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ABSTRACT

The relationship between language, thought, and concept formation has been a central issue in many studies and theoretical discussions in various domains--philosophy, psychology, anthropology, and linguistics. The relation between language and concept development can be framed as two opposing questions: (1) Does the child learn concepts first and then later attach words to them? or (2) Are concepts formed when a child tries to attach meanings to words she hears? The purpose of this study was to investigate the relationship between language and the development of children's conception of plants as living things. This was done by comparing the responses of children with different mother tongues (Hebrew and English) to different tasks (verbal and non-verbal) related to the conception of plants as living things. The children (N=696) were from each of grades 2, 3, 4, 5, and 6 in Canada and Israel. It was found that both groups of children were less successful in the non-verbal task than in the verbal task, and that Hebrew-speaking children performed at a lower level than English-speaking children in both the verbal and non-verbal tasks. These findings suggest that the difficulty in classifying plants as living things is conceptual in origin and may also suggest that language affects concept development on both the verbal and perceptual levels. (KM)

LANGUAGE AND CHILDREN'S CONCEPTIONS OF PLANTS AS LIVING THINGS

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Introduction

The relationship between language, thought and concept formation has been a central issue in many studies and theoretical discussions in various domains: philosophy, psychology, anthropology, linguistics, etc.

The inter-relations between thought and language are very complex and most difficult to investigate experimentally (Vygotsky, 1962). This issue is also discussed in the literature on the development of scientific concepts, e.g. the concept of life (Piaget, 1973; Carey, 1985).

The relation between language and concept development can be framed as two opposing questions. Does the child learn concepts first and then later to attach words to them or, are concepts formed when a child tries to attach meanings to words she hears (Brown, 1958)? In other words, is the concept system built from words or is the word system built from concepts? It seems that the answer lies somewhere in the middle and that language interacts somehow with the development of concepts in children. The purpose of the present study is to investigate the relationship between language and the development of children's conception of plants as living things. This was done by comparing the responses of children with different mother tongues (Hebrew and English) to different tasks (verbal and non-verbal) related to the conception of plants as living things.

"Living thing" (or "Organism") is one of the central concepts in every domain of the life sciences. The concept of "living thing", in contrast to that of "non-living thing", concerns all objects that possess certain attributes which are characteristic of the phenomenon of life. Animals as well as plants possess these attributes and both groups are included in the concept of living things.

Understanding this basic fact is of crucial importance for learning the life sciences. But, although this seems to be obvious to most adults, it was suspected that the fact that animals and plants are both living things is not accepted easily by children in Israel. In the framework of developing life science learning materials, it became apparent to us that many 10-12 year olds have difficulties in perceiving plants as living things. For example, quite a few children in this group thought that seeds originate in shops or factories and that flowers, even wild ones, grow in the fields only because men planted them there or because they are the direct product of the earth (similar to what was reported by Piaget (1973/1929)). The same group of children had an entirely different attitude to animals: they knew for instance that worms found in fruit and rotten meat had originated from animals, such as flies, that had been there before, and not from the fruit or the meat

itself. Pupils in junior high schools (13-15 year olds) even verbally stated that they would not call plants living things. As one of them put it: "Plants are something half-way between the living and the inanimate".

In the literature on the development of the concept of life, little attention has been paid to children's views of the life status of plants. Piaget (1973/1929) and other Piagetian-oriented investigators did not distinguish between children who classified animals solely as living things and those who classified plants as well as animals as living things: all children were supposed to be at the fourth and the last stage of the development of the concept of life.

