar objects. For the other age groups, more subjects judged the stimulus with animate-type movement as alive than the stationary object. Moreover, although both types of movement tended to increase the attribution of animistic properties, animate-type movement induced more animistic responses across all age levels. Five year olds, however, attributed more mental states to the stimuli than older children, irrespective of type of movement or of type of familiar object. Finally, only in relation to the moving displays did adults and children of all ages mention movement as the primary justification for deciding if the stimulus object was alive or not. Taken together, results suggest that children as young as 5 years rely on type of movement when attributing life properties to an unfamiliar object.

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Researchers have long been interested in the fundamental distinction the human mind draws between animate and inanimate objects. The distinction is implicit in the expectations adults hold about objects. For example, a chair that is placed in the kitchen is still expected to be there the next day unless someone, an external agent, has moved it. Young children also seem to understand that animate and inanimate objects are endowed with different properties.

Children as young as four seem to possess basic ontological categories of natural kinds. For example, even pre-schoolers will not agree that a porcupine can become a cactus while they readily acknowledge that a bird feeder can become a coffee pot (Keil, 1986). Yet, children's initial distinction between animate and inanimate objects seems to be mapped onto a distinction between the social and the physical worlds and not onto a biological distinction between living and non-living objects. Only gradually will the extension of the life concept correspond to that of the adult. For example, plants are excluded from the concept of life until about the ages of 8 or 9. In fact, not until the age of ten can children truly master the distinction between living and non-living objects.

Animate and inanimate objects can be distinguished according to a number of criteria. Gelman & Spelke (1981) provide a useful taxonomy of criteria on which children might rely to classify animate and inanimate objects. First, animate objects can act on their own, they are capable of self-initiated movement. Second, animate objects can change over time to sustain themselves, through growth and reproduction for instance. In contrast, transformations undergone by inanimates are not brought on by the self nor can they be self-regulated. Third, animates can experience states and have a capacity for mental representations and processes such as thoughts and emotions. Mental representations are denied to inanimates. Fourth, animates are composed of different parts, their structure is unlike that of inanimates. Inanimates have no life sustaining parts or structures while animates may possess limbs for movement, brains for thinking, reproductive organs, etc.

There is presently enough evidence to conclude that children acquire these different classes of criteria at different times in their development. Self-initiated action or movement seems to be one of the earliest and most salient criterion to be acquired.

Animism

The developing understanding of the distinction between animate and inanimate objects in children has been explained by two broad types of hypotheses. The first pertains to the child's developing notions of causality where self-initiated movement has occupied a central role. The second pertains to the child's growing body of knowledge.

Piaget (1930) was the first to postulate that young children are pre-causal in that they impute psychological causation (or intention) to all objects. He coined the term animism to capture this pre-causal thought process. Children seem initially unconcerned about distinguishing animate from inanimate objects. They first learn to identify those objects that will respond to their actions and this egocentric thinking leads them to call on human behavior as the model for understanding all objects.

According to Piaget, the differentiation between animates and inanimates gradually evolves through a series of stages, marked by different categorization rules. The child first attributes human qualities to all objects possessing some function (ages 4-5 to 6-7), then attributing them only to objects that move (ages 6-7 to 8-9), and finally only to objects that move autonomously (ages 8-9 to 11-12). The child's thinking would thus be constrained by the rule that only animates possess the causal powers to move themselves, while inanimates' movement must be caused by an external source. Only in late childhood, with the transition into formal operational thinking, around the age of 12, can the child abstract the accurate defining biological criteria that distinguish animate from inanimate objects.

Research has shown that animism seems more prevalent in situations where the child is confused and may not be as pervasive as Piaget suggested. Indeed, there seems to be some semantic confusion attached to the term alive/not alive that would make children appear more animistic than they actually are (Gelman, Spelke & Meck, 1983). Unfamiliar stimuli may also contribute to the child's confusion. When attributing animate and inanimate properties to objects, the performance of adults and pre-school children dramatically improves with familiar compared to unfamiliar objects (Massey, 1989). Toys which are very familiar to children such as a doll or their own favourite toy, are rarely judged as alive (Sharp, Candy-Gibbs, Barlow-Elliott & Petrun, 1985)

Piaget's views on animism have also been criticized on other grounds. It is clear from the literature that young children do indeed possess a good grasp of the notion of agency, i.e. an understanding that animate individuals direct their own actions, that they are intentional beings endowed with will and purpose (Shultz & Kestenbaum, 1984). However, opponents of Piaget's claim that animism emerges from pre-causal thinking in children, point out that young children possess not only notions of social causation but also some notions of physical causality. Young children cannot be characterized as pre-causal since they seem to possess an understanding of the mechanisms underlying physical causality.

Indeed, researchers (Bullock, 1985b; Bullock, Gelman & Baillargeon, 1982; Shultz, 1982; White, 1988) have identified the use of three important rules in causal reasoning: temporal priority, spatial or temporal contiguity and similarity of the cause to the observed effect. While three year old children are interested in temporal priority alone and will perceive causality in the absence of physical contact between two objects, most 4 and 5 year olds use both order and contiguity rules.

Bullock (1985b) concludes that the assumption of a necessary causal connection emerges by the age of 4 and 5, much earlier than would have predicted Piaget. Even 3 year old children possess some principles (temporal order) by which to reason causality, although they lack concern about the mechanisms involved. Yet, these children do not necessarily provide animistic explanations. Authors have suggested that 3 year olds may be aware that a mechanism exists even if, in the absence of relevant experience, they may not fully understand the mediating mechanism (Shultz & Kestenbaum, 1984).

This type of evidence lends support to the other major hypothesis about animism. Contrary to Piaget, Carey (1985) postulates that the developing distinction between animates and inanimates evolves out of the child's growing body of knowledge about biology and is not dependent on the understanding of physical causality. She agrees that the developing concept of animate objects is tied to the separation of intentional causality from other types of causality. She attempts to demonstrate, however, that 4 to 7 year olds interpret biological phenomena in terms of psychological causal notions because they lack sufficient knowledge about biology -- not because they are ignorant of the mechanisms underlying physical causality.

Carey (1985) has investigated the properties that children attribute to living objects. She argues that children use inductive projection to decide if an animal has a certain part or function. For instance, if humans are said to have a part (e.g. a fictitious omentum), then children will decide that other animals have it as well. The human is used as the model. She notes, for example, that, before the age of ten, the child's understanding of concepts like reproduction seems to be more social than biological. Keil's (1986) work lends support to this conclusion. In one of his experiments, children recognized that skunks could have parents and babies but they also thought it acceptable for the parents or babies of skunks to be racoons. Carey (1985) concludes that children, like adults, appeal to a systematic body of biological knowledge when categorizing an object, but that they do not possess enough biology to draw the same distinction that adults do.

Animistic thinking is similarly explained. Four to seven year olds possess a clear concept of animals as distinct from inanimate objects -- but do not have a concept of living thing as distinct from inanimate objects. For example, children who consider only animals to be alive, do not make animistic overextensions while children who classify animals and plants in the same category do. When they learn that plants are alive, like humans are alive, children wrongly infer that plants are intentional. Only with the acquisition of knowledge through learning and experience, will the child fully map the life concept on the defining features of biological life (Carey, 1985).

This data about the existence of animism concurs with Piaget's even if the interpretations differ. In support of her contention that physical causation is not at issue in animistic thinking, Carey (1985) shows that children rely on more than the one criterion of autonomous movement to distinguish animate from inanimate objects. When children are asked to produce justifications for deciding if an object is alive or not, they give many types of justifications unrelated to movement.

Recent studies have shed some light on the ages at which other attributes of life are acquired. Biological characteristics are rarely given as spontaneous justifications for life by younger children (Massey & Gelman, 1988). However, when they are shown pictures of objects and asked about breathing, growing and dying, even 5 year olds recognize them as vital properties of animal life.

Psychological attributes or mental states, like biological attributes, are rarely used as spontaneous justifications for life by children 3 to 5 years old (Massey & Gelman, 1988). Looft & Bartz (1969) point out that children seem to follow Piaget's animistic stages when asked about knowing and feeling. In fact, the animate-inanimate distinction is acquired earlier (4-5 years) than the sentient-nonsentient distinction (6-7 years). When deciding if anomalous sentences were acceptable, younger children incorrectly attributed intention to objects but rarely attributed life to an inanimate subject noun (Tunmer, 1985). Keil (1979) reports, however, that even 3 year olds grant feelings to animals and people while denying them to plants and inanimates. For example, when asked to judge the acceptability of sentences, "the door is sorry" was rated as silly by young children.

When 5 year old children were asked to judge if various objects think, they were less willing to attribute thinking to non-human animals than to attribute feelings to them. Older children, on the other hand, did attribute thinking to animals and to plants, once they realized that plants were alive (Beveridge & Davies, 1983).

Other research shows, that, for young children, perceptual features such as parts seem more tangible and salient than internal features such as biological functions and mental states. Gelman, Spelke & Meck (1983) found that young children referred primarily to its parts when considering the life status of animate objects. When asked about an inanimate object such as a rock, young children referred mostly to the parts it lacked such as a mouth to eat or to talk, eyes to see, etc. Children seem to associate mental states with the presence of more concrete perceptual features (e.g. knowing with seeing and wanting with talking) (Tunmer, 1985).

Consistent with Carey's (1985) conclusions, research findings thus suggest that children do not appear to fully understand what the defining biological attributes of life are before the age of ten. These findings also suggest that young children acquire some knowledge of animates and inanimates at an earlier age than had postulated Piaget. When children cannot specify the ways in which animates and inanimates differ, the distinction nevertheless seems to mediate their judgements and behaviors. However, even if children have access to a greater body of knowledge than heretofore believed, evidence suggests that movement still plays an important role in animistic thinking.

The role of movement

When children and adults are asked to list attributes of life, more than one criterion is produced. Movement, however, is the most important criterion of life listed by children up to the age of eleven. In fact, movement is the single most important criterion produced by 5 year olds, the frequency of all other criteria being less than 25% of responses (Richards & Siegler, 1986).

Consistent with Piaget's emphasis on the role of movement, Sharp, Candy-Gibbs, Barlow-Elliott & Petrun (1985) suggest that animistic thinking is dependent on the object and its state. Pervasive animistic thought declines with age but animism is likely to emerge at any age if the child is evaluating objects which appear to possess autonomous movement. For example objects such as candle, moon or river are judged alive more frequently than objects such as pencil or dish and even adults can be animistic in confusing circumstances (Looft & Bartz, 1969). Children are less accurate in identifying as anomalous sentences which violate animacy restrictions when these sentences contain subject nouns which can be characterized as exhibiting autonomous movement (eg. "the thirsty cloud covers up the sun") than when the sentences contain an object noun that does not typically exhibit movement (eg. "the pretty lamp sleeps in the corner") (Schwartz, 1980).

Implicitly, then, children seem to rely heavily on the movement criterion to distinguish animate and inanimate objects. When evaluating familiar objects or objects whose mechanisms they understand, children seem to rely more on their acquired body of knowledge than on any single criterion of classification. When evaluating unfamiliar objects, however, children seem more inclined to use the animistic rule of movement. Researchers seem to agree that children's concept of life is closely associated with psychological causation whether or not they agree that the child possesses rules for understanding physical causation. In the child's mind, animate objects can produce self-initiated actions while inanimate objects cannot. The most salient perceptual expression of self-initiated actions is autonomous movement.

Evidence (Golinkoff, Harding, Carlson & Sexton, 1984; Poulin-Dubois & Shultz, 1988) suggests that knowledge about the causal powers of animate and inanimate objects emerges between the end of the first year and the end of the second year of life. In a study by Poulin-Dubois & Shultz (in press), for example, 8- and 13-month old infants were shown a ball rolling activated by a human agent and one activated by another ball moving on its own. The 13-month old infants exhibited a significant decrease in visual fixation time in the human-as-agent condition but not in the object-as-agent situation. Differences in visual fixation times were taken as evidence that the 13-month olds were reacting to the ball-as-agent event because it violated the category criteria that distinguish animates from inanimates, namely the ability to move autonomously.

Children as young as three give movement justifications (eg. can't move on their own) when denying life to dolls. Older children, 4 and 5 year olds, also rely on autonomous movement justifications but to a lesser extent than the younger age group (Gelman, Spelke & Meck, 1983).

In their study, Massey & Gelman (1988) presented pictures of objects appearing to either move spontaneously or to have its motion elicited in an uphill vs. a downhill condition. Four and 5 year olds often used movement justifications when deciding if an object was alive. Similarly, 4 and 5 year olds make more errors in assigning attributes of life to autonomously moving objects than to stationary objects (Dolgin & Behrend, 1984).

Massey (1989) presented brief story lines, each containing either an animate (animal) or inanimate (machine) object, to adults and children aged 3, 4 and 5 years old. Subjects were to make forced choice inferences about the properties of these objects. Five properties were tested: 1) parts (legs or wheels); 2) material (fur or metal); 3) consumption (bread or gasoline); 4) characteristic movement (climbing or rolling); 5) state (sick or broken). She found that subjects in all age groups scored significantly above chance when inferring properties to the animate and inanimate objects and that performance improved with age. Interestingly, however, subjects showed a different pattern of responding for movement information than for the other 4 kinds of property information. They attributed either kind of movement (climbing or rolling) to animates while accepting only the rolling property for inanimate objects. Again, this pattern of responding points to an implicit use of autonomous movement as a criterion for distinguishing animates from inanimates.

Richards & Siegler (1984) emphasized movement in their story line (e.g. "the cherry tree was moved to its new home. Was the cherry tree alive while it was being moved"). They found that the movement rule was more often used by 4 and 5 year old children than by older children when deciding on the animacy of the object. The rule is also relied on by older children, however. In a second series of studies, subjects were asked to decide if an unfamiliar object was alive according to a story line containing a combination of defining and characteristic features of life (eg. an object that can have babies and that moves on its own: do you think it is alive?). In this experimental paradigm, adults accorded autonomous movement as high a life attribution score (around 40% of stories citing autonomous movement) as did 4 and 5 year olds (Richards & Siegler, 1986).

