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ABSTRACT

Sixty pupils from the third grade of a public school in a middle class suburban community were randomly assigned to four groups. Pupils in one of the groups were given, individually, a two-lesson instructional sequence using the audio-tutorial mode. Pupils in a second group were given the same two-lesson sequence in the teacher-directed, group mode. Pupils in the third group were given the first lesson of the sequence individually, in the audio-tutorial mode, and the second lesson as a teacher-directed group. Lessons were adapted from the SCIS Interaction unit. Data from this study show that: (1) Pupils instructed in the individual, audio-tutorial mode were distracted overtly for a small proportion of instructional time than pupils who were instructed in the teacher-directed group mode: (2) Pupils who were instructed by a combination of the modes defined interaction on the posttest more frequently than pupils who were taught by either mode alone; (3) Pupils who were instructed individually were better able to generalize across several exemplars of interaction than pupils who received instruction in groups; (4) Pupils who received part or all of their instruction from a teacher identified interacting diads more frequently than pupils who receive instruction individually. (BR)

A COMPARISON OF INDIVIDUALIZED AND GROUP INSTRUCTION IN SCIENCE: EFFECTS ON THIRD GRADE PUPILS

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Introduction

A fundamental premise of contemporary elementary science instructional programs is that direct experience with materials exemplifying phenomena is a beginning step in the learning process. Almost without exception, writers of the new programs have directed teachers to permit exploration or investigation at the outset of instruction so that children gain an intuitive familiarity with materials and phenomena. It is assumed by most educators and psychologists that these common, first-hand experiences provide sensory input that is essential for meaningful learning.

The theorized benefits of children's explorations often fail to materialize in actual practice. In the typical classroom setting, small groups of children are given materials on which they are to make observations and perform certain manipulations. Frequently, pupils give only superficial attention to these materials. Instead of making observations and the desired manipulations, children simply look at the objects and handle them in ways which may minimize or preclude the desired educational outcomes, while their major energy and attention is directed toward the teacher and other children. Teachers are quick to recognize these limitations and they either shorten this sensory input phase of the instructional

sequence so that its potential is greatly diminished, or they omit it entirely. Consequently, the well-reasoned plans of the program developer are thwarted and children receive instruction that begins at the verbal level rather than with direct, sensory experiences.

It seems apparent that the tasks required of children during this exploratory phase cannot be done adequately in the crowded conditions that prevail in most classrooms. Distractions arising from other pupils and from the teacher make it difficult for a child to observe thoroughly and perform manipulations with care, or reflect upon these experiences. Moreover, many teachers reward rapid pupil responses to questions more frequently than slower, more deliberate ones. Even more important may be pupils' interest in interacting with peers which is typically greater than their interest in observing and manipulating the objects set out by teachers.

If feasible, these initial, sensory input experiences might prove more effective if children could perform them in isolation. This would permit more careful observation, thought-guided manipulation, and an opportunity for reflection without distraction from the teacher or other pupils. The audio-tutorial mode of instruction

developed by Postlethwaite (1964) and Novak (1966) can provide temporary isolation that may be conducive to more careful and thoughtful activity during the initial, exploratory phase of learning.

Several studies have been made of the audio-tutorial mode (Bridgham, 1969; Hill, 1968; Novak, 1966; Siemankowski, 1969). In these studies, the audio-tutorial mode has generally been used in lieu of the teacher. Thus far, little attention has been given to the potential of this mode to enhance children's educational experiences by providing a physical setting (i.e. temporary solitude) not otherwise available.

The purpose of this study was to compare the effects of instruction presented in the individual, audio-tutorial mode and the familiar teacher-directed, group mode. Also, the impact of a combination of modes was investigated, using the individual audio-tutorial mode for the initial sensory input phase and the teacher-directed, group mode for the subsequent instruction.

In assessing the effects of the different instructional modes, the following hypotheses were made and tested:

Hypothesis 1: Pupils instructed individually in the audio-tutorial mode, will be distracted from tasks less than pupils who are instructed in a group.

Hypothesis 2: Pupils who are individually instructed will demonstrate greater achievement on the post-test than pupils who receive group instruction.

(a) They will define interaction correctly more frequently than pupils receiving group instruction.

