Revista Interamericana de Psicología/Interamerican Journal of Psychology - 2005, Vol. 39, Num. 1 pp. 13-22

Logical Reasoning and Fantasy Contexts: Eliminating Differences between Children with and without Experience in School

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Abstract

An experiment investigated the effect of a make-believe fantasy mode of problem presentation on reasoning about valid conditional syllogisms in three groups of 5-year-old children: a) school children from middle-class families in England; b) school children from middle-class families in Brazil; and, c) children from low SES families in Brazil who had never gone to school. Previous investigations had reported that the use of a fantasy context elicited significantly more logically appropriate responses from school children than did other contexts, and that children with school experiences made significantly more logically appropriate responses than did children without school experience. The present investigation extended these findings to show that the beneficial effects of a fantasy context extended to lower-class illiterate children who never had been exposed to schooling.
Keywords: Syllogistic reasoning; socioeconomic status; children.

Raciocínio Lógico e Contextos de Fantasia: Eliminando Diferenças entre Crianças com e sem Experiência na Escola

Resumo

O estudo investigou o efeito do modo de apresentar em fantasia de faz-de-conta no raciocínio de silogismos condicionais válidos em três grupos de crianças com 5 anos de idade: (a) crianças inglesas que freqüentam escolas de famílias de nível socioeconômico médio na Inglaterra; (b) crianças brasileiras que freqüentam escolas de famílias de nível socioeconômico médio, e (c) crianças brasileiras que nunca foram à escola de famílias de nível socioeconômico baixo. Investigações anteriores verificaram que o uso de contexto de fantasia eliciava significativamente mais respostas lógicas do que em outros contextos e, que crianças com experiência escolar ofereciam significativamente mais respostas lógicas do que crianças sem experiência escolar. A presente investigação estende esses resultados para mostrar os efeitos benéficos do contexto de fantasia em crianças sem escolarização de classe baixa.
Palavras-chave: Raciocínio silogístico; nível sócio-econômico; crianças.

This investigation addressed two basic issues. First, previous investigations reported that middle-class school children made fewer errors when making judgments about logical syllogisms when the problems were presented in the context of a make-believe fantasy context than they did when the problems were presented in other contexts. Second, previous investigations reported that research participants from literate populations with exposure to schooling made fewer errors than have participants from illiterate populations without exposure to schooling. The present investigation combined these two aspects, investigating the effects of presentation of problems requiring judgments about logical syllogisms with make-believe fantasy contexts and with other contexts with both school children and with children who have not been exposed to schooling.

Psychologists have been investigating the effects of literacy, schooling, and socio-economic class (SES) on logical-reasoning performance at least since Luria (1976), whose investigation in Uzbekistan compared adult illiterate peasants from traditional communities with adults who had been integrated in collectively organized communities and had gone to school. Luria presented syllogisms with various

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[2] This material is based upon work supported by the National Science Foundation under Grant No. 0104503 to David P. O'Brien and Patricia J. Brooks, and a grant from CNPq of Brazil (Process Number 910023/01-8) to Antonio Roazzi and Maria da Graça B.B. Dias.

types of premises, some referring to practical experiences, and others referring to non-familiar events that required answers based on purely logical inferences. Illiterate participants solved 60% of the syllogistic problems that involved familiar contents, but performance for these same participants dropped to 15% when the contents were unknown. For the participants who had some schooling, however, or who were used to more complex means of communication, 100% of the responses were correct for both kinds of syllogisms. Luria argued that only the literate participants who had school experience were able to accept the premises of the problems as part of a syllogistic unit that allowed logical conclusions to be drawn.

More recent investigations by Cole, Gay, Glick and Sharp (1971), Scribner (1975) with the Kpelle population in West Africa, and Sharp and Cole (1975, mentioned in Scribner, 1977) with the Mayans in Yucatán, Mexico, all arrived at results that pointed in the same direction. Cole, Gay, Glick and Sharp (1971), for example, used several kinds of verbal logical problems in naturalistic and experimental contexts, aimed at studying inferential processes of Kpelle children and adults. In one study conducted with 10- to 14-year-old children with several degrees of schooling, problems such as the following were presented: "If Flumo or Yakpalo drinks spirits, then the town chief gets annoyed. Flumo is not drinking spirits. Yakpalo is. Is the town chief annoyed?"

Only 30% of the responses made by children who had never been to school were logically appropriate. In contrast, children who were attending the third year of school solved 90% of the problems. According to the authors, the apparent source of the 'non-logical' performance of the unschooled population seemed to be a failure to integrate and retain the information contained in the premises.

