Language and the ability to evaluate contradictions and tautologies*

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"Logic does not by any means treat of the totality of things, it does not treat of objects at all but only of our way of speaking about objects; logic is first generated by language. The certainty and universal validity, or better, the irrefutability of a proposition of logic derives just from the fact that it says nothing about objects of any kind."

Hans Hahn (1959)

Abstract

Children were found to experience difficulty evaluating contradictions of the form p & −p, and tautologies of the form p v −p. It was hypothesized that (a) the difficulty of these statements was not due solely to the logical words occurring in them, (b) part of the difficulty is due to the fact that their truth value derives from their linguistic form rather than from empirical considerations, and (c) the ability to examine language in an objective manner, apart from events and objects to which it refers, is necessary but not sufficient for correct evaluation of contradictions and tautologies. The results of two experiments support the hypotheses.

During our informal conversations with elementary school children, we found that they had difficulty judging the truth-value of sentences corresponding to simple contradictions and tautologies. Roughly speaking, a tautological sentence is true by virtue of its logical form. A contradictory sentence is false by virtue of its logical form. Children were asked

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to say "True", "False", or "Can't tell" in response to statements exemplifying such formulas as p & –p, and p v –p.* To use the tautology p v –p as an example, the children failed to recognize the truth of the statement "Either this chip is red or it is not red" (when the chip in question is entirely of one color).

For the most part, the children's poor performance on tasks such as these did not seem attributable to a misunderstanding of the logical words occurring in them ('or', 'and', 'not'). Thus, nontautologous and noncontradictory statements such as "Either this chip is green or it is blue" and "This chip is yellow and it is not red" were readily understood. In addition to the presence of logical words, then, an important variable in these simple problems seemed to be whether the task demanded evaluating a contradiction or a tautology.

As a first step towards explaining this phenomenon, notice that no empirical evidence is required to falsify or verify contradictions and tautologies. Instead, sentences corresponding to these kinds of formulas are true or false by virtue of their linguistic form, rather than deriving their truth-value from any extra-linguistic states of affairs. For the remainder of this paper, contradictory and tautological sentences will be called *nonempirical*, in that their truth value does not depend upon states of the world.**

To illustrate the difference between empirical and nonempirical statements, compare the sentence "This chip is green and it is not green" with the sentence "This chip is green and it is not red". Determining the truth of the latter requires examining the chip in question; determining the truth of the former requires no such examination. This distinction has been the focus of philosophical controversy (Hahn, 1959 ; Quine, 1953), but our interest in it is mainly psychological. In particular, it appeared to us that the children's difficulty with nonempirical statements stemmed from their failure to appreciate just this distinction. The children indiscriminately sought empirical evidence for both types of sentences. Resisting the tendency to seek empirical support for nonempirical sentences requires an ability to examine the form of the statement itself. This ability in turn presupposes that the child can use language not only as a code for reality but also as an object of thought in its own right. The child must be able to reflect upon his language much as he reflects upon more tangible events; he must be able to regard language independently of the reality it refers to. This amounts to the ability to look *at* language rather than *through* it. That children do have trouble considering language in this objective manner has been documented by Piaget (1929). Although the nature of the child's trouble is not clear, two findings bear comment. First, it has been shown that young

*Throughout this paper, we shall follow standard conventions concerning the interpretation of 'p', '&', 'v' and '–'. Thus, p and q stand for propositions; & stands for logical conjunction ('and'); v stands for logical disjunction ('or') ; and – stands for negation ('not').

**We have coined the term 'nonempirical' rather than relying on the terms 'analytic' or 'logical' for three reasons. First, given our theoretical position, stated below, the term 'nonempirical' has mnemonic value. Second, we wish to avoid questions concerning the relationship between analytic and logical sentences. Third, psychologists commonly characterize contingent statements that include logical connectives as 'logical'.

children do not appreciate the arbitrariness of the relation between words and their referents (Piaget, 1929; Vygotsky, 1962). Second, it is well known that children find perceptually immediate events quite compelling (Piaget & Szeminska, 1965; Bruner et al., 1966). It is plausible that they find aspects of linguistic structure less salient.