(b) They will generalize across the several instructional experiences more frequently than pupils receiving group instruction.

(c) They will be able to identify correctly exemplars and non-exemplars of interaction more frequently than pupils receiving group instruction.

(d) In describing interactions, they will identify interacting diads more frequently than pupils who receive group instruction.

Hypothesis 3: Pupils who received their initial, sensory input lesson individually and subsequent instruction in a teacher-directed group will demonstrate greater achievement on the post-test than pupils who receive instruction in only one mode.

Procedure

Sixty pupils from the third grade of a public school in a middle-class suburban community were randomly assigned to four groups. Pupils in one of the groups were given, individually, a two lesson instructional sequence using the audio-tutorial mode (A-T Taught). Pupils in a second group were given the same two lesson sequence in the familiar, teacher-directed, group mode (Teacher Taught). Pupils in the third group were given the first lesson of the sequence individually, in the audio-tutorial mode, and the second lesson as a teacher-directed group (Combination). The fourth group served as a control and received no instruction (Uninstructed).

The particular elementary school in which this study was done had been utilizing an individualized approach to instruction, especially in mathematics and reading for two years. Pupils were used to working in carrels with tape recorders, and other instructional aids. Consequently, the audio-tutorial mode was not a novelty to the subjects in this study.

The lessons were adapted from Interaction, a unit prepared for primary school children by the Science Curriculum Improvement Study. The lessons, which were each approximately twenty minutes

in length, followed the instructional plan outlined by the unit's writers; that is, the first lesson provided an opportunity for "exploration" of several exemplars of interaction. In the second lesson, the concept of interaction was "invented" and pupils "discovered" ways of applying it. The audio-tutorial lessons and those provided by the teacher paralleled each other as closely as possible.

Three types of data were collected:

1. Achievement Data — pupils were post-tested approximately one week after the conclusion of the instructional sequence to determine their understanding of, and ability to apply the concept of interaction. The test instrument, developed specifically for this study, is presented in Appendix 1.

2. Process Data — information about pupil behavior during the instructional sequence. Included are performance data on specific tasks children were required to complete and a video-tape record of all overt pupil behavior during the instructional sequence.

3. Pupil Background Data — pupil scores on the Iowa Test of Basic Skills administered approximately two months prior to this study. Two scores were utilized to assess pupil background: the reading score and the composite score.

Results

Although pupils were randomly assigned to treatments, the group size (N = 15) made it desirable to determine if the groups were, in fact,equivalent. Pupil scores on the Iowa Test of Basic Skills were used for this purpose. Data are presented in Table 1. Both reading

Table 1

Mean Pupil Scores on the Iowa Test of Basic Skills: Grade Level Equivalents

		A-T Taught N=15	Teacher Taught N=15	Combination N=15	Uninstructed N=15
Iowa Test of Basic Skills					
Reading	Mean	4.66	4.02	4.31	4.29
	S.D.	1.28	.74	1.09	.80
Composite	Mean	4.74	4.04	4.49	4.35
	S.D.	.81	.63	.81	.60

Table 1 (Continued)

Analysis of Variance Data: Reading Scores

	Mean Square	F-Ratio	p
Between	1.03	.93	.434
Within	1.11		

Analysis of Variance Data: Composite Scores

	Mean Square	F-Ratio	p
Between	1.28	2.31	.085
Within	.55		

and composite scores are shown. Analysis of variance indicated that the four treatment groups were not significantly different from one another.

Video-tapes of the initial "exploration" lesson were analyzed to determine the percentage of time pupils were overtly distracted from tasks that were part of the instructional sequence. These data are presented in Table 2. Five specific tasks comprised the "exploration" lesson. First, pupils worked with a series of exemplars of interaction (an Alka-Seltzer tablet in water, a weight bouncing on a spring, a battery and a light bulb, a scissors and some paper, a paper clip and a magnet). Second, after working with each of these exemplars, pupils were directed to reflect on

Table 2

Mean Percentage of Time Pupils Were Overtly Distracted "Exploration" (Lesson 1)

	Pupil Tasks	A-T Taught N = 15 pupils	Teacher Taught N = 15 pupils
1.	Working with objects which exemplify interaction	2.1 %	32.9 %
2.	Examining and reflecting on objects which exemplify interaction	5.0	23.0
3.	Drawing pictures showing interaction	3.0	14.6
4.	Examining and reflecting on drawings	3.1	20.9
5.	Writing a summary of observations	3.2	7.1
	Total	2.9	22.9

what had occurred. Third, they drew pictures of each of the exemplars before and after interaction had occurred. Fourth, pupils were directed to examine and reflect upon their drawings, and, finally, they were asked to write a summary statement concerning their observations.