The goals of a set of exploratory studies reported by Scribner (1975) were (a) to examine whether logical reasoning is related to culture and (b) to identify the processes involved in inferential reasoning that are contained in a culture. One study included illiterate members of a Kpelle tribe that was situated in an isolated West African region, literate members of the same tribe who had received secondary education and a third group of North-American students. All participants received syllogistic problems with content that varied between true or untrue premises. The illiterate Kpelle participants made correct responses to 53% of the problems (equal to chance-level performance), the literate Kpelle school children made correct responses to 80% of the problems, and the North American college students made correct responses to 90% of the problems. (Data concerning differences between syllogisms involving true premises and untrue premises were not reported.)

Scribner (1975) analyzed the justifications for the responses that were provided by the participants. Explanations were classified into three types: (a) theoretical explanations were those in which participants referred to a problems' assumptions, (b) empirical explanations were those in which participants referred to their own knowledge; and (c) arbitrary explanations were those in which no justification was offered or where the explanations were irrelevant to the responses. Scribner reported that 23.3% of the justifications by the illiterate Kpelle were theoretical, 68.1% were empirical, and 9.6% were arbitrary. For the literate Kpelle group, 75% of the justifications were theoretical, 21.9% were empirical, and 3.1% were arbitrary. For the American college students, 82.3% of the judgements were theoretical, 3.1% were empirical, and 14.6% were arbitrary. Thus, theoretical justifications were used more by the schooled Kpelle and by the American college students than by the illiterate Kpelle, whereas the illiterate Kpelle used more empirical justifications. Similar results were reported by Sharp et al. (1975, cited in Scribner, 1977) with schooled and illiterate children and adults in the rural and semi-rural areas of Yucatán, Mexico, and by Cole and Scribner (1974) with a sample of 750 Vai participants in Liberia.

> In her review of these studies Scribner (1977) noted that: "... not only the quantitative results are rather uniform from one study to another, but also certain qualitative aspects of performance are so alike that it becomes frequently difficult to distinguish the protocol of a subject from Uzbekistan from the protocol of a Vai subject - despite the cultural and geographical distance between them." (p. 485)

At the same time, these studies across cultures demonstrated a significant difference between the number of correct answers given by schooled and unschooled participants within a given culture. Thus, for Scribner, educational background, rather than culture, plays the major role in the participants' performance.

Scribner (1977) also reported a large difference between schooled and unschooled participants regarding the number of theoretical justifications provided, with empirical explanations frequently occurring among unschooled participants, and theoretical explanations among school children. "Even seven-year-olds, in their second year of school systems known for emphasising mechanical learning rather than the development of critical thought, tend to refer to what the problem describes, when questioned about their answers" (Scribner, 1977, p. 489). Scribner concluded that these results suggested two conclusions: First, very little schooling is necessary to produce a substantial increase in performance, and second, schooling is a necessary condition for above-chance performance, at least for syllogisms where the participants cannot rely on their practical knowledge.

Hawkins, Pea, Glick and Scribner (1984), however, in a study with pre-school age and school-age children found that both groups attained good results with syllogistic problems with unknown contents of a fantasy kind, or with contents that were congruent with children's experiences.

In the problems whose contents were incongruent, both schooled and unschooled children achieved below mean results. Data from Hawkins and colleagues (1984) also showed that children produced significantly more correct answers and theoretical justifications when they received the fantasy problems first than when they received the problems in other orders. Similar results were found by Dias and Harris (1988a, 1988b, 1990), with pre-school children often solving syllogistic problems even when the contents were contrary to their experiences, so long as the task was presented in a make-believe context. According to these authors, the children seemed to construct a make-believe world where assumptions are accepted even without the support of their daily experiences. Thus, under certain circumstances children with limited exposure to schooling can reason in a logical and theoretical fashion.

The goal of the present study was to investigate the role of a make-believe fantasy context on syllogistic reasoning both with children in school and with children who had never been to school. In order to able to compare results to those previously reported, the present investigation included children from the same two primary schools in Oxford, England, that had participated in experiments reported by Dias and Harris (1988a). In order to obtain children without exposure to schooling, children in Pernambuco, Brazil, were recruited. Unlike England, where almost no children fail to attend school, illiteracy and absence from school is frequent in Pernambuco. In order to be able to make comparisons between these two groups, a third group was included of middle-class school children in Pernambuco. This allowed comparisons between two groups of schooled children, with one group receiving problems in English and the other in Portuguese, which was also the language used to present problems to the group of children without school exposure in Pernambuco. For all three groups, the children recruited were 5-year-olds. This age was chosen first because many of the basic facts are already known to older children, so that it was appropriate to extend the age downward and second because this offered an opportunity to assess the impact on reasoning of a relatively brief period of schooling.