We summarize the above discussion by stating two hypotheses.

> *Hypothesis 1a:* Children tend to treat contradictions and tautologies as empirical statements.
>
> *Hypothesis 1b:* Much of the difficulty children experience evaluating nonempirical sentences is due to their nonempirical character, and not merely to the logical words occurring in them.

Hypothesis 1 will be called the *nonempiricality hypothesis.*

> *Hypothesis 2:* The ability to examine language objectively is necessary for the ability to correctly evaluate nonempirical statements.

Hypothesis 2 will be called the *objectivity hypothesis.*

The converse of Hypothesis 2 – that language objectivity is *sufficient* for evaluating nonempirical statements – is not implied in our discussion. Among other requirements, it is obvious that encoding the logical structure of the statement is also necessary for distinguishing nonempirical from empirical statements. For complex contradictions and tautologies the encoding requirement might be formidable.

Experiment 1 : The nonempiricality hypothesis

Experiment 1 was designed to test the nonempiricality hypotheses 1a and 1b. In order to test Hypothesis 1a, it is necessary to distinguish subjects who correctly evaluate nonempirical sentences on the basis of linguistic form from subjects who correctly evaluate these sentences by relying on empirical considerations. The latter subjects, right for the wrong reason, do not genuinely comprehend tautologies and contradictions. If a subject recognizes the nonempirical nature of sentences of the form p & –p and p v –p, then withholding the empirical means to judge the truth of p should not interfere with this judgment. Conversely, if we are correct in believing that children tend to treat contradictions and tautologies empirically, then the children should be reluctant to respond either 'True' or 'False' to statements for which the truth of p cannot be determined (responding 'Can't tell' instead). Accordingly, items based on the forms p v –p and p & –p were constructed so that objects referred to in the proposition p were hidden. Questions in which objects referred to are hidden will be called, barbarously, *nonvisible* items.

Hypothesis 1b states that much of the difficulty children experience evaluating simple nonempirical sentences is due to the nonempirical character of these sentences, and not simply to the logical words occurring in them. To test this hypothesis we asked children

to evaluate sentences containing various combinations of the same logical words (i.e., 'and', 'or', and 'not') included in the nonempirical sentences. These control sentences, however, were empirical. If Hypothesis 1b is true then correct evaluation of the control sentences should not guarantee success with the nonempirical sentences.

Method

Subjects: Two classes of second graders, N = 26 (13 males, 13 females) and N = 25 (10 males, 15 females), from a middle class suburban school served as subjects. The mean age for the classes was 7 years, 10 months, and 7 years, 8 months, respectively. No subjects were dropped.

Materials: The materials were small plastic poker chips in assorted colors (each chip exemplified only one color).

Procedure: Each subject was seen individually for one twenty minute session. The chips were placed between the experimenter and the subject on a table. It was explained that the experimenter would say some things about the chips, and that in each case the subject should indicate whether the experimenter's statement was true or false. The subject was also given the explicit option of responding 'Can't tell'.

Every item consisted of a statement about a chip held in the experimenter's hand. In each case the question pertained to the chip's color, and was preceded by the interrogative "True, false, or can't you tell?" For the nonvisible items, the subject was asked to close his eyes while the experimenter selected a chip. This chip was then concealed in the experimenter's closed hand until after the subject responded. For the remaining items, the chip was continuously in view. In order to minimize the time required for each subject, two distinct but overlapping sets of items were administered, one to each class. Order of presentation of the items was randomized for each subject. Questions were repeated if the subject hesitated or appeared puzzled.

Items: The left hand columns of Table 1 provide a description of the items. The description includes (a) the question posed by the experimenter, (b) the color of the chip, if visible, and (c) the correct answer.