The data in Table 2 show that pupils who received instruction in the individualized, audio-tutorial mode were distracted less frequently than pupils instructed in the group mode. It is important to note that pupils in the group setting were overtly distracted a much greater proportion of the time during tasks that were of crucial significance in science instruction — during periods of sensory input and reflection.

Data from the post-test were then examined to determine if the attentional differences between the groups resulted in differences in achievement. In addition, the group which received instruction in both modes (combination) and the control (uninstructed) group were considered.

The first item on the post-test asked children to define interaction. Data are presented in Table 3. Four categories of response were identified:

1. A stated definition (e.g., in third graders' language, "When something does something to another thing.").
2. A specific example of interaction (e.g., a weight bouncing on a spring).

Table 3

Pupil Responses to "Tell what interaction is."

Response Category	A-T Taught N=15	Teacher Taught N=15	Combination N=14*	Uninstructed N=15
Stated definition	3	1	8	0
Gave example	3	4	2	2
Defined "evidence"	6	8	0	0
No Response or Unclassifiable	3	2	4	13

* One pupil moved to another community before the post-test was administered.

χ^2 Table: Stated definition or example vs. no definition or example

	A-T Taught	Teacher Taught	Combination	Uninstructed	
Definition or example	6	5	10	2	23
No definition or example	9	10	4	13	36
	15	15	14	15	59

$\chi^2 = 10.27$ ndf = 3 $.01 < p < .02$

3. Confusion of interaction and evidence of interaction.

4. No response or unclassifiable response.

To test the difference among the four groups, the χ^2 test for k independent samples was applied (Siegel, pp. 175 - 179). Because of the small sample size, it was necessary to combine categories 1 and 2 and categories 3 and 4. Thus the test was to determine if the groups differed significantly in the ability to define or give an example of interaction contrasted with not being able to do so. The χ^2 test indicated that the groups are significantly different ($.01 < p < .02$). Examining Table 3, it became clear that the group taught by the combination of methods were distinctly different from the others. Applying Fisher's Exact Probability Test (Siegel, pp. 96 - 104), it was found that the teacher taught and audio-tutorial taught groups are not significantly different from the uninstructed group ($p = .154$, $p = .089$ respectively).

The second post-test item asked "How do you know when an interaction takes place?" Three categories of response were observed:

1. A generalized statement about evidence (e.g., can see something change).

2. A specific example of evidence (e.g., the Alka-Seltzer fizzes).

3. No response or unclassifiable response.

Data are shown in Table 4. To permit the use of the χ^2 test, categories 2 and 3 were combined. Thus, distinction among groups'

Table 4

Pupil Responses to "How do you know when interaction takes place?"

Response Category	A-T Taught N=15	Teacher Taught N=15	Combination N=14	Uninstructed N=15
Generalized about Evidence	11	7	7	1
Gave Specific Example of Evidence	2	6	6	4
No Response or Unclassifiable	2	2	1	10

χ^2 Table: Generalizing about evidence vs. not generalizing

	A-T Taught	Teacher Taught	Combination	Uninstructed	
Generalize about Evidence	11	7	7	1	26
Not Generalizing	4	8	7	14	33
	15	15	14	15	59

$\chi^2 = 13.95$ ndf = 3 $.001 < p < .01$

ability to generalize about evidence was examined ($.001 < p < .01$). Audio-Tutorial taught pupils show the greatest ability to generalize about evidence, with the teacher taught group and the group instructed by the combination of modes being about equivalent.

The remainder of the post-test consisted of pictures that were either exemplars (four items) or non-exemplars (one item) of interaction. Children were asked to state if an interaction was occurring or not and then justify their answer. Pupils were scored on the number of correct responses to the question, "Does the picture show an interaction?" These data comprise Table 5. Differences among groups are small ($.1 < p < .2$).