Three types of content were used to present problems: premises that were based on known facts that were congruent with the children's empirical experience, premises that were contrary to their empirical experience, as well as with premises that referred to things that were unknown to them. Two kinds of valid inference forms were investigated: modus-ponens problems (with premises of the form *if p then q* and *p*, and with *q* as a conclusion to be evaluated) and modus-tollens problems (with premises of the form *if p then q* and *not q*, and with *not p* as a conclusion to be tested). The present investigation thus was intended to extend the findings previously reported by Dias and Harris (1989) with school children showing that, in spite of the fact that modus-tollens problems were more difficult than modus-ponens problems, the use of a make-believe context elicited more correct responses with both forms of syllogisms.

Method

Participants

A total of 144 children participated, ranging in age from 5 years and 0 months to 5 years and 11 months (mean = 5 years, 6 months; *SD* = .03). Of these, 48 were middle-class English who were enrolled in two primary schools in Oxford, 48 were middle-class Brazilian who were enrolled in two primary schools in Recife, Brazil, and 48 were children from Recife, Brazil who were of lower SES and had never attended school.

Materials

Twenty-four modus-ponens problems and 24 modus-tollens problems were adopted from Dias and Harris (1988a,

Table 1.
Examples of the Type of Syllogisms Used in the Experiment

Type of Facts	*Modus Ponens*	*Modus Tollens*
Known Facts (Probing Question: What noise do cats make?)	All cats meow; Tot is a cat; Does it meow?	All cats meow; Tot can only bark; Is Tot different from a cat?
Unknown Facts (Probing Question: What noise do hyenas make?)	All hyenas laugh; Tot is a hyena; Does it laugh?	All hyenas laugh; Tot can only cry; Is it different from a hyena?
Contrary Facts (Probing Question: What noise do cats make?)	All cats bark; Tot is a cat; Does it bark?	All cats bark; Tot can only meow; Is Tot different from a cat?

1989). (See Table 1 for examples of each type of problem.) For each problem form, there were three different kinds of premises: (a) eight included known facts that matched the children's experience, (b) eight included unknown facts and (c) eight included facts contrary to their daily life experience. Probe questions were employed to establish which facts the children actually knew. (See Table 1 for examples).

Procedure

Half the children in each sample were given the modus-ponens problems, and the other half was given the modus-tollens problems. Within each of these subgroups half the children were assigned to the Verbal Group and the other half to the Make-Believe Group, as described below. Each subgroup of 12 children was randomly split into three smaller subgroups, and each subgroup of 4 children was given a set of eight problems in the same fashion, with contents that were either known or unknown, or contrary to the children's own experience. Problem order was varied randomly between participants. Before receiving the task, Probe Questions were asked in order to establish whether the children were familiar with the facts contained in each problem's first premise.

For the Verbal Group, instructions were as follows: *"I will read you some stories about things that: (a) you know about (for the Known Facts subgroup); (b) that you don't know about (for the Unknown Facts subgroup), and (c) you will find odd (for the Contrary Facts subgroup). We will, however, pretend that everything in these stories is true."* The experimenter then proceeded to read each problem with a normal voice.

For the Make-Believe group, instructions were as follows: *"Let's pretend I am on another planet. Everything on this planet (a) is known to you (for the Known Facts subgroup); (b) is unknown to you (for the Unknown Facts subgroup), and (c) will seem odd to you (for the Contrary Facts subgroup)"*. The experimenter then proceeded to present each problem as a story, that is, using the voice and intonation of a storyteller.

For each problem, before responding children were required to mention the first and second premise in the order they had been presented by the experimenter so that the experimenter could ascertain that the child had registered the problem accurately. When any error occurred, and such errors were fairly rare, the problem was repeated up to three times. After the question was posed the experimenter asked the child to justify her/his response: *Why did you answer "yes"?* or *'Why did you answer "no"?* The response to this question occasionally followed by another question: *How do you know that?* This latter question was posed only when a child's previous answer seemed unclear, that is, when he/she did not specify the basis for his/her response.

Results

All data were classified in two ways: (a) according to the number of correct answers, and (b) according to the kinds of justifications for the responses, independently of their correctness. Justifications were classified as theoretical, empirical, or arbitrary, using the same criteria as Scribner (1975) and Dias (1987) in which theoretical justifications were those that referred only to information present in the first or second premise, or both, in a deductively valid form, empirical justifications were those that referred to practical knowledge of the world, and arbitrary justifications were those that seemed to be irrelevant or those for which a child did not offer any justification.

Probe Questions

Before judging the truth or falsity of the conclusion to the problems, the children were asked probe questions concerning whether they understood the premise information to be true. The proportions of children in each group who were familiar with the premise information for each type of problem are shown in Table 2, inspection of which reveals that the children were familiar with the content presented in the known-contents problems, were unfamiliar with the content presented in the unknown-contents problems, and understood that the materials presented in the contrary-facts problems were contrary to what the children understood about the world.