Items 1 - 4 are nonempirical; all other items are empirical. These remaining items were designed to assess subjects' ability to evaluate questions sharing properties of the nonempirical items. These properties include negation, conjunction, disjunction, nonvisibility (items 7, 10, 14, 26) and repetition of a constituent proposition (items 21, 22, 33, 34). Columns 5 and 6 of Table 1 show which of the two groups of subjects (or both) received a given item.

Results

Hypothesis 1a: The righthand columns of Table 1 give the percentage of subjects in each group passing the items. Few subjects answered the nonempirical items (1 - 4) correctly. More importantly, 73% of the mistaken answers to these questions were responses of 'Can't tell'. This supports Hypothesis 1a that children tend to treat contradictions and tautologies as empirical statements; without empirical evidence, the children refused to evaluate them.* The percentage of 'Can't tell' responses to the nonempirical items may even be spuriously low. Items 7 and 10, the simplest, nonvisible, empirical questions, show that the children are in general reluctant to respond 'Can't tell'. Only 63% of the subjects did so, even though the 'Can't tell' response seems plainly appropriate in these cases. Moreover, the percent of correct responses (i.e., 'Can't tell') for the more complex nonvisible, empirical items 14 and 26 was slightly lower. 'Can't tell' was almost never given to the visible empirical items.

Hypothesis 1b: In general, the nonempirical items were substantially more difficult than their empirical counterparts. This supports Hypothesis 1b: The children had more difficulty with the nonempirical questions than with empirical questions of comparable logical structure. Items 28 and 30, involving disjunction, are exceptions to this pattern, being at least as difficult as the tautologous items 3 and 4. However, these items have a property not found in the nonempirical items. In each case, a response of 'True' was required despite the visibility of a chip whose color matched neither of those mentioned in the question. In marked contrast, items of identical logical structure, but not possessing this feature (items 26, 27, 29, 31, and 32) posed little difficulty. Therefore, we do not consider these exceptional items to infirm Hypothesis 1b. Consistent with this interpretation is the fact that there were no such exceptions with respect to contradictions. That is, all of the empirical items involving conjunction were substantially easier than the contradictions.**

Experiment 2: The objectivity hypothesis***

Experiment 1 provided evidence supporting the nonempiricality hypothesis. Experiment 2 was designed to test Hypothesis 2 that the ability to examine language objectively is necessary for the ability to correctly evaluate nonempirical statements.

*On the other hand, in other experiments we included nonempirical items in which the chip was clearly visible, and thus provided such 'evidence'. In this situation, children are still unable to appreciate the nonempirical character of these items, and revert to a simple 'matching' strategy. Both kinds of nonempirical statements (p v –p and p & –p) were judged as true only when p was true, and judged as false when p was false.

**We have conducted three additional studies to test Hypothesis 1. The subjects in these additional experiments ranged in age from 6 years to adulthood. The results are fully comparable to those reported for Experiment 1.

***This experiment is part of a larger study in which the same subjects participated. The data from the larger study are fully consistent with the results reported below.

Table 1. *Items for Experiment I*

Item Number	Question	Status of chip	Correct answer	Percent correct, Group 1 ($N = 26$)	Percent correct, Group 2 ($N = 25$)
	Nonempirical:				
1.	The chip in my hand is white and it is not white.	hidden	false	31%	24%
2.	The chip in my hand is not blue and it is blue.	hidden	false	–	56%
3.	Either the chip in my hand is yellow or it is not yellow.	hidden	true	23%	28%
4.	Either the chip in my hand is not red or it is red.	hidden	true	–	24%
	Simple Assertion:				
5.	The chip in my hand is blue.	blue	true	100%	–
6.	The chip in my hand is green.	blue	false	96%	100%
7.	The chip in my hand is yellow.	hidden	can't tell	73%	56%
	Simple Negation:				
8.	The chip in my hand is not white.	red	true	81%	68%
9.	The chip in my hand is not green.	green	false	96%	–
10.	The chip in my hand is not red.	hidden	can't tell	65%	56%
	Conjunction:				
11.	The chip in my hand is red and it is yellow.	red	false	–	80%
12.	The chip in my hand is blue and it is green.	green	false	–	76%
13.	The chip in my hand is white and it is red.	green	false	–	100%
	Conjunction with Negation:				
14.	The chip in my hand is yellow and it is not blue.	hidden	can't tell	58%	–
15.	The chip in my hand is white and it is not red.	white	true	88%	100%
16.	The chip in my hand is not blue and it is yellow.	yellow	true	–	100%
17.	The chip in my hand is red and it is not white.	white	false	92%	96%
18.	The chip in my hand is blue and it is not yellow.	red	false	73%	96%
19.	The chip in my hand is not red and it is white.	red	false	–	96%
20.	The chip in my hand is not blue and it is green.	red	false	–	100%