Sharp et al. (1985) presented children with two types of inanimate objects, some which appeared to possess autonomous movement (car, airplane) and some which did not (rock, stuffed bear). Both types of objects were presented in a moving and non-moving state. Some of the objects were brought into the room while the child was asked to imagine the other objects. The authors found that 5 and 7 year olds were fooled by movement, changing their answers from "not alive" to "alive" when objects switched from a non-moving to a moving state. Nine year olds, on the other hand, were not misled by the movement of the object.

Results seem to vary with the method used. In some studies, adults and older children rely on motion as much as younger children do. Generally, however, there seems to be a declining use of the criterion with age. Four and five year olds most appear to rely on the criterion while the performance of three year olds remains inconsistent. Older children sometimes call on movement as a differentiating criterion of life but seem less dependent on it as the major source of information.

Studies in the area of social cognition also support the role of movement in the perception of animacy. These studies go beyond the life judgement and investigate the association between movement and the perception of intention in children.

Rappoport & Fritzler (1969) showed cartoon sequences on slides which portrayed geometric forms (circles and/or triangles) in socially meaningful interactions to grade 1, grade 4 and grade 6 children. Such interactions were represented by movement (e.g. contact between figures), changes in size of the figures or changes in quantity (e.g. number of little sticks inside figures ending up in other figures). When asked to tell a story about the stimuli, grade 4 and grade 6 children did project intentions onto the objects in the simpler displays while grade 1 children spoke mostly of the salient perceptual features of movement.

More re[illegible]ly, Dasser & Premack (1989) videotaped sequences of 2 abstract objects (balls of different colors) engaged in what looked like social interactions (e.g. following or rubbing against each other) and measured 3- and 5-year olds visual fixation time. Children of both age groups looked longer at the pattern of actions presented in a synchronized (intentional) sequence than the same pattern presented in a desynchronized sequence. Only 3 year olds, however, dishabituated more in the intentional than in the desynchronized sequence when the roles of the balls were reversed (e.g. the instigator of the action became the recipient of the action, and vice versa). From these results, the authors concluded that children of both ages perceived intention when the sequence was properly ordered but only 5 year olds could mentally order a desynchronized sequence giving them the ability to perceive intention in even desynchronized sequences. It should be noted that Dasser & Premack (1989) did not collect qualitative data (children's verbal explanations) to substantiate their conclusions drawn from measures of visual fixation. Moreover, they manipulated the order of different actions rather than investigating the effect of the actions themselves on the perception of intention.

These studies indicate that voluntary movements, exchanges of things from one object to another and reversal of roles contribute to the perception of intention in older children. It is not clear from this type of research whether children younger than 5 years can discriminate between intentional and unintentional actions.

The perception of animacy was implicit in these two studies since measures focused on the perception of intention. The next two studies also used computer generated geometrical stimuli to investigate the perception of intention. But, unlike previous studies, animacy was directly assessed by measuring subjects' production of animate labels in a free format story-telling task about the stimuli.

Bolivar (1987) tested adults as well as grade 1, grade 4 and grade 7 children. She manipulated the movement of a circle which contained another small circle inside its perimeter. She found no significant results when manipulating the outer circle but the inner circle's movement was considered more animate, more motivated and more contingent than the stationary one by all age groups. An answer was scored as motivated if it referred to self-initiated movement or goal direction. An answer was scored as contingent if the stimulus movement was seen as dependent or related to that of another stimulus. Bolivar reports that a stimulus was rated as more motivated when the inner circle moved in synchrony with another stimulus object than when the inner circle's movement was random or motionless. Also, for an object to be considered contingent on another, it had to move toward another stimulus. Adults tended to yield larger differences than children.

Bassili (1976) investigated the circumstances which bring about the perception of goal-direction in adults and observed no significant differences in "animatedness" across the various displays. However, subjects produced only inanimate labels when describing a display where both stimuli moved randomly while they produced some animate labels when describing a display where the two stimuli moved in spatial synchrony with one of the stimuli "pursuing" the other.

All these findings suggest that the life judgements of both children and adults can be influenced by the perception of intentional or goal-directed movement. These findings also suggest that as children get older they perceive intentionality more readily and better discriminate between intentional and unintentional movements.

Apart from this work in social cognition, very few studies directly investigating the phenomenon of animism have manipulated actual movement. Experimenters in this field usually resort to pictures of familiar objects that may normally move or not or they describe movement in a story line. Three studies stand out as exceptions.

Bullock (1985a) presented two sets of film clips to adults and children aged 3-, 4-, and 5-years old. One depicted various objects made to move autonomously and the other depicted elicited movement. Two objects were animate (girl and rabbit) and two were inanimate (block and toy worm). Bullock (1985a) asked subjects if the object was alive but also asked about 4 properties true of some animates but not inanimates and 4 attributes mostly true of inanimates. She wished to find out if children's answers would be more influenced by the type of object (alive/not alive) or by the type of movement (autonomous/elicited).

She found that 3 year olds attributed properties to the 4 stimulus objects with less accuracy than 5 year olds or adults independently of movement condition, while four year olds were more accurate in the elicited movement. This indicates that 4 year olds give undue weight to movement characteristics when deciding if an object is alive. She found, however, that 3 year olds presented more of a tendency (although it did not reach significance) to mislabel an object as alive if it was seen in an unusual movement condition, such as an inanimate object moving spontaneously.

When an animism score (which included all questions) was tallied, all age groups described the animate objects as more animate than the inanimate objects, indicating that even 3 year olds differentiated the stimulus objects according to whether they were animate or inanimate regardless of the type of movement. Five year olds consistently performed nearer adult levels than 3 and 4 year olds.

Bullock (1985a) concluded that 3 year olds do not possess a firm understanding of the properties of animates and inanimates nor a consistent ability to classify objects according to object type or to type of movement. Four year olds are more accurate and more consistent but give undue weight to movement characteristics. By age five, children rely more on object type alone to decide if the object is alive or not.

Bullock (1985a) pitted object type information against movement type information. A major problem with her study is that the objects she chose as stimuli were not completely unfamiliar to children. It is remarkable that 4 year olds used movement information to decide on the animacy of even familiar objects. But, given that children were familiar with the objects, the decision as to whether they rely on movement characteristics when forming a life concept about an unknown object remains unanswered in her study.

In the two other studies investigating the effects of actual movement on the perception of animacy, a more abstract and novel stimulus, a computer generated geometrical form, was manipulated. Since the object is totally unfamiliar, subjects had to rely more on their categorization criteria than on their knowledge of the object or of typical representations.

In a series of experiments with adult subjects, Stewart (1984) examined the effects of movement on the perception of animacy by manipulating a computer generated novel stimulus. She manipulated six different movement conditions. In three of these conditions, the individual object's movement characteristic was manipulated while in the three other conditions the relation of the movement between two objects was manipulated.

Stewart found that in the absence of an external source of movement, 50% of subjects judged the object to be alive, while in the presence of an external source of movement only 12% of subjects judged it to be alive. When manipulating direction, more subjects judged the object travelling in a curved motion as alive than the object moving in a straight path. Abrupt changes in speed increased the impression of animacy.

The strongest impression of animacy occurred when the object seemed to avoid impact with a stationary barrier than when an impact occurred. The action of avoiding is implied to involve some intentionality. In contrast, the perception of animacy did not differ across different manipulations of impact violations. In the dependency condition, she found that more subjects classified the stimulus in the person/animal category (instead of the categories mechanized object, not alive or don't know) when two objects moved in temporal and spatial synchrony (90% alive) or in spatial synchrony alone than when two objects moved in opposite directions but in temporal synchrony (29% alive) or when the movement of the two objects was unrelated. Stewart (1984) concluded that spatial dependency does contribute to the impression of animate movement.

An important conclusion to come out of Stewart's work is that adult subjects will judge some internally directed movements as animate movement while other manipulations of objects with internally directed movements will be perceived as mechanical movement. Such a distinction seems to be based on the complexity of characteristics of the movement.

Richards & Siegler (1986) asked children 5 to 11 years old to decide whether a computer generated unfamiliar object (a rectangle) was alive or not. Four types of movement were manipulated: 1) spontaneity (autonomous vs. elicited); 2) appendages (legs vs. wheels vs. no appendages); 3) terrain (level ground vs. downhill); and 4) goal-directedness (goal-directed vs. haphazard). Results indicated that 5 year olds judged the stimulus to be alive mostly if it had legs. Seven and eight year olds' answers were mostly influenced by autonomy of movement and, to a lesser extent, by the presence of legs. In 9 and 10 year olds, the presence of legs and autonomous movement accounted for most of the variance. The salience of perceptual features such as legs in the judgement criteria of children is illustrated by the fact that, overall, children judged the stimulus to be alive on 73% of trials with legs as compared to 37% of trials when wheels were present.

Surprisingly, given other research findings, goal-directedness was not significantly associated with the children's life judgements at any age. To represent movement toward a goal, a toy truck was placed just beyond the stopping point of the artificial object's movement. It may be that this situation was not clearly portraying goal-directedness.

Rationale

The literature reviewed shows that motion plays an important role as a criterion children use to distinguish animate from inanimate objects. Previous research nevertheless contains some flaws. Most studies have presented familiar objects to children making it difficult to tease out the role of previous knowledge and the role of categorization rules in the child's decision making. Little is known about the criteria children use to classify unfamiliar objects. The manipulation of an unfamiliar stimulus should provide a better access to the inferential process involved in distinguishing animate from inanimate objects. Moreover, since few studies have actually manipulated movement, little is known about the aspects of movement which most elicit the perception of animacy. The extent to which the effect of movement in the perception of animacy varies with age also remains unclear.

Finally, most previous research has been restricted to the animacy judgement, asking subjects whether or not the object was alive. Little is known about other life attributes and about children's understanding of the concept alive. Researchers working with novel artificial stimuli, for example, have not yet investigated which other attributes (biological functions or mental states) are granted to objects exhibiting animate-type movement. In studies by Stewart (1984) and Richards & Siegler (1986), subjects were only asked if the object is alive or not. Research has shown that this question is often ambiguous, especially for young children (Looft & Bartz, 1969). Furthermore, a yes or no answer does not tell us what the concept alive represents for the child.

Given the role of familiarity in the perception of animacy, a novel computer generated stimulus is used as the unfamiliar object in the present study. Given the shortcomings of previous work, four objectives are pursued.

The first objective is to determine the effect of different types of movement (the absence of movement as well as movement typical of animate or of inanimate objects) on the perception of life. If children use the rule of movement to categorize an object as alive or not alive, it is hypothesized that a stimulus with animate-type movement will be perceived as alive more frequently than the same stimulus with inanimate-type movement. Moreover, both moving stimuli are more likely to be judged as alive than a stationary stimulus.

The second objective is to determine which other attributes of life are associated with the life judgement and whether these properties will also be influenced by the type of movement. Although Piaget's work on animism was limited to the "is it alive" question, other researchers (Bullock, 1985a; Dolgin & Behrend, 1984) nave asked questions pertaining to several attributes of animate and inanimate objects. From their work, it is hypothesized that more biological properties and mental states will be attributed to the objects with animate-type movement than with inanimate-type movement. Conversely, more inanimate properties will be attributed to the stationary stimulus than to either moving stimuli.

The third objective is to determine whether the effect of different types of movement on the perception of animacy varies as a function of age. Given the role of familiarity in the perception of animacy, only children who can accurately judge the animacy of a familiar object will be included in the study. There is some controversy in the literature as to whether children as young as three possess this baseline knowledge of the life concept. For example, Bullock (1985a) found that 3 year olds were guessing about whether or not a rabbit, a toy worm or a block were alive and she concluded that such knowledge emerges by the age of 4 years. However, Gelman, Spelke & Meck (1983) showed that 3 year old children possessed good knowledge about the properties of a cat and a rock. A major problem with many studies is that they did not systematically include questions concerning the properties associated with inanimates as a means of controlling for response biases. In the present study, such questions will be incorporated to assess if children as young as 3 years possess a firm understanding of the properties of animates and inanimates.

Although still guided by the rule of movement, neo-Piagetian researchers have attempted to empirically demonstrate that children grow out of the animistic stages earlier than would have predicted Piaget. It is hypothesized that the life judgement will be more strongly influenced by the type of motion in young children. Younger children, more often than older children and adults, should judge as alive an object with animate-type movement. Younger children are thus more likely to be misled by the movement rule.

As with the animacy judgement, Piagetian theory would predict that younger children will attribute more biological properties to objects with an internal source of movement (animate-type) than with either an external source of movement (inanimate-type) or the absence of movement. However, given Carey's (1985) findings that children's knowledge of biology increases with age, it is hypothesized that older children and adults will show greater consistency in their answers, attributing more biological functions to objects they have labelled alive than not alive.

Piaget found that younger children attribute consciousness to more objects than they attribute life. It is thus hypothesized that younger children are likely to attribute mental states more indiscriminantly than older children or adults, whether the object is stationary or engaged in either animate- or inanimate-type movement. Carey's findings suggest, however, that young children do not attribute mental states to inanimate objects. As we have seen, she believes that the understanding of physical causality is not at issue in the child's developing concept of life.

A fourth and final objective is to determine whether the perception of animacy varies as a function of different sub-types of movement. Based on previous research (Bullock, 1985a; Richards & Siegler, 1986; Stewart, 1984), it is hypothesized that the perception of life will be more strongly influenced by a stimulus with self-initiated movement than with externally caused movement. Since few other aspects of movement have been tested with children, two other manipulations will be explored. The effect of goal-directed movement (animate-type) on the perception of animacy will be contrasted with random movement (inanimate-type) and the effect of a stimulus moving with angular turns (animate-type) will be contrasted with linear movement (inanimate-type).

Method

Subjects

A total of 150 subjects participated in the study, including 30 3-year olds (*M*= 3 years,5 months;range= 2 years, 11 months to 3 years, 11 months), 30 5-year olds (*M*= 5 years, 6 months; range= 4 years,9 months to 6 years), 30 7-year olds (*M*= 7 years, 4 months; range= 6 years, 11 months to 7 years, 11 months), 30 9-year olds (*M*= 9 years, 5 months; range= 8 years, 10 months to 9 years, 11 months), and 30 adults (*M*= 23 years; range= 19 years, 3 months to 35 years, 1 month). Each age group included 15 female and 15 male subjects. Eighty percent of 3-year olds, 83.33% of 5-year olds, 63.33% of 7- and 9-year olds were recruited from private French language schools of the Montréal area. The remaining subjects were recruited from public child care institutions (school, nursery, city day camp) in middle-class neighbourhoods of Montréal.