Correct Answers

The mean proportions of correct answers to the problems (out of 8) as a function of group, type of fact,

Table 2.
Proportions of Correct Answers to the Probing Questions as a Function of the Type of Fact in the Three Sample Groups

Sample	Type of Facts		
	Known	Unknown	Contrary
English	.98	.01	1.00
Schooled Brazilian	.97	.03	.96
Unschooled Brazilian	.95	.00	.94

Table 3.
Means of Correct Answers (Out of 8) as Function of Group, Type of Fact, Type of Syllogism in the Three Samples

Sample/ Syllogism	Verbal Group Known	Unknown	Contrary	Make-believe Group Known	Unknown	Contrary
English						
M. Ponens	8.00	6.00	4.75	8.00	7.50	8.00
M. Tollens	7.75	4.00	2.75	8.00	7.75	7.75
Total	7.87	5.00	3.75	8.00	7.62	7.87
Schooled Brazilian						
M. Ponens	7.75	6.75	2.75	7.50	6.75	7.50
M. Tollens	7.75	6.25	3.50	8.00	7.25	6.25
Total	7.75	6.50	3.12	7.75	7.00	6.87
Unschooled Brazilian						
M. Ponens	6.50	4.50	2.75	7.75	6.75	7.75
M. Tollens	7.25	3.50	2.25	7.00	6.25	6.00
Total	6.87	4.00	2.50	7.37	6.50	6.87

and form of syllogism in the three samples are shown in Table 3. Inspection of Table 3 suggests that the Make-Believe Group provided more correct answers than the Verbal Group, especially in the Unknown Facts and Known Facts categories, that slightly more correct responses were made to modus-ponens problems than to modus-tollens problems, and that the unschooled Brazilian children gave fewer correct answers than did the schooled children of both nationalities.

To verify these initial impressions, a 2 (Group) x 3 (Fact Type) x 2 (Problem Form) x 3 (Sample) ANOVA was computed with the frequency of correct replies as the dependent variable. This analysis produced a significant main effect for Group [$F(1,108) = 178.56$, $p < .001$], for Fact Type [$F(2,108) = 85.18$, $p < .001$], for Problem Form ($F(1,108) = 8.35$, $p < .01$] and for Sample [$F(2,108) = 64.85$, $p < .001$). The ANOVA also yielded the following significant interactions: Group x Fact Type [$F(2,108) = 53.23$, $p < .001$], Group x Sample [$F(2,108) = 4.41$, $p < .01$] and Fact Type x Sample [$F(4,108) = 2.49$, $p < .05$] The significant effect for Group, with a greater number of correct replies in the make-believe context (mean 7.32; *SD* = .73) than in the verbal context (mean 5.26; *SD*= 1.64) is consistent with reports by earlier researchers (Dias & Harris, 1988a, 1989, 1990; Holanda, 1989; Santos, 1989). The main effect for Problem Type, with more correct responses made for modus-ponens problems (mean = 6.51; *SD*= 1.22) than for modus-tollens problems (mean = 6.07; *SD*= 1.30) is also consistent with findings of previous studies (e.g., Braine & Rumain, 1983; Dias & Harris, 1988a).

Differences among means for the significant main effects and for the interactions were assessed using post-hoc Newman-Keuls Tests. (Except where indicated, all significant results reported for Newman-Keuls tests were significant at $p < .01$). The test for Group revealed that both English and Brazilian children who were enrolled in school made significantly more correct answers (mean = 6.69 for the English and 6.50 for the Brazilian children, respectively; *SD*= .92) than did the unschooled Brazilian children (mean = 5.69; *SD*= 1.57). Comparisons among the three types of Facts revealed that Known Facts (mean 7.60; *SD*= .64) led to a significantly higher number of correct responses than did Unknown Facts (mean 6.10), which in turn elicited a significantly higher number of correct responses than did Contrary Facts (mean = 5.16; *SD*= 1.61). These findings are consistent with those reported by Dias and Harris (1988a).

Neuwman-Keuls tests among the means for the Group x Sample interaction (See Figure 1) revealed that in the Verbal Group, the unschooled Brazilian children gave a smaller number of correct answers than did the English children or the Brazilian schooled children, whereas these two samples of schooled children did not differ significantly from one another. In the Make-Believe Group, however, differences between the English children and the Brazilian unschooled children did not reach significance, nor did differences between schooled Brazilian and English children. Analyses also showed in all three samples that performance improved significantly in the Make-Believe context. The greatest benefit from the use of make-believe materials was for unschooled children (mean increase of 2.46), followed by the English schoolchildren (mean increase of 2.29) and lastly by the schooled Brazilian children (mean increase of 1.42). These results confirmed the beneficial effect of make-believe context on these problems reported by Dias and Harris (1988a, 1988b, 1989, 1990).