Table 1. *(continued)*

Item Number	Question	Status of chip	Correct answer	Percent correct, Group 1 ($N = 26$)	Percent correct, Group 2 ($N = 25$)
	Conjunction with Repeated Propositions:				
21.	The chip in my hand is blue and it is blue.	blue	true	100%	–
22.	The chip in my hand is green and it is green.	white	false	96%	–
	Disjunction:				
23.	Either the chip in my hand is red or it is blue.	red	true	–	76%
24.	Either the chip in my hand is green or it is white.	white	true	–	92%
25.	Either the chip in my hand is yellow or it is blue.	red	false	–	100%
	Disjunction with Negation:				
26.	Either the chip in my hand is red or it is not green.	hidden	can't tell	73%	–
27.	Either the chip in my hand is white or it is not blue.	white	true	81%	96%
28.	Either the chip in my hand is red or it is not yellow.	green	true	15%	16%
29.	Either the chip in my hand is not green or it is white.	white	true	–	96%
30.	Either the chip in my hand is not red or it is blue.	yellow	true	–	0%
31.	Either the chip in my hand is yellow or it is not green.	green	false	81%	100%
32.	Either the chip in my hand is not blue or it is yellow.	blue	false	–	88%
	Disjunction with Repeated Propositions:				
33.	Either the chip in my hand is white or it is white.	white	true	96%	–
34.	Either the chip in my hand is yellow or it is yellow.	blue	false	81%	–

Method

Subjects: Eight children from each of grades 1, 2, and 3 (mean ages: 6 years, 11 months; 7 years, 10 months; and 8 years, 9 months, respectively) were haphazardly selected to serve as subjects from a middle class suburban public school, while eight sixth graders

(mean age, 11 years, 7 months) were selected from a nearby private school. In addition, seven tenth-graders and eleven adults volunteered as subjects. In all, there were 50 subjects, 22 males and 28 females. No subject from Experiment 1 participated in Experiment 2. No subjects were dropped.

Materials: The materials were the poker chips described in Experiment 1, 15 cm. figurines made of blue construction paper, a color photograph of a cat, and a color photograph of a dog.

Items

Nonempirical items

There were four nonvisible nonempirical items, two based on each of the formulas p & –p and p v –p. These items are described in Table 1, numbers 1 and 3.

Language objectivity items

The objectivity items were designed to investigate various components of an objective attitude towards language. One component investigated was the awareness that words bear an arbitrary relation to their referents, for example, the awareness that interchanging the names of common objects does not affect their other properties (c.f., Piaget, 1929; Vygotsky, 1962). This first item is called *Arbitrariness of Language.* Allied to the awareness assessed by the first item is the realization that words do not share the physical properties of the things they signify. Thus, the word 'needle' is not itself sharp. This item is called *Nonphysical Nature of Words.* In a similar vein, other items assessed the subject's belief in the stability of the meaning of words in the face of destruction of the word's empirical referent (consider the word 'dinosaur'). This is the *Meaning and Reference* item. In more detail, the objectivity items were administered as follows:

1. Meaning and Reference. The experimenter began by saying: "Do you know what the word *glump* means? The word *glump* means a toy creature made out of blue paper that smiles and is round. What does the word *glump* mean? [The subject responds with the experimenter coaching if necessary.] There are only two glumps in the whole world, and here they are. [The experimenter produces two glumps and expands instructions as necessary.] Now what would you tell a kindergartener who asked you 'What does the word *glump* mean?' " [After the subject responds, the experimenter proceeds to completely destroy both glumps in front of the subject, and continues questioning as follows]: "Now, there are no glumps left in the world. What would you say now to a kindergartener who asked 'What does the word *glump* mean?' [The subject responds.] Suppose someone said 'glumps are blue'. Would he be right? [The subject responds.] Has the meaning of the word *glump* changed? [The subject responds.] Does the word *glump* now have any meaning?"