Richards and Siegler (1984) as well as Carey (1985), who did distinguish between children who attributed life to animals alone and those who attributed life to animals and plants, found that by the age of ten almost all recognized that plants and animals are both living things. Our own observations, as stated above, were different. Therefore, we systematically examined the attitude of Israeli 6-15 year olds to find out whether or not they perceive plants, as well as animals, as living things (Stavy and Wax, 1989). Children between grade levels K to 8 (30 from each of the 9 grade levels) were asked to classify pictures of animals, plants and inanimate objects according to whether they were alive and possessed the following attributes of life: growth, breathing, feeding and reproduction. The results indicated that even among 6th grade children (11-12 year olds), more than 40% do not consider plants as living things which possess attributes of life. Some of the children who misclassified plants classified them as non-living things, others as falling within a third category of the neither living nor non-living. Children's explanations to their correct classifications were different for animals and plants. For animals mainly: movement, feeding and breathing; for plants mainly growth. As suspected, Israeli children's behavior contradicted that of children from other countries (Richards and Siegler, 1984; Carey, 1985; Inagaki and Hatano, 1987) who were reported to have succeeded far better in similar tasks. In order to verify these findings, an international cross-cultural study was carried out. In this study the same methods were applied to children in the USA (by Richards and Siegler), Japan (by Hatano et al.) and Israel (by Stavy and Wax).

Forty children from each of the grades K, 2 and 4 in each of the above mentioned countries were asked to define the life status of people, animals, plants and inanimate objects, and to answer related questions such as Can they die? Do they grow? and so on (Siegler, Richards, Hatano, Stavy and Wax, in preparation).

Table 1: Percentage of Correct Classifications of Each Group of Objects according to their Life Status by Grade and Nationality

	People			Other Animals			Plants			Inanimate		
Grade	J	US	I	J	US	I	J	US	I	J	US	I
K	100	100	92	98	99	92	66	68	58	80	96	82
2	100	100	100	97	99	100	72	88	59	94	99	98
4	100	99	100	100	100	100	91	98	59	92	100	100

The results presented in Table 1 supported our previous findings that Israeli children less successfully classified plants as living things than did children from the US and Japan.

Rules analysis (Siegler, 1976; Richards & Siegler, 1984) was also performed on the patterns of each child's life judgments. Four major rules were anticipated: 1) The People Rule (people alone have life); 2) The People and Other Animals Rule (people and other animals alone have life); 3) The People other Animals, and Plants Rule (people, other animals, and plants have life); and 4) The Everything Rule (everything has life). Children were classified as using a rule if their judgements matched the predictions of that rule on all eight items examined. Table 2 shows the distribution of children in each of the rule-patterns according to grade and nationality. This analysis again revealed that Israeli children were less successful in attributing life to plants.

Table 2: Distribution of Children in the Different Rule-Patterns according to Grade and Nationality

	ISRAEL			JAPAN			US		
	K	2	4	K	2	4	K	2	4
People Rule	0	0	0	0	0	0	0	0	0
People & Animals Rule	24	25	30	23	14	3	25	5	0
People, Animals, Plants Rule	24	38	48	30	56	79	55	78	95
Everything Rules	8	0	0	10	3	6	3	0	0
Other	45	38	23	38	28	12	18	18	5

It was suggested that the use of the Hebrew language might inhibit Israeli children from attributing life to plants. In Hebrew there are three basic concepts which relate to the life status of objects: animal (Chai - the same word in everyday speech may also mean "alive", or Baal-Chaim - which literally means owner of life [Baal=owner, Chaim=life]), plant (Zomeach - this word unlike the word for animal is not derived from the word for "life", the same word is also used as a verb which means grow and refers only to plant's growth - vegetate) and inanimate (Domem- which may also mean silent or still and its root is the same for bleed). In English, however, there is only one basic concept related to the life status of objects - Living, and a derived one, Non-living: plants and animals are two subordinate concepts within the living things. Moreover, in Hebrew the word for tree (Etz) means tree as well as wood (a substance). In addition the verbs describing plants growth and death are different in Hebrew from those for animals (grow for animals - Gadel, for plants - Zomeach; die for animals - meth, for plants - novel). One can use the animal verbs to describe plants, however, the use of plant words to describe animals is metaphorical. (It is usually used for growth of nails or hair.) In addition, the Hebrew language differentiates between the genders of animals (in those cases where the differences are perceptible), but does not do with plants (even in those cases where they are perceptible). The differentiation between plants and animals referred to above can be found also in the Bible: "And to every beast of the earth, and to every bird of the heavens, and to everything that creepth upon the earth, wherein there is LIFE, I have given every green herb for food, and it was so" (Genesis 1,30).