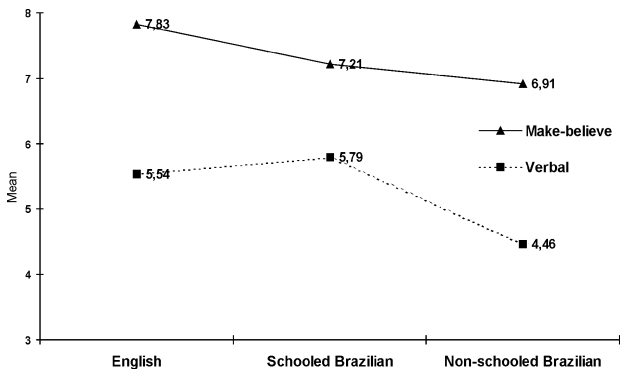

Figure 1. Interaction of group x sample with correct replies as the dependent variable

Newman-Keuls comparisons among the means for the interaction of Fact Type x Sample (see Figure 2) showed that among English children a higher number of correct replies were given for Known Facts than for Contrary Facts or for Unknown Facts. The comparison between Contrary Facts and Unknown Facts did not achieve statistical significance. For Brazilian school children, the number of correct replies to Known Facts was substantially higher than for Contrary Facts or Unknown Facts. The Brazilian school children also made a higher number of correct responses to problems involving Unknown Facts than to problems involving Contrary Facts. Brazilian unschooled children, on the other hand, made a higher number of correct replies for Known Facts than for Contrary Facts or Unknown Facts. The mean for correct responses to Unknown Facts problems did not differ significantly from the mean for Contrary Facts problems.

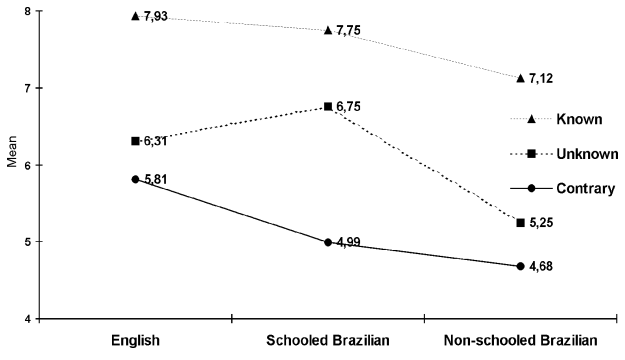

*Figure 2. I*nteraction of fact type x sample with correct replies as the dependent variable

Post-hoc tests failed to reveal any significant differences for Known Facts problems. The mean for correct answers to Unknown Facts problems by English school children and Brazilian school children was markedly higher, however, than the mean for unschooled Brazilian children. For Contrary Facts problems, English children made more correct responses than did unschooled Brazilians or Brazilian school children (p<.05). The groups of Brazilian children did not differ significantly from one another for this type of content. This significant interaction effect clearly showed that as the content of the problems increased in difficulty, schooling played an increasing role.

The post-hoc comparisons for the interaction of Group x Fact Type (see Figure 3) revealed that for the Verbal group significantly more correct responses were given to Known Facts problems than to Contrary Facts problems or to Unknown Facts problems, with the means for these two latter types of contents differing significantly. In the Make-Believe Group none of the possible comparisons achieved statistical significance. The means for Known Facts problems did not differ significantly between the two groups. For Unknown Facts problems the mean was significantly higher for the Make-Believe Group than for the Verbal Group. This also was the case for Contrary Facts problems where the children belonging to the Make-Believe Group made more correct responses than did those in the Verbal Group. These results for the interaction of Group x Fact Type were similar to those reported by Dias and Harris (1988a), where the effect of make-believe was significant for the Contrary and Unknown contents, but had no effect for the problems involving Known Facts.

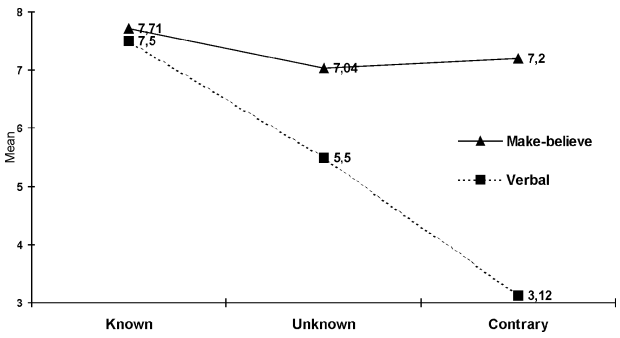

Figure 3. Interaction group x fact type with correct replies as the dependent variable

Types of Justification

Two independent people classified justifications with an agreement of 95.3%. When discrepancies in judgement occurred, they were presented independently to a third person, who assessed 36 such cases. This third assessment was final.