A subject was scored as correct only if he (1) gave essentially the same definition for the word *glump* as before, or gave it with an added proviso as to the glumps' nonexistence; (2) affirmed that glumps are still blue; (3) claimed that the meaning of the word *glump* had not changed (or had only changed through the addition of the extinction proviso); and (4) claimed that the word still had meaning after the destruction of the two glumps.

After the questions concerning glumps, essentially the same questions were posed concerning the word *giraffe*. This time, however, the subject was asked to *imagine* the annihilation of the word's referent; that is, he was asked to imagine that every giraffe in the world had suddenly disappeared. Scoring was the same as for the glump-subitem.

To be counted as passing the Meaning and Reference item, a subject had to pass both the glump and giraffe subitems.

2. Arbitrariness of Language. The subject was instructed as follows: "Suppose everyone in the world got together and decided that from now on we will call the sun 'the moon' and we will call the moon 'the sun'. All we are going to do is change the names. Could we do that if we wanted to?" All subjects acquiesced with minimal coaching. The subject was then asked "Now when you go to bed at night, what will you call the thing in the sky?" Virtually all subjects responded correctly, and otherwise they were coached. The subject was then asked to describe what the sky would look like. The correct answer was to describe a night sky.

After the sun–moon question, the subject was similarly asked to imagine that the names for cats and dogs were interchanged. He was then shown a picture of a cat and asked to give its new name. All subjects responded correctly (i.e., "dog"). The experimenter then asked: "What sound will this animal make?" The correct answer is "meow". A picture of a dog was produced and the same questions asked, the correct answers being "cat" and "ruff", respectively.

To be counted as passing the Arbitrariness of Language item, a subject had to pass both the sun–moon and cat–dog subitems.

3. Nonphysical Nature of Words. Subjects were asked the following questions, a negative answer being correct for all of them.

1. Is the word 'nickel' worth five pennies?
2. Is the word 'book' made of paper?
3. Does the word 'bird' have feathers?
4. Can you buy bubble gum with the word 'penny'?*

*Additional questions were originally included (e.g., "Is the word *fire* hot?" "Is the word *ice* a cold word?"), but they were not scored since adult subjects reported confusion as to whether the questions should be interpreted literally or metaphorically. No adults reported confusion for the items scored, above.

All four subitems had to be answered correctly for a subject to be counted as passing the Nonphysical Nature of Words item.

Procedure

All subjects were seen individually for one 30-minute session. The order of administration was objectivity items 1 - 3 followed by the four nonempirical items, or the reverse. The two orders were counterbalanced within age groups. All subjects received every task.

Results

The number of subjects passing each task is arranged by grade in Table 2. Since there were no striking effects of task order, the table makes no reference to this variable.

Modal errors

As in Experiment 1, the modal error for the nonempirical items was a response of "Can't tell". In the first meaning and reference problem, after the destruction of the glumps, the majority of the erroneous responses were that the meaning of the word 'glump' had changed (beyond a proviso of nonexistence) and/or that the word no longer had any meaning. Nonetheless, virtually all subjects still agreed that "glumps are blue". The results of the meaning and reference item concerning giraffes were analogous to the problem concerning glumps. In the first problem concerning the arbitrary connection between a word and what it signifies, after agreeing that the moon is now called 'the sun', the universal erroneous response was to describe a day sky in place of a night sky (e.g., to describe the sky as bright blue). Similarly, in the problem wherein the names of cats and dogs were interchanged, the universal erroneous response, with the relevant picture in plain view, was to interchange the sounds that cats and dogs produce (i.e., the cat, now correctly called 'a dog', was incorrectly said to bark; similarly, the dog, now correctly called 'a cat', was incorrectly said to meow). In the item concerning the nonphysical nature of words, the nearly universal erroneous response was to reply affirmatively to such questions as "does the word *bird* have feathers?" The errors to these three language items reflect, we believe, an inability to regard language objectively, to disentangle it from the reality it encodes.