Children were selected if parents consented to their participation and if their first language or their language of schooling was French. Adult subjects were recruited from undergraduate psychology courses at Concordia University and were paid five dollars for their participation. They were selected if their first language was French or if they had studied in French since the beginning of their high school.

Apparatus and Stimuli

An Apple 11GS micro-computer was used to create and present six displays of a moving irregular stimulus measuring about 3 cm X 2.5 cm in dimension. The computer screen was completely black while the two-dimensional shape was coloured as either turquoise or fuschia. The Fantavision program (Broderbund Co.,1987) served to create the animation. An identical stimulus, coloured purple this time, was drawn on a 7.5 cm X 9.5 cm white cardboard and served as the control stationary stimulus. Three coloured pictures of familiar objects (a child, a dog and a table) were each pasted on white cardboard of the same dimensions as above and used as baseline measures.

Two different types of movement, ANIMATE and INANIMATE, were manipulated and contrasted with the STATIONARY control stimulus. Both types of movement were featured in each of three conditions, resulting in a total of six moving displays. The spontaneous, goal-oriented and angular displays were classified as animate-type movement. The elicited, random and linear displays were classified as inanimate-type movement. (see Appendix I).

The first condition, manipulated AUTONOMY and involved spontaneous as the animate-type movement and elicited as the inanimate-type. In the first display, spontaneous movement was depicted by having the stimulus move on its own in a squared S-like path. At the outset, the stimulus was in full view and was stationary for 3 seconds on the upper left-hand side of the screen before departing. The stimulus then encountered four right-angle turns along its trajectory, stopping each time for 1 to 1.5 seconds. It paused and started again three other times for 1 to 1.5 seconds, once between each of three of the right angle-turns so as to make the spontaneity of its motion more salient. Adding occasional stops enhances the perception of animacy and humanness (Wyatt, 1984 as cited in Bolivar, 1987). The stimulus disappeared on the lower right-hand side of the screen. (see Appendix I, Figure 1a).

In the second display of the autonomy condition, elicited movement was represented by having the stimulus pulled by a rope. The agent of the action was not seen on the screen. In order, to make both movement displays in the autonomy condition comparable, the stimulus followed the same path as that in the spontaneous movement, including pauses at and between right-angle turns. (see Appendix I, Figure 1b).

<u>The second condition</u>, manipulated <u>CONTINGENCY</u> and involved the presentation of <u>goal-oriented</u> movement as the animate- type and <u>random</u> movement as the inanimate-type. In the first display, the stimulus followed a goal-object, a stickperson. The path was the same as in the autonomy

condition just described above except that stops were removed and that the stimulus departed from outside of the upper left-hand side of the screen and was thus only half visible at the outset. This last feature was added so that the subjects would be kept guessing as to whether or not there was an agent activating tne movement of the stimulus. In the spontaneous display of the Autonomy condition, on the other hand, it is clear that no agent was activating the stimulus. The display simulated a pursuit by making the movement of the stimulus and the stickperson contingent on the other object's movement. After a lag of 3 seconds, the stimulus followed the direction of the stickperson. The speed of the stimulus was slightly greater than that of the stickperson, so that it gradually caught up to it. When the distance between the two became smaller, the stickperson surged forward at an increased speed. In the meantime, the stimulus decelerated, turned at a right-angle to the direction of travel of the stickperson, and proceeded to accelerate in this new path. The stimulus never catches the stickperson. Every change in direction was preceded by a deceleration and followed by an acceleration period of both the stimulus and the stickperson. (see Appendix I, Figure 2a).

In the second display of the contingency condition, randomness was portrayed by ensuring that all systematic relationship between the movement and changes in direction of the two objects were eliminated. The two objects were portrayed as moving independently from each other. In this instance, the stickperson departed from a different side of the screen than the stimulus, which departed from its usual place on the upper left-hand side of the screen. However, the pattern of the path and the same temporal lag between changes in direction found in the goal-oriented display were retained. (see Appendix I, Figure 2b).

<u>The third and final condition</u>, manipulated <u>DIRECTION</u> and involved the presentation of <u>angular</u> movement as the animate-type and <u>linear</u> movement as the inanimate-type. In the first display, angular movement was depicted by having the stimulus move along the same path as in the other conditions. Unlike the spontaneous display of the Autonomy condition, the stimulus departed from outside of the upper left-hand side of the screen and was thus only half visible at the outset while it remained still for three seconds. Subjects were thus kept guessing about whether or not there was an agent activating the movement of the stimulus. It followed the same path as above except that all stops were removed and speed was kept constant. Removing stops took away the clue that the movement of the stimulus might have been self-initiated. (see Appendix I, Figure 3a).

In the second display of the direction condition, linear direction was depicted by having the stimulus move in a straight line from the middle left-hand side of the screen to the middle right-hand side while maintaining a constant speed and without stopping. Again, the stimulus departed from outside of the screen and was thus only half visible at the outset while it remained still for 3 seconds. (see Appendix I, Figure 3b).

Design

A mixed design was chosen, with one third of the subjects in each age group assigned per condition. Ten subjects from each age group were randomly assigned to each of the conditions, resulting in a total of 50 subjects per condition. Within each condition, subjects were exposed to both animate- and inanimate-type movement.

Displays varied in duration between 30 and 40 seconds. The stimulus for each of the two types of movement was of a different colour so as to make it clear to subjects that they were evaluating different objects. All subjects were thus exposed to a purple stationary stimulus, to a turquoise stimulus engaged in inanimate-type movement and to a fuschia stimulus engaged in animate-type movement. No other perceptual dimension of the object was manipulated.

Each subject was administered a total of four trials. Subjects were first administered the control trial with the stationary unfamiliar stimulus. The second trial consisted of presenting one of the two experimental stimuli, displaying either animate- or inanimate-type movement within the assigned condition. The order of presentation of the specific display run first, was counterbalanced within each sex and each age group. The order of presentation in the third and fourth trials consisted either of the second type of movement within the assigned condition or one of the familiar baseline objects (child, dog or table). The order of presentation of the movement condition and the baseline object was counterbalanced within each sex and each age group, as was the choice between one of the three familiar baseline objects.

Dependent Measures

Two types of responses were gathered to assess attributions of animacy. These can be categorized as one animacy judgement and 12 attribute accuracy questions. Each subject answered all questions about one of the three familiar baseline objects, about both levels (animate and inanimate) of the assigned movement condition and about the control stationary stimulus. Each subject thus answered a total of 52 questions, 26 per testing session. Attribute accuracy for the object in each of the conditions was assessed with 12 questions about properties which belong to animate and inanimate objects. All questions required a yes-no response.

Eight of the questions involved properties true of some animates but not true of inanimate objects. Four of these attributes referred to *biological* functions: (1) can x grow bigger? (2) If we forget to give x food, will it get hungry? (3) can x breathe? (4) Does x have a mommy or daddy? The four other animate attributes were classified as *state/cognition*: (5) Can x cry if you pinch it? (6) Can x talk if you ask it a question? (7) Can x remember what happened yesterday? (8) Can x want a present for Christmas? The four remaining questions involved properties generally true of *inanimate objects*, but not true of animate objects: (9) if x breaks, can we fix it with glue? (10) If we want to make x smaller, can we slice it in two? (11) Can we throw x in the garbage? (12) Can we store x in a cupboard? Finally, *life judgements* for each condition were ascertained by asking subjects the question "Is it alive" and then by asking them to justify why they thought it was alive or not.

Procedure

All children were tested individually at their school and were brought to a quiet room. Subjects in the 3-, 5- and 7-year old age groups were told that they would be watching some things on a computer screen and that they would be asked to help their friend the puppet by telling what they had seen.

"Today we will be looking at pictures and things on the computer screen. I'm going to ask you to help our friend Niko (the puppet) by telling him what you have seen. You can help Niko understand by answering a few questions. First, let's start with this picture. It's the picture of a thing that has been found in a far, far away land and that no one has ever seen before. We drew it and brought it here to help Niko better understand what the thing is all about. Now let's see if we can answer a few questions to help Niko."

To be sure subjects complied with speaking to the "friend", they were asked to tell it their name and age before answering the questions. When the three other stimuli were subsequently presented, children were told that they were different objects coming from different far away places.

When starting each of the four trials, the experimenter said: "We need to help our puppet friend discover some things about the x". Subjects were given questions in a predetermined randomized order which was different for each of the four trials and for each subject within any one age group. The justification for the life judgement, however, was always asked last. The x in questions was replaced by the objects' name corresponding to its colour (eg. "the blue thing"). Children were tested in two sessions spaced apart by no more than a week. Each session lasted approximately 10 or 15 minutes. Nine year old children followed the same procedure except that they talked directly to the experimenter rather than to the puppet.

Each subject was first presented with a picture of the stationary stimulus. The 12 test questions and the life judgement were then asked. For each question except the justification, the child gave a yes/no answer. The picture of the stimulus was left facing subjects while they answered questions.

When presented with the moving stimuli, the display was run twice and subjects were then asked to describe what they had seen to ensure that they had paid attention. The same questioning procedure as above was repeated as the display was kept running for both trials featuring movement. When presented with the baseline stimulus, subjects were asked to identify the familiar object. The same questioning procedure as above was repeated.

Adult subjects were also tested individually and followed a similar procedure. However, they were tested in only one session which lasted 20 to 30 minutes. Again, the puppet was omitted from the procedure and questions were phrased in a more " adult" format. Adults were told that they were being used as a comparison group and their instructions varied somewhat from those of the children's.

"This research was initially designed for children and you might find the set-up a little simple. You may also find that questions are somewhat repetitive. However, we wanted to test adults so as to better compare and situate the development of children. I am going to present you with 4 drawings of objects -- of which two will be on cards and two will be animated on a computer screen. Some of these objects you will already know while others will be completely unknown. These unfamiliar objects will have been seen in far away lands and have been reproduced on the screen and on the card. Now, imagine that you have been named president of a committee to identify unidentified objects. Your task as president will be to answer a dozen questions that would help your committee members to understand and to classify the objects according to their respective features."

Results

Subjects were included in the analyses involving the unfamiliar stimulus only if they showed an understanding of the life concept for at least one familiar object. Children's answers to the "alive" question for one of the three familiar objects (dog, table, child) were scored for accuracy. Overall, children and adults were very accurate. Adults, 5-, 7- and 9-year-olds performed uniformly above the chance level for all three objects. The 3-year-olds were above chance only for the person, indicating that they were guessing as to whether or not the dog and the table were alive (see Appendix IIa for proportions of accurate answers).

Given these findings, subjects were included in further analyses only if they met the following selection criteria: subjects needed to correctly answer 4 out of 5 of the biological questions combined with the alive question and 3 out of 4 of the inanimate questions. Answers to the cognition questions were omitted from the selection criteria since establishing the accuracy of such answers was more problematic, especially for the dog. Moreover, subjects found these questions more ambiguous and more difficult to answer. Only 6 out of 30 3-year olds (20%) met these criteria while 25 5-year olds (83.3%), 29 7-year olds (96.7%), 29 9-year olds (96.7%) and 30 adults (100%) did. Three year olds were thus eliminated from any subsequent analyses since 80% of them failed to demonstrate a basic understanding of the life concept as it applies to familiar objects. The five 5-year olds, one 7-year old and one 9-year old who did not meet the selection criteria were also eliminated from subsequent analyses. They showed a perseveration of "yes" responses, indiscriminantly attributing life properties to both animate and inanimate objects as well as attributing inanimate properties to living and non-living objects (Subjects' biological and inanimate scores are listed in Appendix IIb).

Animism score

To test our hypotheses about the effect of age and type of movement on the perception of animacy, answers concerning the unfamiliar stimuli were analyzed. The 12 questions about life properties were first examined. These dependent measures were divided into three types of questions, each assessing a different set of life properties: 1) biological; 2) state/cognition; and 3) inanimate properties. Although state/cognition questions were not taken into account for the selection process, it seemed important to investigate the effect of movement on the attribution of mental states.

Answers to the 12 attribute questions were submitted to a split-plot 4 (age group) X 3 (condition: autonomy, contingency, direction) X 3 (type of movement: animate, inanimate, stationary) X 3 (type of question) analysis of variance. Age and condition are between-subject factors while type of movement and type of question are within-subject factors. Three animistic scores on the three different sets of properties were obtained for each subject to constitute the type of question factor: 1) the biological score was computed by assigning "yes" answers a value of "1" and "no" or "I don't know" answers a value of "0", for a maximum score of 4; 2) the cognitive score was computed by assigning "yes" answers a value of "1" and "no" or "I don't know" answers a value of "0", for a maximum score of 4; 3) the inanimate score was computed by assigning "no" answers a value of "1" and "yes" or "I don't know" answers a value of "0", for a maximum score of 4. A global score combined all three of these scores, for a maximum score of 12.

As expected, there was a main effect of type of movement, $\underline{F}$ (2, 202) = 6.47, $\underline{p} < .005$. The Scheffé test was used for all post hoc pairwise comparisons. Results indicate that the stimuli with animate-type movement ($\underline{M}$ = 4.43) generated a significantly higher animism score (maximum score of 12) than stimuli with inanimate-type movement ($\underline{M}$ = 3.97), $\underline{p} < .05$ or than the stationary stimulus ($\underline{M}$ = 3.43), $\underline{p} < .01$. Moreover, stimuli with inanimate-type movement yielded a higher animism score than the stationary stimulus, $\underline{p} < .01$. No two-way condition by type of movement interaction, nor any other interaction with condition or type of movement, were found. Scores for displays with animate-type movement or inanimate-type movement or for the stationary stimulus did not vary differentially across any of the three conditions (autonomy, contingency or direction), across age groups or across type of question (see Appendix III for mean scores).

Also as expected, a main effect of age groups was found, $\underline{F}$ (3,101) = 6.14, $\underline{p}$ < .001. Five year olds ($\underline{M}$ = 6.04) scored significantly higher on an overall animism score (maximum score of 12) than did the 3 other age groups, the 7-year olds ($\underline{M}$ = 4.00), $\underline{p}$ < .05, 9-year olds ($\underline{M}$ = 3.93), $\underline{p}$ < .05 or adults ($\underline{M}$ = 4.00), $\underline{p}$ < .01, whose scores did not differ from each other.