Theoretical Justifications

Table 4 shows the mean number of theoretical, empirical and arbitrary justifications as function of group, type of fact and form of syllogism in the three groups. Inspection of Table 4 suggests that more theoretical justifications were provided in the Make-Believe Group than in the Verbal Group, especially following Contrary Facts and Unknown Facts. It also appears that for all kinds of facts, and in both groups, unschooled

Table 4.
Mean Number of Theoretical, Empirical and Arbitrary Justifications as Function of Group, Type of Fact and Form of Syllogism in the Three Groups

Sample & Syllogism	Verbal Group			Make-Believe Group		
	Known	Unknown	Contrary	Known	Unknown	Contrary
Theoretical English						
M. Ponens	3.50	2.50	1.25	5.00	6.75	6.00
M. Tollens	2.25	2.50	0.50	4.75	7.25	5.75
Schooled Brazilian						
M. Ponens	0.00	5.00	0.25	0.00	3.75	6.00
M. Tollens	0.25	3.25	1.25	4.25	7.25	5.25
Unschooled Brazilian						
M. Ponens	0.50	0.50	0.25	0.50	2.00	3.00
M. Tollens	0.25	0.50	0.00	0.50	2.00	2.00
Empirical English						
M. Ponens	2.50	0.25	1.75	3.00	0.75	0.50
M. Tollens	2.25	0.00	2.50	3.25	0.00	0.00
Schooled Brazilian						
M. Ponens	8.00	0.00	7.00	8.00	0.50	0.75
M. Tollens	5.50	0.00	3.25	3.00	0.00	2.25
Unschooled Brazilian						
M. Ponens	3.00	0.50	3.50	4.00	0.25	0.50
M. Tollens	3.00	0.25	3.00	4.00	0.00	0.25
Arbitrary English						
M. Ponens	2.00	4.25	5.00	0.00	0.50	1.50
M. Tollens	3.50	5.50	5.00	0.00	0.75	2.25
Schooled Brazilian						
M. Ponens	0.00	3.00	0.75	0.00	3.75	1.25
M. Tollens	2.25	4.75	3.50	0.50	0.75	0.50
Unschooled Brazilian						
M. Ponens	4.50	7.00	4.25	3.50	5.75	4.50
M. Tollens	4.75	7.25	5.00	3.50	6.00	5.75

Brazilian children offered fewer such justifications than did Brazilian and English school children. The theoretical justifications were only slightly more frequent for Modus Ponens than Modus Tollens problems.

In order to assess statistically these initial impressions, the data were analysed with a 2 (Group) x 3 (Fact Type) x 2 (Forms of Syllogism) x 3 (Sample) ANOVA with number of Theoretical Justifications as the dependent variable. The analysis showed a significant effect for Group [F (1,108) = 103.15, $p < .001$], for Fact Type [F (2,108) = 15.38, $p < .001$] and for Sample [F(2,108) = 46.04, $p < .001$].

The main effect of Group for Theoretical Justifications confirms the superior performance in the Make-believe group (mean 4.00) as compared to the Verbal group (mean 1.36). The mean number of Theoretical Justifications in the three samples was compared with the Newman-Keuls Test. English children (mean 4.00) gave a higher number of such justifications than Brazilian unschooled (mean 1.00) or schooled children (mean 3.04; $p < .05$). The latter offered more theoretical justifications than their unschooled counterparts.

This test was also applied in the analysis of Theoretical Justifications for the three kinds of facts. More Theoretical Justifications were offered for Unknown Facts (mean 3.60) than for Known Facts (mean 1.81) or Contrary Facts (mean 2.62; $p < .05$). There were more such justifications for Contrary Facts than Known Facts ($p < .05$).

Empirical Justifications

Inspection of Table 4 shows that the number of Empirical Justifications was greater in Verbal Group than in the Make-Believe Group and that, in both groups, they were used more frequently for Known Facts than for the other two kinds of facts. Unschooled Brazilian children offered this kind of

justification more frequently than schooled English or Brazilian children, chiefly for Known Facts. The number of Empirical Justifications for the problems involving Modus Ponens was generally higher than that for problems involving Modus Tollens. A 2 (Group) x 3 (Fact Type) x 2 (Type of Syllogism) x 3 (Sample) ANOVA was computed with Empirical Justifications as the dependent variable. The analysis confirmed the existence of a significant effect of Group [$F(1,108) = 14.08$, $p < .001$], of Fact Type [$F(2,108) = 100.32$, $p < .001$], of Sample [$F(2,108) = 22.65$, $p < .001$], and of Type of Syllogism [$F(1,108) = 9.08$, $p < .01$].