Of the total number of responses given to the objectivity items 1 - 3, 56%, 50% and 44%, respectively, were correct. This finding suggests that common psychological processes underlie the solution of all the language items. To provide a further test of this possibility, we calculated phi-correlations between each of the three language items. The three resulting correlations (0.56, 0.62, and 0.40) are all significant ($p < 0.05$). These moderate correlations support the idea that common psychological processes mediate the diverse language items. The correlations thus render less plausible the idea that the difficulty of the objectivity tasks is due to idiosyncrasies of the questions, with resulting misinterpretations by the subjects.

Table 2. *Number of subjects passing each item of Experiment 2 by grade*

		Objectivity items			*Nonempirical items*			
		Reference and meaning	Arbitrariness of language	Nonphysical nature of words	p & −p 1	2	p v −p 1	2
Grade	*N*							
1	8	1	1	0	0	0	1	0
2	8	2	2	2	0	0	0	0
3	8	3	2	0	1	1	1	1
6	8	4	6	6	1	2	2	4
10	7	5	6	6	4	3	3	3
adult	11	10	11	8	8	8	10	9
Total	50	25	28	22	14	14	17	17

Table 3. *Conditional Probabilities of a subject passing each of the three language objectivity items given he has passed every item from the two kinds of nonempirical items (Test of the Objectivity Hypothesis)*

Nonempirical items	Language objectivity items			Total number of subjects passing nonempirical category
	Nonphysical nature words	Arbitrariness of language	Meaning and reference	
Nonvisible p v −p	10/12	12/12	11/12	12
Nonvisible p & −p	8/10	10/10	9/10	10
Total number of subjects passing language objectivity item:	22	28	25	

The objectivity hypothesis

In the introductory section we argued that being able to distance oneself from language, to consider it as independent of the events it refers to, is a necessary condition for comprehending nonempirical statements. If this hypothesis is correct, then those subjects passing the nonempirical items should have also passed the language tasks. In turn, this implies that the conditional probability of a given subject passing language items given that he passed a nonempirical item ideally equals one. Table 3 provides such conditional probabilities in matrix form, the columns representing the three language objectivity items and the rows representing the two kinds of nonempirical items. To be counted as

passing a given kind of nonempirical item, a subject had to pass both items of the given kind. Each cell of the table gives the conditional probability of a subject passing each language objectivity item given that he is successful with the designated nonempirical items.* These conditional probabilities range from 8/10 to 12/12, with a mean of 0.91.

Compare these results with the results of an analysis designed to test the hypothesis that language objectivity is a *sufficient* condition for the ability to correctly evaluate nonempirical statements. We suggest that this is not the case, that processes other than language objectivity are likely to be required as well (e.g., logical computation). The hypothesis that language objectivity is sufficient implies that the conditional probability of a given subject passing nonempirical items, given that he passed objectivity tasks, ideally equals one. Using categories identical to those in Table 3, we computed the conditional probabilities associated with this hypothesis. These range from 9/25 to 10/22, with a mean of 0.40.

Additional analyses were performed in which the criteria for language objectivity and comprehension of nonempirical statements were relaxed. For purposes of this analysis, to be considered as passing language objectivity, a subject need only pass one of the three objectivity items. For the two nonempirical categories in this analysis, a subject was considered to have passed that category so long as he passed at least one of the two items in it (rather than both items). The obtained conditional probabilities for the objectivity hypothesis are comparable to those in the previous analysis, with a mean of 0.88. The conditional probabilities for the converse hypothesis, that language objectivity is sufficient for nonempiricality, are again low, with a mean of 0.52.