A main effect of question was also found, $\underline{F}$ (2, 202) = 30.20, $\underline{p}$ < .0001. Subjects obtained higher animistic scores when asked about the inanimate ($\underline{M}$ = 2.01), $\underline{p}$ < .01, and biological properties of the stimuli ($\underline{M}$ = 1.44), $\underline{p}$ < .05, than when asked about cognitive properties ($\underline{M}$ = 1.05). Biological scores and inanimate scores were not significantly different from each other.

Finally, an age by question interaction, $\underline{F}$ (6, 202) = 2.25, $\underline{p}$ < .05, revealed that the main effect of age was entirely accounted for by the cognitive score (see Figure 1). Independent $\underline{t}$-tests were run for all post-hoc pairwise comparisons of age groups within each level of type of question (biological, cognition and inanimate). The Bonferroni corrected alpha level was set at .008 (two-tail test). When asked about cognitive attributes, 5- year olds ($\underline{M}$ = 1.92) scored significantly higher than the 7-year olds

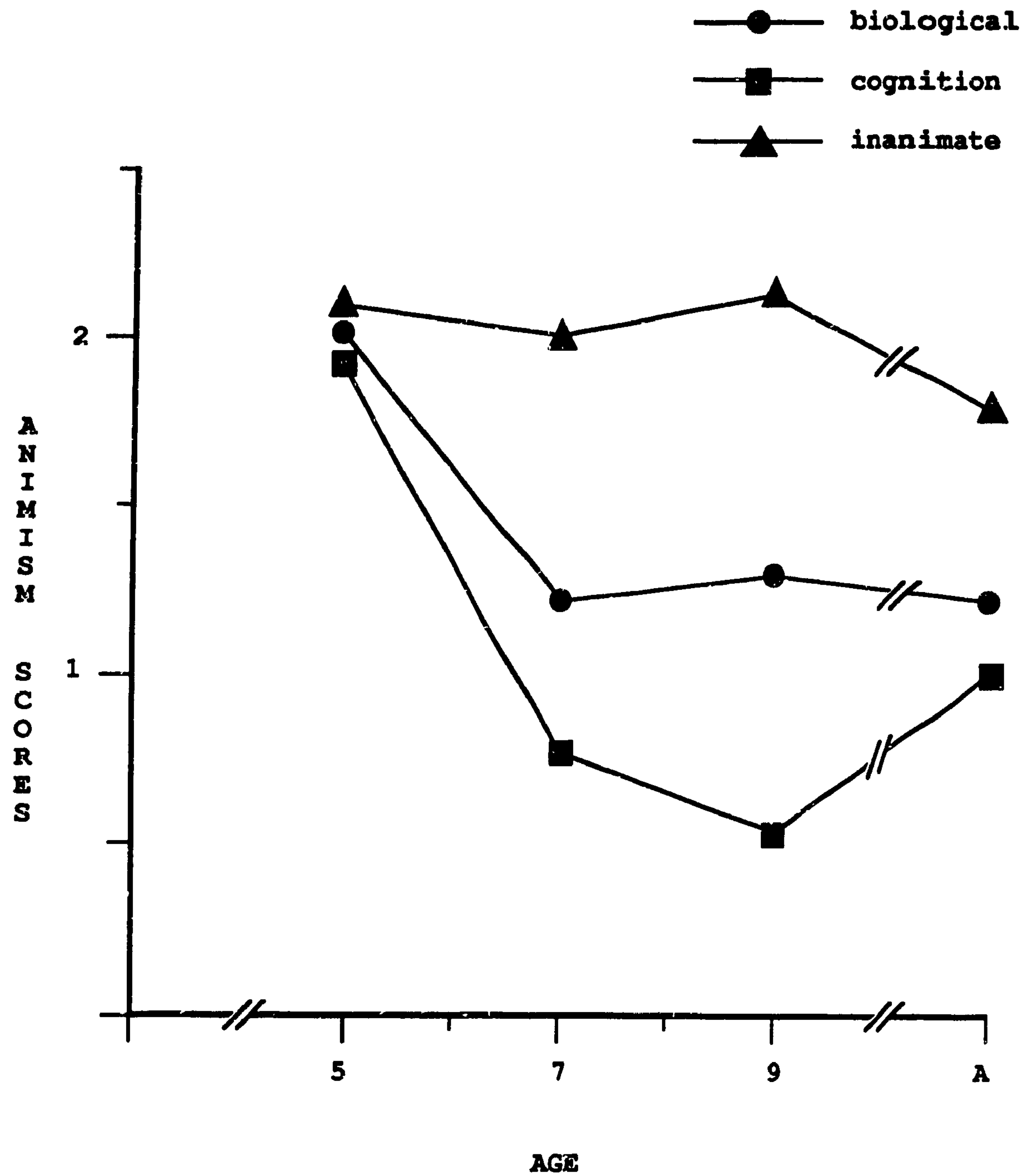

Figure 1. Mean animism scores as a function of age and type of question.

(M = 0.76), $p < .001$, and the 9-year olds (M = 0.52), $p < .0001$ while the difference with adults approached significance levels (M = 1.00), $p < .01$. No other significant age differences were found within the cognitive attributes and no age differences appeared among the biological or the inanimate scores. No other two-way or three-way interaction reached significance in this analysis.

Animacy judgements

Since much past research has focused on the animacy judgement, separate analyses were also performed on the "Is it alive?" question. It was expected that subjects would answer more frequently that the object is alive when observing the stimulus with animate-type movement than with inanimate-type movement or with no movement (the stationary stimulus). To test this hypothesis, positive responses to the question "is it alive? were compared with the combined frequencies of "no" and "I don't know" responses and submitted to the Cochran Q test. The Dunn-Bonferroni inequality test was used for all post hoc pairwise comparisons involving the Cochran Q test. Results indicate that the hypothesis was partially confirmed. Indeed, the frequencies of positive responses differed across the three types of movement, Q (2, N = 113) = 36.27, $p < .001$. As expected, the frequencies of "yes" responses for both the stimulus with animate-type movement (62.83%) and the stimulus with inanimate-type movement (52.21%) were greater than the frequencies of positive responses for the stationary stimulus ((28.32%), $p < .01$. Contrary to expectation, however, although movement induced more animacy judgements than no movement, the perception of animacy did not significantly differ between animate- and inanimate-type movement.

Analyses were also conducted within each of the age groups. Five year olds responded differently to the three stimuli, Q (2, N = 25) = 14.533, $p < .001$. They were more likely to consider alive the stimulus with animate-type movement than the stationary stimulus, $p < .05$. Nine year olds, Q (2, N = 29) = 6.42, $p < .01$ and adults, Q (2, N = 30) = 9, $p < .01$, showed the same pattern. Seven year-olds also gave significantly different responses to the three stimuli, Q (2, N = 29) = 10.11, $p < .01$ but they judged both the stimuli with animate-type movement, $p < .05$, and inanimate-type movement, $p < .05$, as alive more often than the stationary stimulus (see Table 1). In summary, at all age levels, the stimulus with animate-type movement induced more animacy judgements than the stationary stimulus, while only seven year olds more frequently judged as alive the stimulus with inanimate-type movement than with no movement. Finally, at none of the age levels did the frequencies of "yes, it is alive" responses differ between animate- and inanimate-type movement.

Table 1

Percentage of Positive Responses to the Animacy Question as a Function of Age and Type of Movement.

TYPE OF MOVEMENT	AGE			
	5	7	9	ADULT
STATIONARY	32.0	31.0	31.0	20.0
INANIMATE	60.0	65.5	44.8	40.0
ANIMATE	80.0	62.1	62.1	50.0

The percentage of animacy judgements in the animate-type, inanimate-type and stationary displays were also compared within each condition. Age groups were collapsed since the n's per cell were too small to be considered reliable (See Appendix IV). Within the autonomy condition, subjects produced a significantly different number of positive responses to the three stimuli, $Q\ (2, N = 39) = 7.238$, $p < .05$. The stimulus with animate-type movement (spontaneous) was considered as alive more often than when stationary, $p < .05$ (see Figure 2). Subjects in the contingency condition also produced a different number of positive responses to the three stimuli, $Q\ (2, N = 38) = 12.08$, $p < .005$. More subjects judged the stimulus with animate-type movement (goal-oriented) as alive than when stationary, $p < .01$ (see Figure 2). Finally, within the direction condition, subjects also gave a different number of positive responses to the three stimuli, $Q\ (2, N = 36) = 18.9$, $p < .0001$. More subjects judged as alive both the stimuli with animate-type movement (angular), $p < .01$, and inanimate-type movement (linear), $p < .01$, than the stationary stimulus (see Figure 2).

In summary, all three stimuli with animate-type movement (autonomous, goal-directed or angular) were judged as alive more frequently than the stationary stimulus. Only one sub-type of inanimate-type movement (linear movement) induced more animacy judgements than the absence of movement.

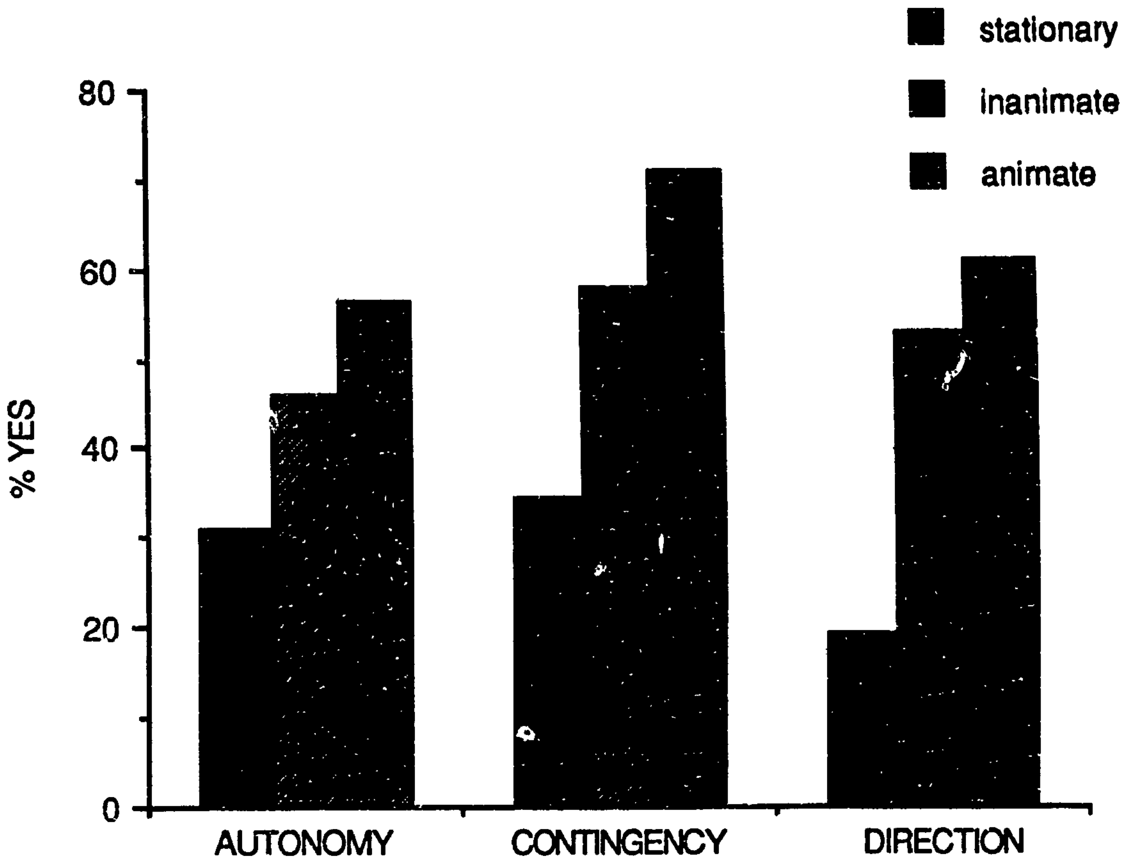

Figure 2. Percentage of positive responses to the animacy question across age groups as a function of condition.

Overall, in none of the analyses was the stimulus with animate-type movement judged as alive more often than with inanimate-type movement. Significant differences appeared only when movement was contrasted with the absence of movement. However, while in all analyses more subjects judged as alive the stimulus with animate-type movement than the stationary stimulus, few analyses showed that the object engaged in inanimate-type movement differed from the stationary stimulus. Such results were obtained in only three cases: in the global analysis where both age groups and conditions were collapsed, in the direction condition (collapsed across age groups) and in 7 year olds (collapsed across conditions).

Another question of interest is whether type of movement differentially affects the perception of animacy across age levels. Three chi-square tests were run to answer this question. Responses for the stimulus with animate-type movement were collapsed across the three conditions as were those for the inanimate-type movement and the stationary stimulus. Positive responses to the question "is it alive?" were compared with the combined frequencies of "no" and "I don't know" responses. No significant age differences were found when subjects were presented with animate-type movement, X^2 (3, $\underline{N}$ = 113) = 5.285, inanimate-type movement, X^2 (3, $\underline{N}$ = 113) = 5.092, or with the stationary stimulus, X^2 (3, $\underline{N}$ = 113) = 1.4, all $\underline{p}$'s > .05, (see Table 1). Younger children were no more likely than older children or adults to consider the stimulus alive when viewing the stationary stimulus or either of the two moving stimuli.

Analyses on each of the six individual movement displays will not be reported as the N's were too small to be considered reliable. More than fifty percent of the cells contained n's smaller than five.

Relationship between animacy judgements and animism scores

The relationship between answers to the life judgement and the attribution of life properties was assessed using point-biserial correlation coefficients. Since the analysis of variance showed no differences between subjects' answers to the biological and inanimate scores, the life properties score for this analysis was defined with an animistic score combining the answers to both the biological and the inanimate questions (maximum score of 8). The Bonferroni corrected alpha level was set at .008 (two-tail test).

For the stationary stimulus, positive correlations between the animacy judgement and the attributes score were significant for all age groups. Having decided that the stationary stimulus was not alive, subjects at all age levels also tended to deny it life attributes. For the inanimate-type movement (3 conditions combined), only seven year olds and adults showed a significant relationship between their answers to the life judgement and their attribution of life properties (see Table 2).