The main effect of Group and Type of Syllogism for Empirical Justifications indicates that there were more Empirical Justifications in the Verbal group (mean 2.57) than in the Make-Believe group (mean 1.72), and more Empirical Justifications for Modus Ponens (mean 2.49) than for Modus Tollens (mean 1.80). The mean number of Empirical Justifications offered by the different samples was analyzed with the Newman-Keuls Test. (All Newman-Keuls results reported are at the $p < .01$ unless otherwise indicated.) English children (mean 1.39) and Brazilian unschooled children (mean 1.85) did not differ significantly regarding the number of justifications. These two samples, however, offered fewer empirical explanations for their answers than did Brazilian schooled children (mean 3.18).

As regards Fact Type, this test showed that a greater number of empirical explanations were offered for Known Facts (mean 4.12) than for Contrary Facts (mean 2.10) or for Unknown Facts (mean .21). This kind of justification was also used more for Contrary Facts than for Unknown Facts.

Arbitrary Justifications

Inspection of Table 4 also shows that Arbitrary Justifications were more widely used in the Verbal Group than in the Make-Believe Group, especially for Unknown Facts. Brazilian unschooled children offered more such justifications than English or Brazilian schooled children. Analysis of variance with Group x Fact Type x Type of Syllogism x Sample as the factors, with Arbitrary Justifications as the dependent variable showed significant effects of Group [$F(1,108) = 28.79$, $p < .001$], Fact Type [$F(2,108) = 13.50$, $p < .001$], and Sample [$F(2,108) = 39.74$, $p < .001$].

The main effect of Group on Arbitrary Justifications indicates the greater number of this type of justifications in the Verbal group (mean 4.01) than the Make-believe group (mean 2.26). The mean number of Arbitrary Justifications in the three samples was compared with the Newman-Keuls Test. This analysis showed that Brazilian and English schooled children (means 1.75 and 2.52, respectively) gave a significantly smaller number of such justifications than Brazilian unschooled children (mean 5.14). Brazilian schooled children offered a smaller number of these justifications than English children.

In relation to the three kinds of Facts, the numbers of justifications of this kind did not differ between Contrary and Unknown Facts (means 3.27 and 4.10, respectively). However, the children gave a smaller number of Arbitrary Justifications for Known Facts (mean 2.04) and for Contrary Facts than for Unknown Facts.

Discussion

The results clearly indicate the importance of context in the solution of these valid conditional syllogism problems. When problems were presented in a make-believe fantasy context they were much more like to be evaluated correctly. In this respect, the present results are consistent with those reported previously by Dias and Harris (1988a, 1988b, 1990). The present results extend those earlier findings, however, by confirming that the presentation of problems in a make-believe fantasy context also elicits problem solution from Brazilian children who have never gone to school. Moreover, this improvement in performance was found for both types of syllogisms and for all three types of fact. Indeed, as revealed most clearly in Figure 1, which show the interaction between group and sample, when a make-believe fantasy context was used to present the problems, differences in the rate of correct responses between school children and children who had never attended school disappeared. This finding offers strong support for the recent proposal made by Harris and colleagues (Harris, 2000, 2001; Leevers & Harris, 1999, 2000). The capacity to reason in a valid consequential manner from given premises is not an ability that is engendered in the context of schooling. Rather, it is a capacity that children can exercise both prior to, and also in the absence of, schooling. Moreover, in exercising that ability, children who have not been to school display the same level of competence as children who have been to school. Thus, even if schooling does eventually capitalize on children's ability to reason accurately, it appears to recruit a pre-existing competence and to extend its application – without changing the initial form of that competence.

Performance worsened substantially both for school children and for unschooled children when the problems were presented in the standard verbal mode. This was especially so when the content of the problems was unknown or was contrary to their daily experience. This phenomenon was also reported in previous studies with English children (Dias & Harris, 1988a, 1988b, 1990). The explanation provided by these two authors was that correct answers for problems that involve known facts can be achieved by either the deductive mode, as reflected in Theoretical Justifications, or the empirical mode, as reflected in Empirical Justifications. Only the deductive mode, however, leads to correct answers when the facts

are unknown or contrary. Therefore, children in the Verbal group were less likely to solve problems involving these kinds of contents, but they were able to produce a good performance when facts were known.