Clearly, the 'non-living' green herb is just food for the things in which there is life.

A problem as to whether Israeli children's difficulty in classifying objects according to whether they are living or not, is conceptual in origin or constitutes a direct association response to the use of the words "alive", "living", "Life" etc. in the task itself, was raised. To avoid the influence of the use of these words a further study was carried out. Hebrew speaking children in Israel and English speaking children in Canada were asked to distinguish between the two groups: "animals and plants" and "inanimate objects" without the use of these words ("non-verbal" task). This was done by asking children to single the odd one out among three pictures showing an animal, a plant and an inanimate object and to explain their choice. Then they were asked to classify animals, plants and inanimate objects into living and non-living and to explain their decision ("verbal" task).

Method

Subjects

Children from each of the grades 2,3,4,5,6 in Canada and Israel were tested. Children in Israel were from three elementary schools in the vicinity of Tel Aviv. Children in Canada were

from three elementary schools in Vancouver, British Columbia. The distribution of the research population according to grade and nationality is present in Table 3.

Table 3: Distribution of the Research Population according to Grade and Nationality

Nationality	Grade 2	3	4	5	6
Canadian	48	101	70	69	67
Israeli	75	67	72	66	61

The Tasks

Paper and pencil questionnaires were administered to all children. Two tasks were presented: a non-verbal task and a verbal one. The non-verbal task was first presented followed by the verbal one.

The Non-Verbal Task

Children were presented with three pictures showing a dog, a tree and a rock. They were asked to circle the picture which does not belong and to explain why they thought it does not belong.

The Verbal Task

Children were asked to classify different items (animals, plants and inanimate objects) into living and non-living. Children were asked, 'Is X a living thing?' and 'What makes you think so?'. These questions were asked about six animals (men, cats, birds, fish, flies, and worms), four plants (flowers, trees, bushes, and grass), and six inanimate objects (fire, clouds, cars, hammers, tables, and stones). Questions about these objects were presented in random order.

Results

The Non-Verbal Task

As can be seen in Table 4 the percentage of Israeli children who though that the rock was the exceptional among the three presented objects (rock, dog and tree) is significantly lower than that of Canadian children, in all grade levels except for the sixth when they compare. In both

groups a very small number of children chose the tree while the majority of those who did not chose the rock, chose the dog.

Table 4: Percentage of Children who Singled out the Rock the Dog or the Tree as the Odd One by Grade and Nationality

Grade	2		3		4		5		6	
Nationality	Isr.	Can.	Isr.	Can.	Isr.	Can	Isr.	Can	Isr.	Can.
Rock%	29	63	37	58	26	51	33	54	56	51
χ^2	11.869		6.355		8.697		4.849		0.150	
p	.0006		.0117		.0032		.0276		N.S.	
Dog%	64	31	51	41	66	40	56	46	30	49
Tree%	3	6	4	1	3	9	2	-	-	-

Children's explanations of their choice were similar in both groups. Children who chose the rock mostly used "scientific" explanations: "the rock is not alive", "is not living", "does not die", "does not eat, grow, breath, etc.", "does not move".

Children who chose the dog usually referred to its being alive or its being an animal: "it is alive", "it is a living thing", "it eats, blows air, etc.", "it is an animal", "it walks, runs, etc.", "it moves", "it makes noise" or "it has fur, feet, tail, etc." . Many children, especially in Canada, related to other properties of the dog such as "it is not a part of nature" (this explanation had two meanings; the younger children thought that dogs are not made by nature but by a mother dog, while the older children thought that a dog does not live naturally outside in the wild but is grown by people), "it is not part of soil or earth", or "it does not live outside".