For the animate-type movement (3 conditions combined), only adults' animacy judgements were significantly correlated with the attributes score. Five year olds showed almost no relationship between how they answered the life judgement and how they answered the life attributes questions. Although 5 year olds considered the stimulus with animate-type movement to be alive, they attributed few life properties (such as biological functions) to it. Thus, within animate-type movement, only adults generally attributed life properties to an object they identified as alive and denied life properties to the object they judged as not alive (see Table 2). In fact, of all age groups, adults exhibited the strongest consistency across both sets of questions for all three types of movement (animate, inanimate or stationary).

The relationship between answers to the life judgement and answers to the cognition questions (maximum score of 4) was also assessed using point-biserial correlation coefficients. The Bonferroni corrected alpha level was set at .008 (two-tail test).

Only one correlation proved to be significant. Only adults judging the stimulus with animate-type movement showed a significant and positive relationship between their animacy judgement and their attribution of mental states (see Table 3). These results indicate that adults tend to associate

Table 2

Correlation Coefficients Between the Animacy Judgement and the Combined Biological and Inanimate Scores for Each Age Group.

TYPE OF MOVEMENT	AGE			
	5	7	9	ADULT
STATIONARY	.71	.65	.59	.88
INANIMATE	.41	.62	.39	.74
ANIMATE	.01	.52	.46	.78

Note: Underlined correlations are significant at the Bonferroni corrected alpha ($p<.008$).

Table 3

Correlation Coefficients Between the Animacy Judgement and the Cognition Score for Each Age Group.

TYPE OF MOVEMENT	AGE 5	7	9	ADULT
STATIONARY	.46	.43	.21	.18
INANIMATE	.50	.17	.54	.46
ANIMATE	.28	.27	.17	.77

Note: Underlined correlations are significant at the Bonferroni corrected alpha ($p<.008$).

animate-type movement with intentionality and not just with life alone. Adults' lowest correlation is for the stationary stimulus indicating that they seem to deny mental states in the absence of movement, whether the stimulus is judged as alive or not alive.

Judgement justifications

Finally, subjects were asked to justify why they thought the stimulus was alive or not. If subjects relied on the rule of movement to decide whether the stimulus was alive, they were likely to explain their decision with justifications involving the role of movement. Justifications were coded into four different categories: 1) answers which included some reference to movement (e.g. it's alive because it moves or walks); 2) answers which included some reference to speech or cognitive functions (e.g. it's not alive because it doesn't talk; it's alive and makes decisions since it stops); 3) answers which included some reference to the shape, colour or texture of the object (e.g. it's not alive because it looks like a rock; it's alive because it has the shape of an amoeba; it's alive because it's purple); and 4) all other answers. Coding and reliability checks were carried out by two independent coders who were blind to the specific experimental hypothesis. There was an 82% agreement for five year-old justifications, a 95% agreement for seven and nine year-old's and an 88% agreement for adult justifications. Disagreements were discussed and resolved with the experimenter.

Goodness of fit chi-squares (with Yates' correction) comparing the frequencies of justifications across these four categories were run for each age group within each of the three types of movement. The frequency expected by chance corresponds to 25% of answers in each of the four justification categories. When presented with the animate-type movement, subjects of all age groups, 5 year olds, X^2 $(3, \underline{N} = 36) = 53.31$, $\underline{p} < .001$; 7 year olds, X^2 $(3, \underline{N} = 41) = 45.14$, $\underline{p} < .001$; 9 year olds, X^2 $(3, \underline{N} = 43) = 29.$[illegible], $\underline{p} < .001$; and adults, X^2 $(3, \underline{N} = 41) = 34.53$, $\underline{p} < .001$, produced a significantly different number of justifications across categories. Movement answers were produced with the greatest frequency for all age groups (varying between 44% and 47% of all justifications) and were much above the value expected by chance. Justifications belonging to the three other categories were produced either at or well below the value expected by chance, except for "other" justifications in 5 year olds (38%) (see Figure 3).

It is interesting to note that the frequency of justifications based on cognitive functions gradually increased with age to become the second most important life justification generated by adults across the animate-type movement conditions. The high proportion of cognition

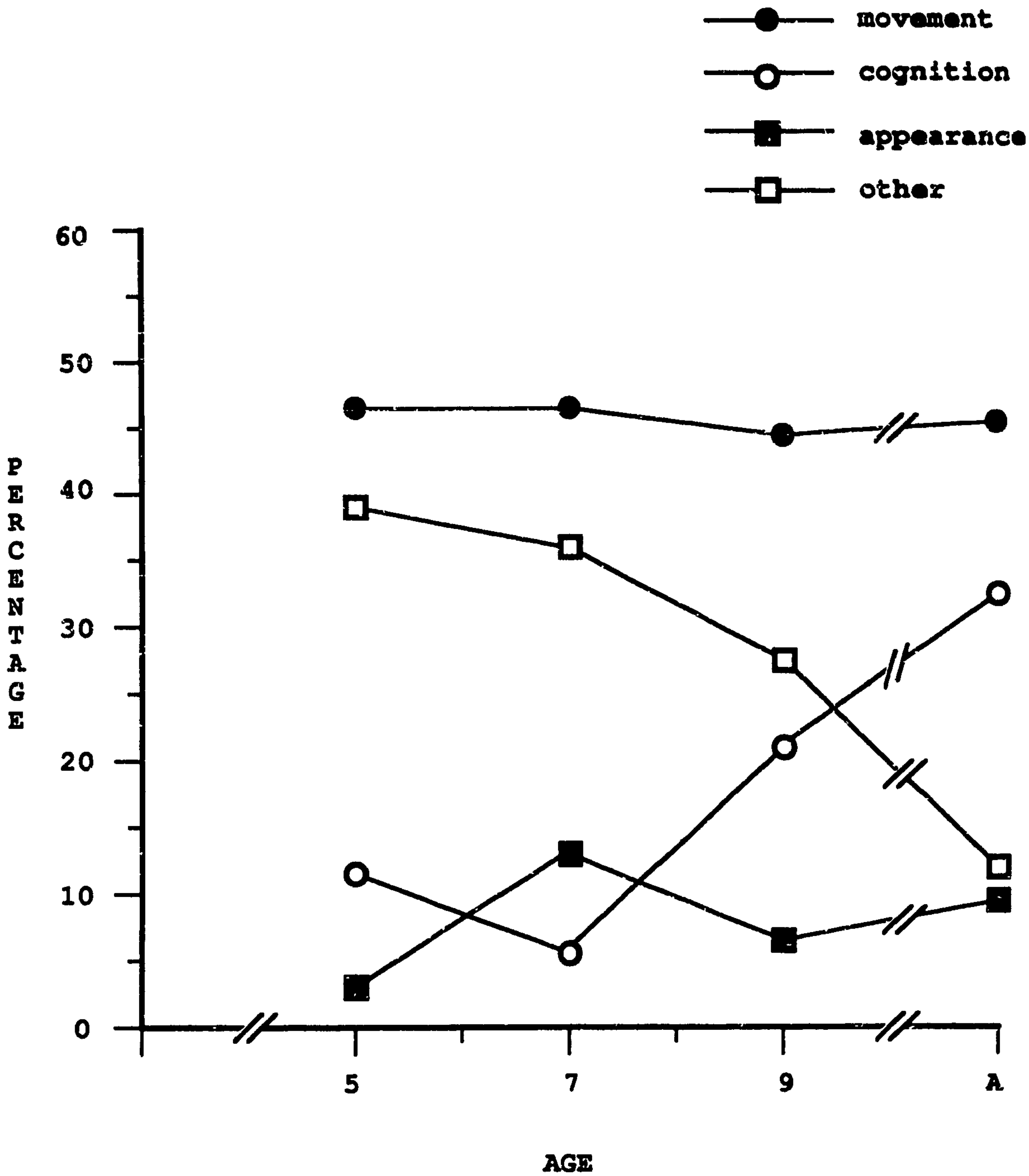

Figure 3. Percentage of responses in each category of justification as a function of age for the animate-type movement.

justifications is accounted for by the spontaneous display (autonomy condition) where cognition is the dominant justification in adulthood (37.5% of all adult justifications) and the goal-oriented display (contingency condition) where cognition is dominant in adulthood (44.4% of all adult justifications) and closely follows movement justifications in 9 year-olds (31.82% of all 9 year old justifications). These figures suggest that self-initiated movement and goal-oriented movement influence adults' and older children's attribution of mental states.

When presented with the inanimate-type movement, subjects of all age groups, 5 year olds, X^2 (3, N = 41) = 43.92, $p < .001$; 7 year olds, X^2 (3, N = 37) = 49.29, $p < .001$; 9 year olds, X^2 (3, N = 43) = 10.53, $p < .05$; and adults, X^2 (3, N = 37) = 34.67, $p < .001$, produced a significantly different number of justifications across categories. In contrast to the pattern found for the animate-type movement displays, movement justifications were dominant only for adults (45% of all justifications) and 7 year olds (56% of all justifications). Adult and 7 year old justifications belonging to the three other categories were produced either at or well below the value expected by chance. In 5-year olds, movement justifications (36%), although different from chance levels, came second to the "other" category (46%) which was produced much above the value expected by chance. Five year old justifications belonging to the other two categories were produced much below the value expected by chance. In 9 year olds, none of the observed frequencies deviated significantly from the expected frequencies (see Figure 4).

When presented with the stationary stimulus, subjects of all age groups, 5 year olds, X^2 (3, $\underline{N}$ = 42) = 42.24, $\underline{p}$ < .001; 7 year olds, X^2 (3, $\underline{N}$ = 35) = 14.74, $\underline{p}$ < .005; 9 year olds, X^2 (3, $\underline{N}$ = 34) = 44.73, $\underline{p}$ < .001; and adults, X^2 (3, $\underline{N}$ = 39) = 23.92, $\underline{p}$ < .001, produced a significantly different number of justifications across categories. Contrary to what was found for the moving stimuli, the frequencies of movement justifications for the stationary stimulus were never dominant and were never produced at above chance levels. The dominant justifications in 5 year olds belonged to the "other" category (50%), all other categories being produced at or below the value expected by chance. For all other age groups, appearance justifications (37% for 7 year olds; 47% for 9 year olds; 41% for adults) were dominant and produced with frequencies above the value expected by chance. In adults and 7 year olds, justifications belonging to all other categories were either at or below the value expected by chance. In 9 year olds, frequencies of justifications from the "other" category (35% of all justifications) was produced above the value expected by chance, while movement and cognitive justifications were much below expected frequencies (see Figure 5). Overall, then,

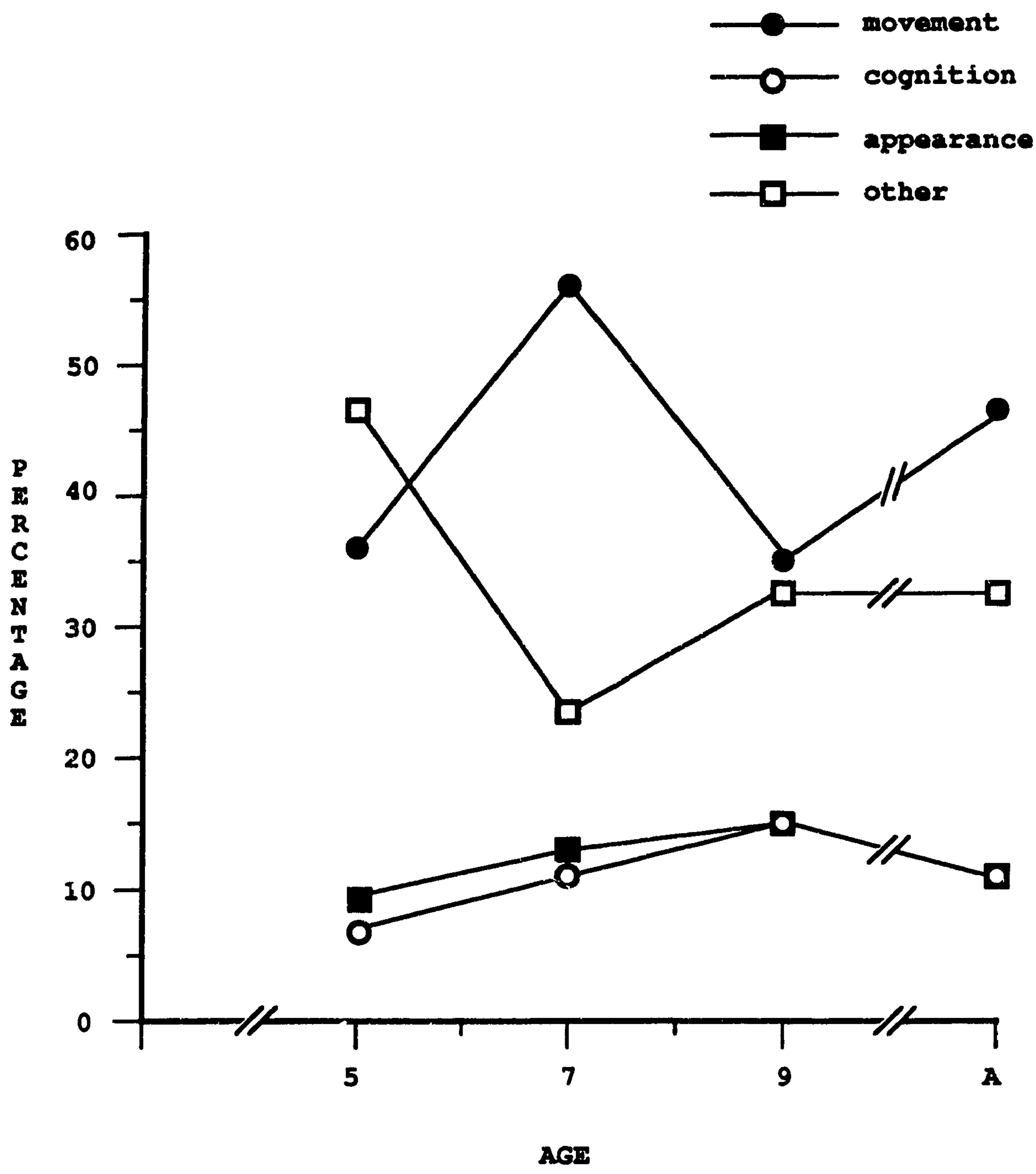

Figure 4. Percentage of responses in each category of justification as a function of age for the inanimate-type movement.