As regards the two forms of valid inference, both Brazilian and English children were more accurate with problems involving Modus Ponens than those involving Modus Tollens, replicating results obtained by Dias and Harris, 1988b, Ennis (1976), Evans and Lynch (1973), and Kodroff and Roberge (1975). This finding presents no surprise from the perspective of the theory of conditional reasoning presented by Braine and O'Brien (1991). Modus-ponens problems present a relatively simple argument form that can be solved straightforwardly once one encodes the propositional information in the problem. Modus-tollens arguments, however, require that the problem solver appreciate that acceptance of the antecedent, *p*, of the premise *if p then q*, entails a contradiction with the second premise, *not q*, which entails rejection of the truth of *p*. Even adult research participants at times have difficulty appreciating the logical necessity of rejecting *p* in such arguments, so the present finding that the use of a make-believe fantasy context elicits correct solution in unschooled 5-year olds is quite impressive.

The present investigation leaves unanswered some questions concerning differences between the two groups that had some school experience and the group that did not. Unlike most previous investigations into differences between schooled and unschooled populations, the two school groups in the present investigation were only in the first year of primary school and therefore did not have extensive exposure to school. (We do not have data about the amount of experience in pre-school programs these children may have had, although it is common for both the English and Brazilian middle-class children to have some experience in pre-school systems.) Further, most 5-years are not yet literate beyond a rudimentary level. This raises the possibility that the difference between the schooled and the unschooled children revealed when the problems were presented in Verbal mode (that is, without the benefit of the make-believe fantasy context) had more to do with differences between middle SES and low SES than between presence of exposure to school and absence of exposure to school. Of course, to ascertain the extent to which schooling *per se* and social class *per se* is responsible for this reported difference would require inclusion of two sorts of populations that were not included in the present investigation: a middle-class group that had not gone to school and a lower-class group that had gone to school. Finding a middle-class group without school experience is difficult if not impossible, and including a lower-class group with school experience would provide only a partial answer to this question. Nonetheless, the goal of the present investigation was not to address the reasons for differences in performance on Verbal problem presentation between schooled and unschooled populations, but to ascertain whether performances of unschooled children might benefit from the presentation of problems in a make-believe fantasy context in the same way as schooled children have in previous investigation. The finding of principal interest — that children without school exposure also benefit from the use of a make-believe fantasy context — does not rely on the addition of middle-class children without schooling or of lower-class children with schooling. Indeed, the beneficial effect of the make-believe fantasy context for the unschooled children was so great that not only did it benefit them as it did the schooled children, but it also made up for the significant deficit between the unschooled and the schooled children that was revealed when the problems were presented without a make-believe fantasy context.

Of more compelling interest than the question of why children who have gone to school performed better than those who have not on the problems presented without a make-believe fantasy context is the question of why all the populations in the present investigation benefited from the use of a make-believe fantasy context. The results of the present investigation, like those of previous investigations by Dias and Harris (1988a, 1988b, 1990) and by Hawkins, Pea, Glick and Scribner (1984), do not provide an exact explanation of the beneficial effects of a make-believe fantasy context for such judgments. However, one reasonable conjecture is that the use of a make-believe context prompts participants to disregard the empirical knowledge that typically — and reasonably — provides the basis for most such judgments in ordinary circumstances. Note that adults often correct children when they make an assertion that is epistemically false, that is, when they tell a factual lie. Adults are not as reliable, however, in monitoring children when they commit errors in logic. Thus, when they offer a judgment to an adult, one could expect children to attend to the correspondence of their judgments to known facts with greater care than they attend to the logical entailment of a conclusion. When they are invited to make their judgments in a fantasy context, however, they are being told explicitly to abandon epistemic facts and to replace them with the only other thing available: the premises as they are related in the story. Thus, if the premises of a problem logically lead to the conclusion that *all cats bark*, a child would ordinarily hesitate to convey that conclusion to an adult. If a child has been invited to abandon ordinary conventions about the world, however — and surely a make-believe fantasy context invites a child to do exactly this — then any hesitation of this sort is removed and the assertion that *all cats bark* not only follows on logical grounds, but is permissible on social

and pragmatic grounds as well. A child is not likely to expect to be castigated by the adult experimenter for making an assertion that is not merited on the facts if the adult has explicitly invited the child to ignore the usual facts. Note, in particular, that make-believe fantasy play is not unusual for children. No culture that we have encountered — and no culture about which we know — fails to feature make-believe play among the ordinary aspects of the daily life of its children. Children have make-believe friends, they practice playing at make-believe roles, and they use make-believe objects. Sticks become guns, bars of soap become cars, and little boys and girls become cowboys and policemen. Worlds are imagined in which pigs fly and frogs become princes. In such worlds, one might even imagine that impoverished, uneducated lower-class Brazilian children can perform as well as educated Brazilian or European children at solving logical syllogisms. Indeed, it turns out that such a world is not a make-believe world.

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Received 18/2/4
Accepted 25/7/04

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