The Verbal Task

Table 5 describes the percentage of Israeli and Canadian children who correctly classified the different animals, plants and inanimates according to their life status. As expected Israeli and Canadian children did not differ in their ability to distinguish between animals and inanimate objects and that majority of them succeeded in doing so at all grade levels. However, Canadian

children significantly outperform Israeli children in their ability to classify plant as living things. (χ^2 test - for flower: 2nd grade p=.0148, 3rd grade p=.0000, 4th grade p=.0000, 5th grade p=.0000, 6th grade p=.039; for grass: 2nd grade p=.0017, 3rd grade p=.0000, 4th grade p=.0000, 5th grade p=.0000, 6th grade N.S.; for tree: 2nd grade p=.0022, 3rd grade p=.0000, 4th grade p=.0000, 5th grade p=.0000, 6th grade N.S.; for bush: 2nd grade p=.0283, 3rd grade p=.000, 4th grade p=.0000, 5th grade p=.0001, 6th grade N.S.)

Table 5: Percentage of Correct Classifications of Each Group of Items according to their Life Status, by Grade and Nationality

Grade	2		3		4		5		6	
Nationality	Isr.	Can.	Isr.	Can.	Isr.	Can	Isr.	Can	Isr.	Can.
ANIMALS (average)	**99**	**90**	**100**	**97**	**99**	**96**	**99**	**99**	**99**	**98**
cat	100	94	100	99	100	99	100	100	98	100
boy	99	96	100	99	100	99	99	100	98	99
fly	100	92	100	96	100	97	99	97	100	97
bird	100	96	100	97	99	99	100	99	100	96
fish	100	96	100	95	97	91	100	97	100	99
worm	99	98	100	93	100	93	99	99	100	97
PLANTS (average)	**46**	**73**	**41**	**87**	**49**	**85**	**64**	**95**	**74**	**85**
flower	49	75	43	93	55	90	64	96	75	90
grass	43	70	40	85	48	86	61	93	74	84
tree	49	79	43	88	49	84	65	96	74	90
bush	45	67	37	83	44	81	65	94	72	79
INANIMATES (average)	**91**	**91**	**91**	**89**	**94**	**93**	**94**	**91**	**97**	**89**
cloud	83	73	79	77	85	86	85	84	92	78
car	91	92	93	93	96	99	100	100	100	91
stone	96	96	97	94	99	97	100	96	98	99
fire	81	98	80	87	89	87	82	75	92	75
hammer	97	92	97	93	97	96	100	97	100	96
table	100	94	97	92	97	94	99	96	100	97

Discussion

The results presented above indicate that both groups of children were less successful in the non-verbal task than in the verbal task. This is quite understandable, as there was nothing in the former that could direct them to the properties related to life. The use of language in the verbal task directed children in both groups towards the concept of life. However, Hebrew speaking children performed at a lower level than English speaking children in both the verbal (those which relate to plants) and non-verbal tasks. These results may suggest the Israeli children's difficulty in classifying plants as living things is conceptual in origin. These findings may also suggest that language affects concept development on both the verbal and perceptual levels.

One should be cautious in drawing any of these conclusions, as it is extremely difficult to differentiate between the effect of language and that of culture. Therefore, some additional studies are now carried out with children who speak other languages such as Russian and Arabic and with children who grow up in different cultural environments such as religious versus secular communities.

Most misconceptions and difficulties children encounter in science are very similar throughout the world. They probably originate from our common experience of the physical world. However, our experience in the linguistic-cultural world also affects our worldviews and conceptions. It is therefore important that science educators be aware of the specific difficulties their language can generate, so that they can specifically relate to them. In this line of thought we are now engaged in developing specific learning activities to deal with our specific linguistic problems.

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