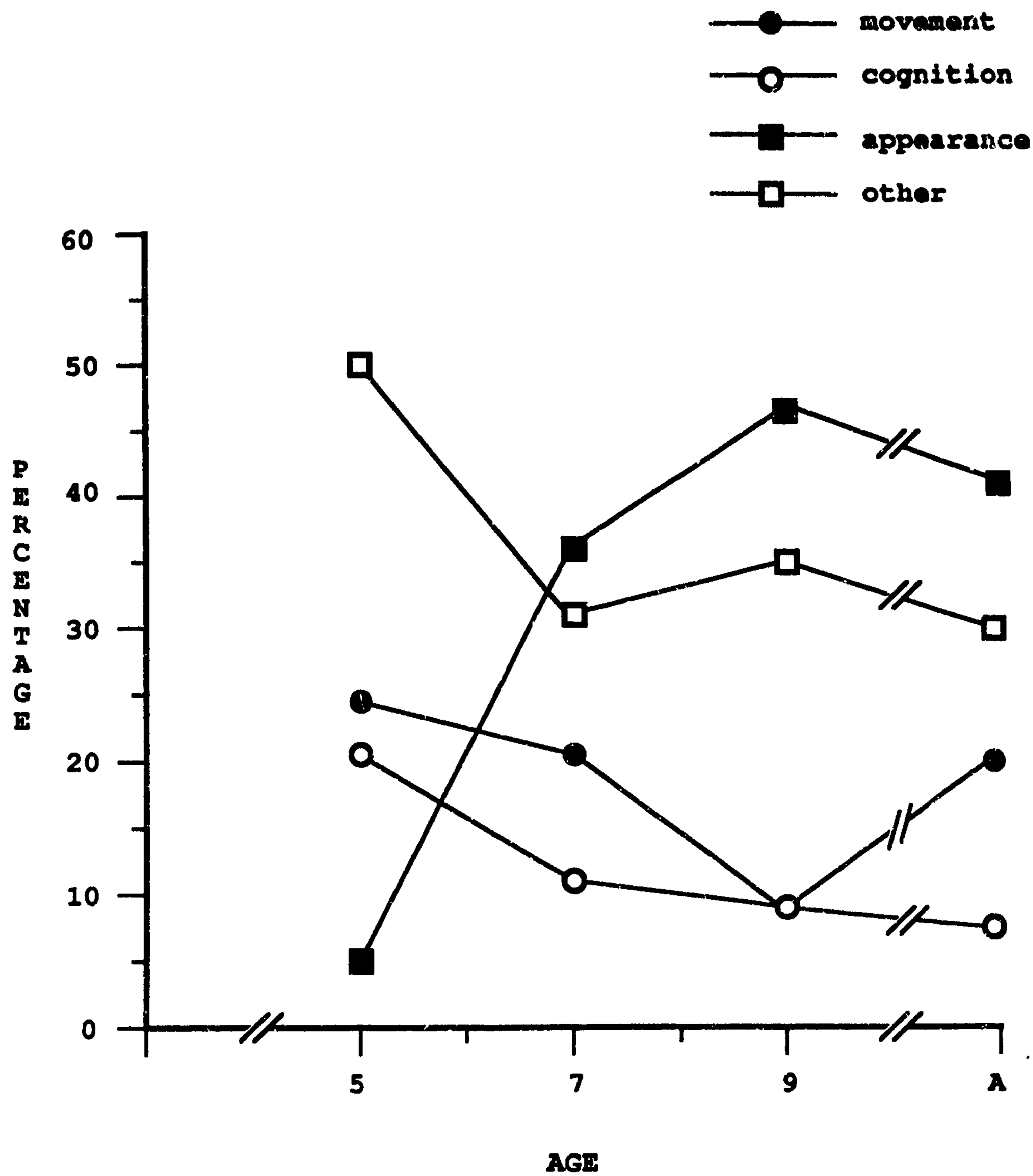

Figure 5. Percentage of responses in each category of justification as a function of age for the stationary stimulus.

movement justifications were dominant when the stimulus was in motion, while the frequency of such justifications dropped dramatically when the stimulus was stationary.

Finally, within the total number of movement justifications, the number of answers containing a reference to self-initiated movement was computed and submitted to a source of movement X age chi-square for independent samples. Source of movement was scored "yes" if subjects referred to the movement of the stimulus as being in some way self-initiated or scored "no" if the source or agent of the movement remained unspecified. For both the inanimate-type movement, X^2 (3)= 131.399, p<.001, and the animate-type movement displays, X^2 (3)= 262.044, p<.001, subjects produced significantly more self-initiated movement justifications as they grew older. The most dramatic increase occurred between 9 year-olds and adults. For the stimuli with animate-type movement, 100% of movement answers given by adults referred to the presence or absence of a self-initiated source of movement, while only 21% of 9-year old answers included them. For the stimuli with inanimate-type movement, 82% of adult movement answers referred to the source of movement while children younger than 9 years referred to it in fewer than 15% of their movement justifications. Finally, although 46% of 9-year old movement justifications contained a reference to source of movement for the stimuli with inanimate-type movement, 9-year olds produced, overall, relatively few movement justifications.

In conclusion, although subjects at all age levels produced movement explanations to justify their decision that the stimulus with animate-type movement is alive or not, only adults specified the source of movement in their answers. Adults also specified the source of movement when justifying their decision that the stimulus with inanimate-type movement is alive or not, while very few children referred to it.

Discussion

The major purpose of the present study was to determine the effect of different types of movement on the perception of animacy (alive or not). A related objective was to determine if the type of movement would affect the attribution of life properties. As expected, results indicate that the type of movement differentially affected the attribution of life properties across all age levels. When answers to all 12 life attribute questions were combined, subjects attributed the highest number of life properties to the object with animate-type movement. Moreover, the object with inanimate-type movement was assigned more life attributes than the stationary stimulus. This tendency was particularly clear in the autonomy condition, where the stimulus moving spontaneously was assigned a score of 5.3 compared to a score of 4.1 when its movement was elicited. Consistent with Stewart (1984) and Richards & Siegler's (1986) findings that the source of movement (internal vs. external) affects the animacy judgement, our results indicate that the source of movement also influences the perception of life properties. The type of movement manipulation for the contingency condition in the present study similarly affected the attribution of life properties (a score of 4.6 for the goal-oriented display compared to a score of 3.9 for the random display). Having only examined the "is it alive?"

question, Richards & Siegler's (1986) did not find that goal-orientation significantly affected the perception of animacy. Our results tend to indicate, however, that subjects use goal-orientation, or dependency in the movement between two objects, as a criterion for attributing life properties to an object (see Appendix III for mean scores).

In contrast to the findings with the life attributes scores, our predictions for the animacy judgement were only partially confirmed. For all age groups, the stimulus with animate-type movement (be it spontaneous, goal-oriented, angular or all 3 collapsed) was considered alive significantly more often than the stationary stimulus. This result confirms the hypothesis that animate-type movement induces more of a tendency to perceive an object as alive than no movement at all. Contrary to our predictions, however, the perception of animacy did not vary across the two types of movement (animate vs.inanimate) at any age level. Even when each movement condition was analyzed separately (autonomy, contingency, direction) and collapsed across ages, no significant differences between the two types of movement appeared. Consistent with these results, Bullock (1985a) found that only four year olds gave undue weight to movement characteristics. As early as age five, children relied more on object type (living vs. non-living) than on type of movement (spontaneous vs. elicited) to decide if an object is alive or not. Bullock's subjects, however, could rely on other perceptual features of the object to judge its animacy since the stimuli were relatively familiar to the children. In our study, object type was not available as a categorization criterion since subjects were presented with a completely unfamiliar stimulus.

Our results are nevertheless surprising in the light of research findings from studies in which an artificial computer generated stimulus was manipulated. As in the present study, Richards & Siegler (1986) found no differences in children's animacy judgements between the goal-directed and random displays. But, when they contrasted spontaneous and elicited movement, the animacy judgement of 7 and 8 year olds as well as 9 and 10 year olds were influenced by the type of movement.

It must be said that their stimuli were different from the ones manipulated in the present study. As in our display, spontaneity was illustrated by having the rectangle start moving without any apparent external impetus. Contrary to the elicited movement display in the present study, where the stimulus was being pulled by a rope, Richards & Siegler (1986) had a little man pushing it. The presence of the person on the screen illustrated very clearly that an external agent was causing the object to move. Young children understand well the notion of human agency (Shultz & Kestenbaum, 1984) which, in the display, made quite salient the distinction between the agent and the patient (object which is acted upon; see Lempert, 1989). Our spontaneous movement display did not feature a salient agent as the cause of movement.

Stewart (1984) also showed that spontaneity of movement influences the animacy judgement, although she only tested adults. This discrepancy in results might be explained by minor differences in the elicited movement display: in the present study, a rope pulled the object while a stick pushed it in hers. An examination of the animism scores nevertheless indicates that our manipulation was successful in that adults tended to attribute more life properties to the stimulus with spontaneous movement (a score of 3.7) than to the stimulus with elicited movement (a score of 2.9).

Consistent with our study, results from Stewart's (1984) direction and contingency conditions indicated no differences in adults' perception of animacy (alive vs. not alive) between the animate- and inanimate-type movement displays. Interestingly, however, Stewart found that the formulation of the question and the number of response choices given to subjects affected the results. Indeed, when another group of subjects was offered a broader response set (person/animal, mechanized, don't know, non-alive) for the very same displays, marked differences in the answers to the two types of movement appeared in both the direction and the contingency conditions. Since Stewart did not report statistics in her paper, it remains unclear whether differences in responses were significant between animate- and inanimate-type movement displays. Her results are nevertheless consistent with our findings that the attribution of life properties was more sensitive to the type of movement manipulations than the animacy judgement itself.

Another major purpose of this study, was to investigate age differences in the effect of movement on the perception of animacy. Contrary to expectations, no significant age differences were found in the subject's judgements of whether or not the stimulus was alive. When percentages are examined more closely, the number of subjects judging the stationary stimulus as alive was essentially the same across all age groups. However, for children between the ages of 5 and 7 years judging the animate-type movement displays, there was a sharp decline in the number of subjects judging the stimulus as alive (from 80% in 5 year olds to 62% in 7 year olds) while there was virtually no change for the inanimate-type movement displays (from 60% in 5 year olds to 66% in 7 year olds). Consistent with our hypotheses, the greatest difference thus tends to occur for 5 year olds whose perception of animacy is more often misled by animate-type movement than that of older children and adults. However, such a pattern was not observed for the attribution of life properties. Although we found an age effect, there was no interaction with type of movement. As with the "is it alive" question, type of movement did not significantly differentiate the age groups: subjects' willingness to attribute life properties to a stimulus with animate-type movement did not vary across age levels.

Contradictory results emerge from the literature concerning age differences in the perception of animacy. Our failure to find significant age differences supports Bullock's (1985a) results showing that five year olds consistently performed nearer adult levels than 3 and 4 year olds. These findings thus seem to indicate that whatever developmental changes occur during this period, they emerge before the age of five. Bolivar (1987; 1988) also failed to detect age differences in the number of animate labels produced by her subjects (grade 1 to adulthood) in stories they told about the displays. She found, however, that children improved with age in their ability to match their story to the actual movements depicted in the displays, with adults showing the most consistent match.

Other researchers have found some differences across ages (Richards & Siegler, 1986). Autonomy of movement was not associated with the life judgement in 5 and 6 year olds, while it was strongly associated in 7 & 8 year olds and influenced 9 and 10 year olds' judgement only in a minor way. These findings support the Piagetian conclusion that children younger than 8 years do not yet distinguish different types of movement, movement alone being sufficient to produce an animacy judgement. Yet, contrary results from Bullock's

(1985) work show that 4-year old children are misled by spontaneous movement when judging the animacy of familiar objects while 5 year olds are not. This indicates that, in her study, the distinction between different types of movement was mediating the animacy judgements of young pre-school children. In the present study, 3-year olds showed no understanding of the life concept while 5-year olds exhibited only a mild animistic tendency when observing a stimulus with animate-type movement. Had we included a sample of 4 year, we might have found a more definite and conclusive age effect, as did Bullock (1985).

Differences at higher age levels are nevertheless reported by researchers using other methods to assess the role of movement in the perception of animacy. Richards & Sieglers (1986) show, for example, that movement was the most important life criterion listed by children up to age 11, while adults listed it in fifth place. One would have thus expected adults' animacy judgements to be less influenced by the type of movement than children's. It seems, however, that inferring animacy and properties of life from observing the movement and shape of a stimulus constitutes a different operation from having to list attributes defining the concept alive (see Massey, 1989, for example).

It must be noted that the stimuli manipulated in the present study varied only along two dimensions, colour and movement. We might conclude that even adults will rely on the rule of movement to classify objects as animate and inanimate when no other properties are available. Richards & Siegler (1986) found, for example, that adults gave autonomous movement as high a life attribution score as did 4 and 5 year olds when evaluating stories in which only two properties of a unfamiliar object were mentioned.

The conclusion that even adults rely on the rule of movement to classify objects as alive or not alive, is supported by the analysis of the justifications subjects produced for their animacy judgement. For the animate-type movement, subjects in all age groups gave movement as the most important justification for their answers. The effect was weaker for the inanimate-type movement with only 7 year olds and adults producing movement as the most important type of justification. Moreover, in the absence of movement, the frequencies of movement justifications diminished considerably. Taken together, the analysis of judgement justifications supports the hypothesis that many subjects at each age level were using movement as a criterion to classify the objects as animate or inanimate.

It must be noted that very few 5- and 7-year old children specified the type of movement when justifying their animacy judgement. They simply said that it was alive because it moved. More nine year olds produce answers referring to the cause of movement of the object (self-initiated or not), but these still constituted a minority of answers. Adults dramatically distinguished themselves from the children in that the vast majority of them specified the type of movement when giving a movement justification for either the animate or inanimate displays.

In their study, Sharp et al. (1985) found that subjects aged 5 to 9 years referred to general movement explanations when attributing life to inanimate moving objects (rock, car, airplane) and rarely referred to the cause (internal/external) of movement. The authors concluded that children only demonstrate the more sophisticated Piagetian reasoning (specifying the spontaneity of movement) when it was necessary, but that general movement explanations were usually deemed sufficient. They noted for example that if a child had already declared that a rock is not alive because it cannot move, the child would add that the rock cannot move on its own if the experimenter set it in motion. Gelman, Spelke & Meck (1983) reported that preschool children occasionally referred to the source of an object's movement such as declaring that a doll cannot walk unless someone moves it. These findings support the conclusion that some children, at least, are aware of distinctions between types of movement, i.e. are aware that movement can either be internally caused or caused by an outside agent.