Discussion

Hypothesis 1a was supported by the large number of "Can't tell" responses to the non-visible, nonempirical items in both experiments. A subject recognizing the nonempirical nature of simple contradictions and tautologies should be willing to evaluate these sentences in the absence of empirical evidence.

Hypothesis 1b is supported by the subjects' generally good performance on the empirical items in Experiment 1. These control items differed from the contradictions and tautologies mainly in being empirical.

We are aware that the nonempirical items violate certain "conversational postulates" described by H. P. Grice, and this may contribute to their difficulty. However, this is not sufficient to account for the relative difficulty of the nonempirical items. For one thing, the empirical items involving disjunction (items 23 - 34 of Table 1) similarly violate

*This conditional probability is represented by the fraction as follows: The numerator in each cell c_{ij} gives the number of subjects passing every task indicated by the ith row and jth column, while the denominator gives the number of subjects passing every task in the ith row.

conversational postulates, but in general are not nearly so difficult. For another, one would expect older subjects to be at least as sensitive as younger subjects to conversational postulates. Yet, as seen in Experiment 2, older subjects have more success than younger subjects with the nonempirical items.

The results of Experiment 2 support Hypothesis 2. Comprehension of nonempirical sentences predicts well an objective attitude toward language. In contrast, passing the language objectivity items is not a good predictor of success with the nonempiricality items. Comparable results were obtained using weak and strong scoring criteria.

The experiments help to clarify an issue raised by Piaget, concerning the relation between advanced logical thinking and language. According to Genevans, advanced logical thinking, including facility with propositional logic, is attained in the stage of "formal operations", an achievement of adolescence (Inhelder & Piaget, 1958). Piaget is explicit that the acquisition of a natural language is not sufficient for attaining formal operations (Piaget, 1967, pp. 94 - 98; Sinclair-de-Zwart, 1969, p. 320). To the extent that our nonempirical items partake of formal operations, our results are consistent with this claim. Piaget also states that language is at least a trivial prerequisite for formal operations if only because "these operations no longer bear upon the objects themselves ... but on propositions, on verbally announced hypotheses, etc.". To what extent and in what way linguistic competence plays a more significant role in the acquisition of advanced logical thinking is left open by Piaget (Piaget, 1969, p. 127; Furth, 1969).* Our study emphasizes the role of "meta-linguistic" skills rather than linguistic competence per se in evaluating contradictions and tautologies.

The present study is exploratory, and both empirical and conceptual elaboration is needed. Obviously, our conditional probability analyses are only a weak test of Hypothesis 2. Training studies would be useful to support our conclusions. Also, the source of children's difficulty with the language objectivity items remains to be determined. Aside from additional experiments, however, the concepts of language objectivity and nonempiricality require clarification. Our treatment of language objectivity is intuitive, rather than based on explicit criteria.** As for nonempiricality, its clarification amounts to a deeper understanding of logical truth.

*On the other hand Piaget is quite explicit that the acquisition of a natural language is neither necessary nor sufficient for attaining the stage of "concrete operations" (Piaget, 1967; Furth, 1969; Sinclair-de-Zwart, 1969).

**See Cazden (1972) for a review of research using tasks akin to our language objectivity items.

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Résumé

On a remarqué que les enfants éprouvent des difficultés à évaluer des contradictions de la forme p & −p et des tautologies de la forme p v −p. On a fait les hypothèses suivantes:

(a) Les difficultés de ces énoncés ne sont pas uniquement dues aux mots logiques qui les composent.

(b) Une partie des difficultés provient du fait que leur valeur de vérité repose davantage sur leur forme linguistique que sur des considérations empiriques.

(c) La capacité à examiner le langage de manière objective, en dehors des événements et des objets auxquels il se réfère est une condition nécessaire mais non suffisante pour une évaluation correcte des contradictions et des tautologies. Les résultats des deux expériences confirment ces hypothèses.