In our study, age differences in subjects' reference to the source of movement when justifying their animacy judgement are consistent with Piaget's animistic stages. He postulated that only starting at the ages of 8 or 9 do children use the rule of autonomous movement, while younger children simply use the rule of general movement. It may be that these stages reflect more a development in the ability to articulate justifications rather than in an inability to master the distinction between types of movement (autonomous vs. elicited).

For example, Tunmer (1985) found that there was often a discrepancy between children's justifications and their life judgements. Older children who were better at detecting anomalous sentences also provided correct and well articulated justifications for their decisions. Younger children who correctly identified anomalous sentences often provided inappropriate explanations or no reasons at all.

Another interesting age difference was observed in the present study. Five year old children attributed more mental states to objects, regardless of the type of movement or of the condition, than any of the other age groups. More surprising was the finding that five year olds also attributed mental states to the table, a very familiar inanimate object, while no adults or other children ever did. Fifty percent of 5 year old children said that the table could cry, remember or want while 20% said it could talk. This finding seems anomalous in light of past research. Carey (1985) and Gelman, Spelke & Meck (1983) report that, by age five, children tend to be quite accurate in their denial of mental states to inanimate objects. Carey's (1985) data shows, however, that the question can have an effect on children's responses. For example, some four year olds said that a cloud and a harvester can "get hurt". It may be that our mental state questions appeared confusing to 5 year olds.

Piaget (1930) had himself noted that most children attribute life to fewer objects than they attribute consciousness. He added that the notion of consciousness seems to have a wider extension for the child than the notion of life and that this was particularly striking in younger children. As we have seen, however, Piaget's methodology was criticized as being too complex and confusing for the verbal capacities of young children. In a more recent research, Tunmer (1985) also found that the animate-inanimate distinction (ages 4-5) is acquired before the sentient-nonsentient distinction (ages 6-7), indicating that the ability to distinguish objects which possess mental states from those which do not, seems to develop between the ages of 5 and 7 years. But, like Piaget, Tunmer used anomalous sentences as stimuli which may have required more sophisticated verbal skills than 5 year olds possess.

Other age differences in the application of the sentient-nonsentient distinction appeared in our sample of subjects. When correlating the life judgement with the cognitive score, at no age level were children's animacy judgements significantly associated with the cognitive score for any of the three types of movement. In contrast, adults showed consistency in their answers to the animate-type movement displays. If they said that the animatedly moving object was alive, they were also likely to attribute it cognitive properties and vice-versa. This indicates that adults are more likely than children to attribute sentient properties to objects seen moving in an animate-type pattern while they are less likely to make such attributions to objects moving in an inanimate-type pattern. These observations indicate that adults better master the sentient-nonsentient distinction.

This hypothesis is corroborated by justifications subjects gave to the life judgement. Adults distinguished themselves from children in that they primarily produced mental state explanations when justifying their life judgement in the animate-type movement (spontaneous) of the autonomy condition and the animate-type movement (goal-oriented) of the contingency condition. Only the older children, nine year olds, also produced a substantial number of mental state justifications but only for the goal-oriented display. Conversely, adults produced very few mental state justifications when assessing the object with inanimate-type movement. Adults are thus using type of movement as a criterion to discriminate sentient from nonsentient objects while children younger than nine seem rather oblivious to this distinction.

When attributing biological and inanimate properties to objects they label as alive or not alive, adults showed consistency for all three movement types. If an object is labelled as not alive it will be denied biological properties while it will be attributed inanimate properties and vice versa. For children at all age levels, consistency was only achieved with the stationary stimulus (and the inanimate-type movement for 7 year olds), indicating that children of all ages say that the stationary stimulus is not alive and also deny it biological properties while attributing it inanimate properties. For the moving stimuli, however, a number of children who say that the object is alive, deny them biological properties and may attribute them some inanimate properties. This indicates that movement is associated with life. It also indicates, however, that in the absence of familiar perceptual features, a number of children will be somewhat confused about the properties possessed by the object. Our results show that it is misleading to rely exclusively on the animacy question, as so many authors have done, to conclude on children's knowledge of life. Children's judgement that an object is alive or not alive reveals little about their understanding of the properties associated with the life concept.

It should be pointed out that, in our study, the animism scores assigned to the artificial stimulus are low when compared to the attributes accuracy scores for the familiar objects. The high accuracy of even 5 year old subjects in attributing properties to familiar objects (especially the person and the dog) suggest that children do have knowledge of these biological properties. The fact that they can label an unfamiliar artificial stimulus as alive while denying it defining biological life attributes indicates that these children do not fully master the criteria of life. Our results show the importance of using unfamiliar stimuli as a means to access the inferential process involved in distinguishing animate from inanimate objects.

Our results support Carey's (1985) contention that children do not really understand the defining attributes of life before the age of ten, tending to rely on previous knowledge to infer properties before this age period. In fact, Carey (1985) showed that preschool children underattribute life properties to animate objects which do not resemble people. The stimulus used in the present study may have looked so different from prototypical objects that even older children underattributed life properties to it. This hypothesis might have been tested more conclusively if children in our study had been asked to identify or label the stimulus at the end of the testing session. This dissociation between children's attribution of life and their attribution of life properties may be explained by Massey & Gelman's (1988) suggestion that aspects of the animate-inanimate distinction (biological and other properties) which are further removed from cause of movement, develop relatively late.

It might also be suggested that these low scores may have been a function of the medium and of the artificiality of the stimulus. Subjects were not judging real objects moving. They were judging two-dimensional images moving on a computer screen and might have experienced some confusion as to whether their responses applied to the referent of the image or to the image itself. Although research in the field of adult causal processing shows that solid objects are unnecessary for producing an impression of causality (Michotte, 1963; White, 1988), the perception of animacy and life attributes may be more sensitive to the medium. The manipulation of three-dimensional objects might have yielded higher scores.

It is clear from the present study that movement plays a role in the categorization process of animate and inanimate objects. But, given the overall low animism scores, it might be suggested that movement in itself does not provide sufficient information to convince the child that the object is truly alive or that it possesses properties of life. It seems that, even for 5 year old children, other features must also be involved as their low scores for the artificial stimuli indicate. In their work with static pictures, Massey & Gelman (1988) found that children relied on clusters of features to distinguish animates from inanimates.

In a future study, researchers might want to systematically manipulate various features, including movement, to determine which features seem most salient in the categorization of the world into animate and inanimate objects. We have seen that even adults use movement when no other criterion is available. Will they also use another feature, such as texture for instance, if no other feature is made available? Such manipulations would help determine the importance of the movement rule in the perception of animacy. If children younger than 12 are really pre-causal and bound by the rule of movement, as suggested Piaget, the manipulation of movement should show larger effects on the perception of animacy in children below this age level than the manipulation of other features.

Our results show that the animacy judgement reveals little about the child's understanding of the defining properties associated with the life concept. Future studies should therefore include questions pertaining to life properties and should also include a group of children aged 10 to 12 years. As we have seen, Carey found that only by age 10 do children understand the life concept and Piaget reported that only by the age of 12 does animism abate. Testing children at this age level would allow to verify if the shift in the understanding of the life concept proves to be more dramatic between the ages of 9 and 11 years than between the age of 11 years and adulthood.

Our results also point to the importance of including both familiar objects and questions pertaining to inanimate properties as a means to guard against subject response bias. The inclusion of such questions enabled us to determine that three year olds were perseverating in their "yes" responses and not truly demonstrating an understanding of the questions as they applied to familiar objects. It remains unclear whether a task containing fewer verbal requirements would have revealed a firmer understanding of the life concept in these young pre-school children. The administration of a sorting task with pictures or of a task comprising a forced choice response measure (as did Massey, 1989) might answer this question.

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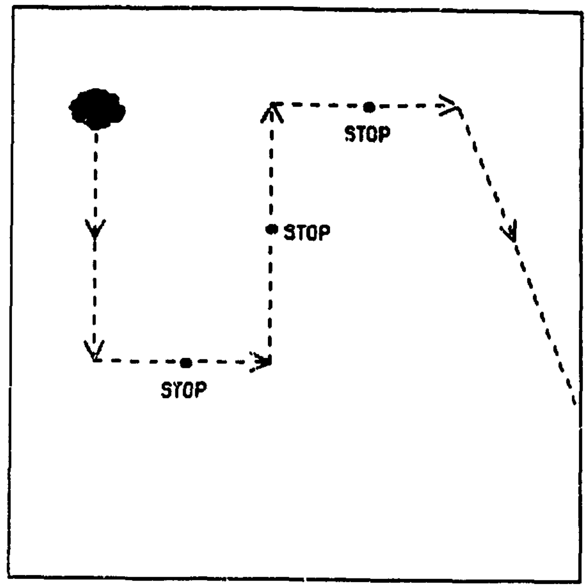
APPENDIX I

DRAWINGS OF THE SIX MOVEMENT DISPLAYS

APPENDIX I

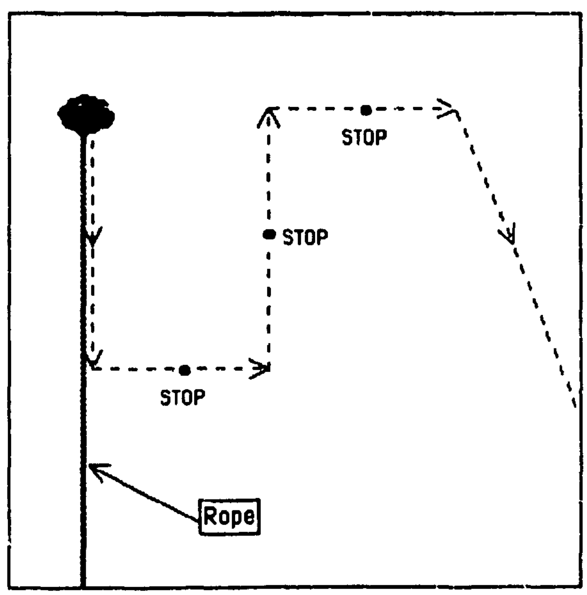
1) AUTONOMY CONDITION

1(a)



SPONTANEOUS
(Animate-Type)

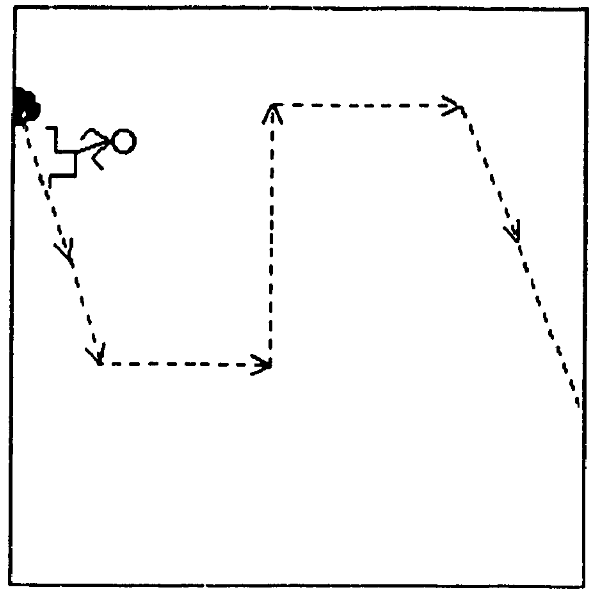
1(b)



ELICITED
(Inanimate-Type)

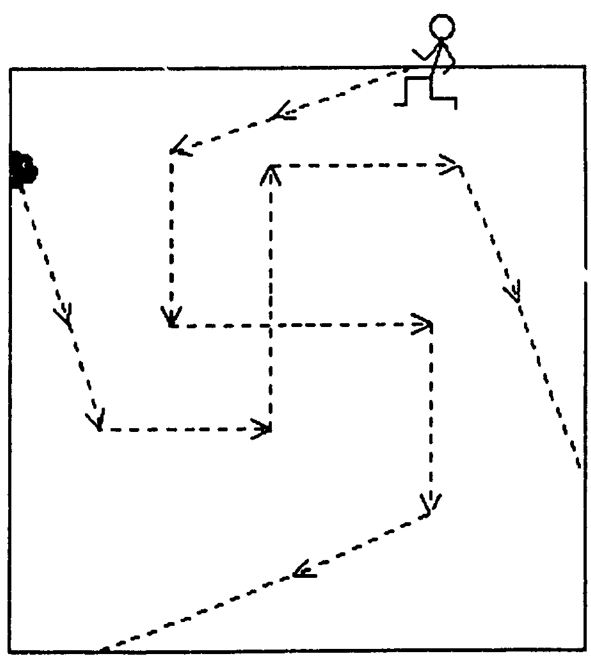
2) CONTINGENCY CONDITION

2(a)



GOAL-ORIENTED
(Animate -Type)

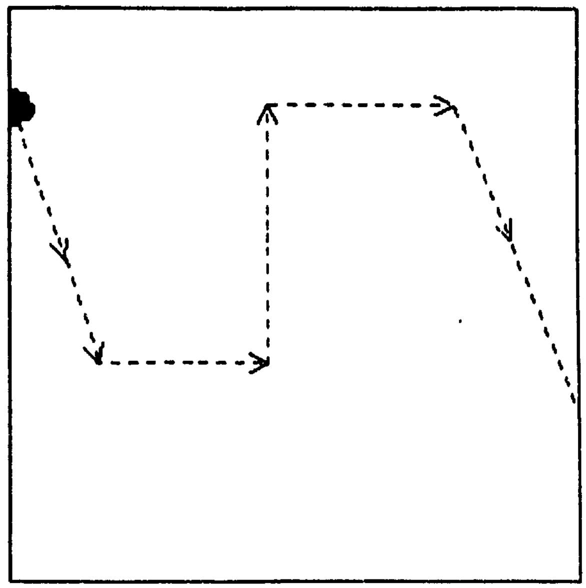
2(b)



RANDOM
(Inanimate-Type)

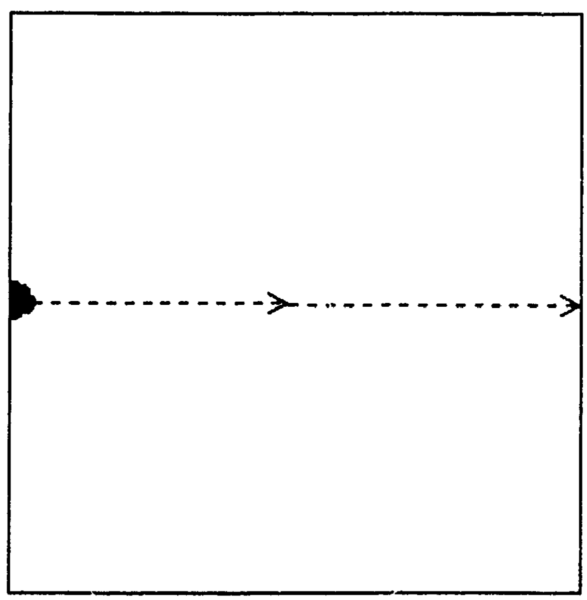
3) DIRECTION CONDITION

3(a)



ANGULAR
(Animate-Type)

3(b)



LINEAR
(Inanimate-Type)

APPENDIX II

DATA ON FAMILIAR OBJECTS.

APPENDIX IIa

Proportion of Subjects in Each Age Group who Correctly Judged Each Familiar Object as Animate or Inanimate.

AGE	STATIC FAMILIAR OBJECT		
	CHILD	DOG	TABLE
3	90	60	60
5	100	100	90
7	100	100	90
9	100	100	100
ADULT	100	100	100

Note: Each familiar object was presented to 10 different subjects at each age level. Underlined proportions are significantly greater than chance according to the binomial expansion ($p<.01$).

APPENDIX IIb

Mean Correct Scores to Biological and Inanimate Questions for Familiar Objects as a Function of Age.

STATIC FAMILIAR OBJECT	AGE 3	5	7	9	ADULT
CHILD					
BIOLOGICAL	4.0	3.9	4.0	4.0	3.9
INANIMATE	0.6	3.5	4.0	3.8	4.0
DOG					
BIOLOGICAL	3.1	4.0	4.0	4.0	4.0
INANIMATE	2.0	3.6	4.0	4.0	3.5
TABLE					
BIOLOGICAL	1.7	3.0	3.8	3.9	4.0
INANIMATE	3.5	2.9	3.2	3.2	4.0

Note: Maximum score = 4. Mean scores are computed across ten subjects at each age level for each object (N=150).

APPENDIX III

MEAN ANIMISM SCORES

APPENDIX IIIa

Mean Animism Scores as a Function of Age for the Autonomy Condition.

AGE	n	TYPE OF MOVEMENT		
		STATIONARY	INANIMATE (Elicited)	ANIMATE (Spontaneous)
5	(10)	4.4	4.3	5.3
7	(10)	3.8	5.2	5.3
9	(9)	4.2	4.0	6.7
ADULT	(10)	1.2	2.9	3.7
TOTAL	*(39)*	*3.4*	*4.1*	*5.3*

NOTE: Maximum score = 12.

APPENDIX IIIb

Mean Animism Scores as a Function of Age For the Contingency Condition.

AGE	n	TYPE OF MOVEMENT		
		STATIONARY	INANIMATE (Random)	ANIMATE (Goal-oriented)
5	(8)	4.9	6.0	6.3
7	(10)	4.2	3.6	3.7
9	(10)	3.4	2.8	3.2
ADULT	(10)	2.1	3.1	5.1
TOTAL	*(38)*	*3.7*	*3.9*	*4.6*

Note: Maximum score = 12.

APPENDIX IIIc

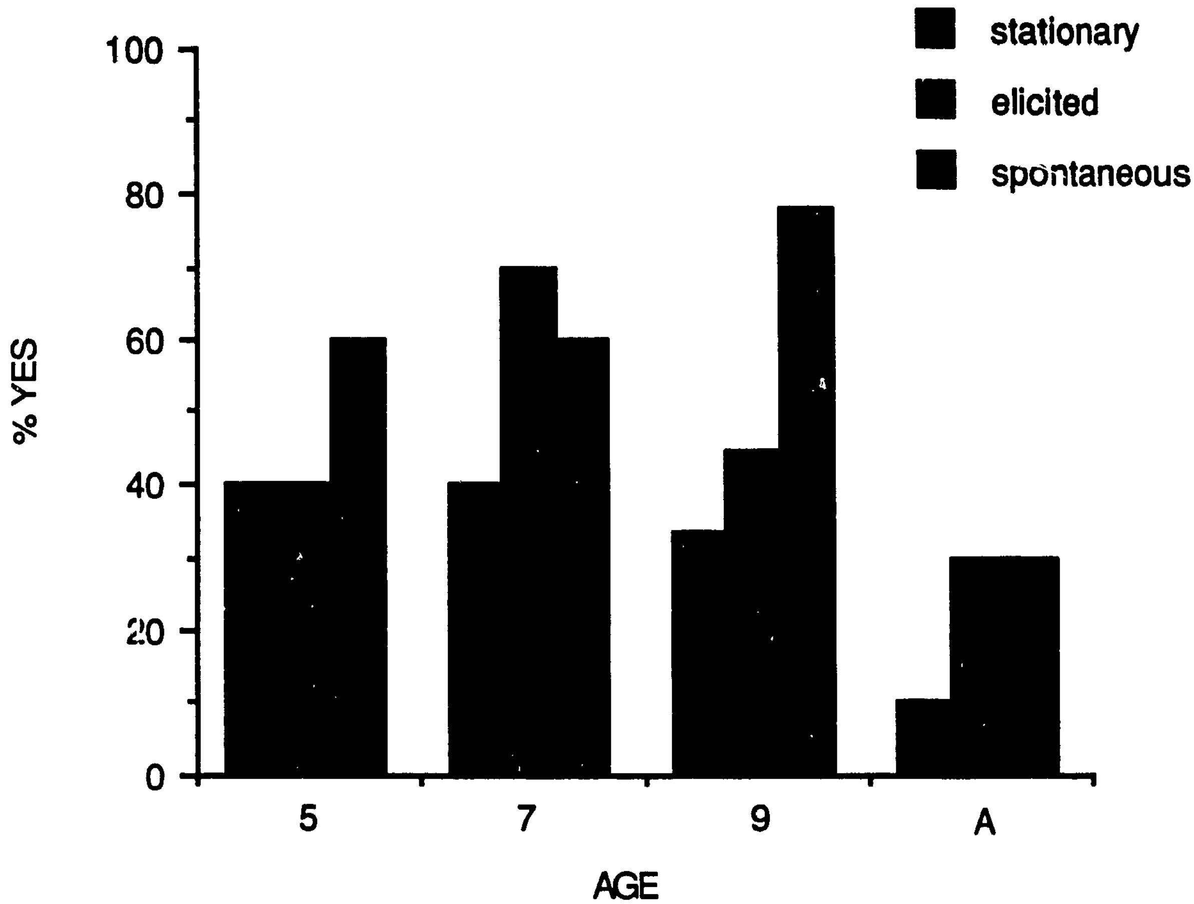
Mean Animism Scores as a Function of Age for the Direction Condition.

AGE	n	TYPE OF MOVEMENT		
		STATIONARY	INANIMATE (Linear)	ANIMATE (Angular)
5	(7)	5.3	7.7	6.9
7	(9)	2.1	3.3	2.9
9	(10)	3.3	2.7	2.2
ADULT	(10)	3.1	3.5	3.2
TOTAL	*(36)*	*3.5*	*4.3*	*3.8*

Note : Maximum score = 12.

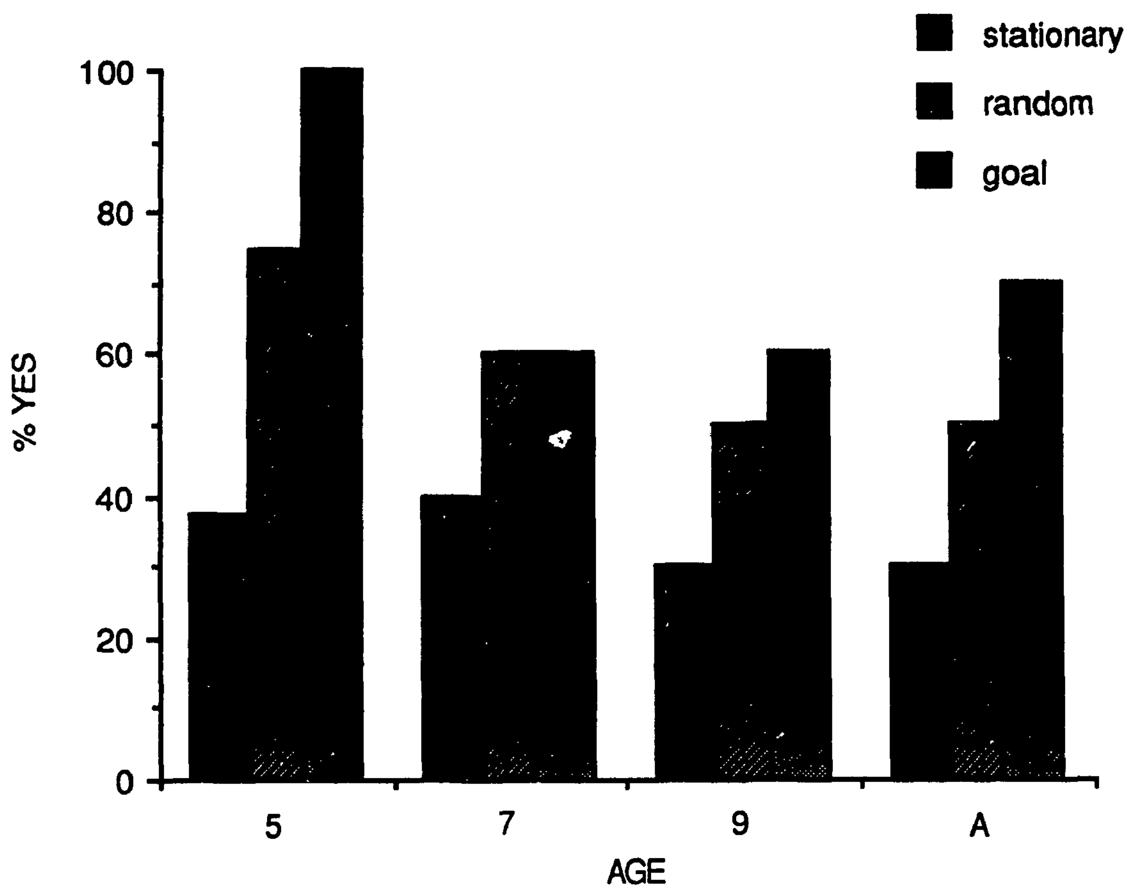
APPENDIX IV

PERCENTAGE OF POSITIVE RESPONSES TO THE ANIMACY QUESTION



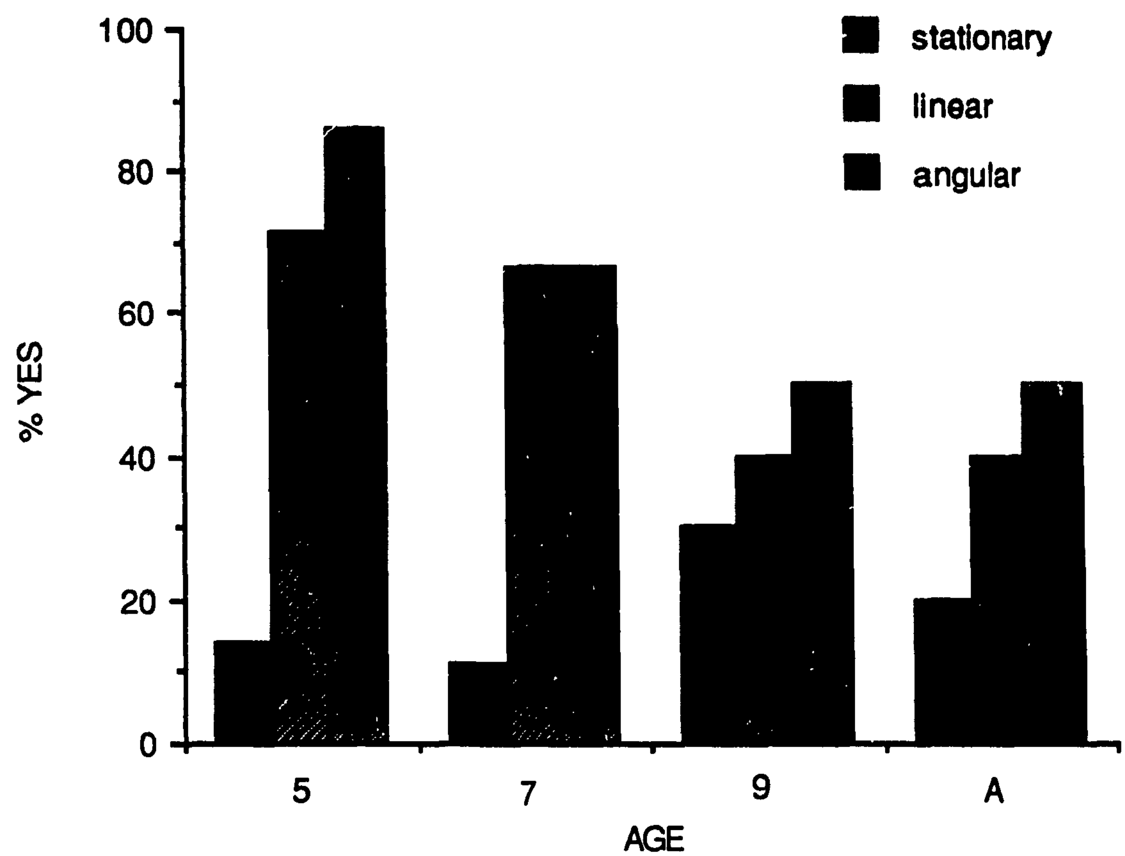
Percentage of positive responses to the animacy question as a function of age for the autonomy condition.

APPENDIX IVb



Percentage of positive responses to the animacy question as a function of age for the contingency condition.

APPENDIX IVc



Percentage of positive responses to the animacy question as a function of age for the direction condition.