Table 5

Number of Correct Identifications of Interaction

	A-T Taught	Teacher Taught	Combination	Uninstructed
Number Correct	66	67	64	60
Number Incorrect	9	8	6	15
Number of Items	5	5	5	5
Number of Pupils	15	15	14	15
Maximum Possible Score	75	75	70	75
Mean Score Per Pupil	4.4	4.5	4.6	4.0

$\chi^2 = 4.88$ ndf = 3 $.1 < p < .2$

Analysis of reasons pupils gave for their answers required categorization of responses for each item. Data for these items are presented in Appendix 2. In the four items that were exemplars of interaction, an interesting phenomenon occurred: In referring to the elements of interaction some pupils referred to interacting diads (e.g., the flame melts the wax or the diver bends the board); whereas, other pupils would refer only to one element of the interacting pair. Thus pupil responses to the four items that were exemplars of interactions were categorized as:

1. References to interacting diads
2. References to a single element
3. Other (including no response and unclassifiable).

In Table 6, pupil responses are shown. The data suggest that pupils who received part or all of their instruction from the teacher refer to both members of interacting diads more frequently than either the audio-tutorial taught pupils or those who received no instruction.

Table 6

Evidence of Interaction Cited by Pupils:
Four Exemplars of Interaction from Post-Test

Response Category	A-T Taught N=15	Teacher Taught N=15	Combination N=14	Uninstructed N=15
References to Interacting Diads	10	19	21	6
References to Single Element	34	27	21	33
Other	16	14	14	21
Total	60	60	56	60

$\chi^2 = 16.64$ ndf = 6 $.01 < p < .02$

Discussion

The audio-tutorial mode of instruction provides a form of isolation for children in crowded classrooms. The headphones and the study carrel can serve to reduce ambient visual and aural stimuli which may interfere with learning. The data shown in Table 2 demonstrate the distracting effects of other pupils and a "live" teacher during the sensory input phase (Task 1). Nearly one third of the time, children in the group setting are attending overtly to things other than the exemplars of the phenomenon. During the periods designed for reflection (Tasks 2 and 4), children in the group setting

are distracted overtly more than one-fifth of the time. The effect of the setting on distraction is smaller but still observable during times of pupil output (Tasks 3 and 5). When children are writing or drawing, distraction is reduced.

In science, sensory input in the form of careful observations of exemplars of phenomena is a fundamental part of instruction. This assumption is the basis of much of science teaching at the elementary school level. However, the typical classroom setting provides distractions which may cause pupils to make incomplete and invalid observations. Consequently, their sensory input may provide an inadequate basis for learning. Moreover, the distracting effects of the teacher and other pupils on the reflective or contemplative components of instruction can only be guessed by anyone whose contemplative efforts are interrupted by telephones or "unscheduled" appointments. The familiar phrase, "Where were we before we were interrupted?" attests to man's inability to recall events that have been terminated abruptly.

Studies on memory have demonstrated the detrimental effects of interruption, especially during the few seconds immediately following a specific experience (Norman, 1969). Applying knowledge

from these studies to the classroom setting, it would seem reasonable that an indeterminate proportion of children's school experiences are simply not remembered because of interference to memory resulting from distractions that abound.

This notion may account for the lesser ability of group-instructed pupils to generalize about evidence (Table 4). The pupils who received instruction in isolation were distracted less frequently, and then only voluntarily; whereas, pupils in the group were subjected to much more frequent distractions over which they had little or no control. Differences in ability to generalize across exemplars may be due, in part, to the fact that some of the group-instructed pupils essentially did not experience all of the exemplars because they were distracted at a critical time in the establishment of the memory trace of the event. Thus, even though all pupils went through the motions of engaging in the experience it had no lasting effect on some.

Critics of the audio-tutorial mode sometimes cite isolation as detrimental to children and stress the importance of socialization in learning. Clearly, interaction among pupils, and between pupils and adults is important in verbalizing ideas and in testing one's

ability to use ideas and convey them to others. The data in Tables 3 and 6 attest to this point. However, socialization may impede and limit the formation of ideas if it limits or detracts from the sensory input from which ideas are built.

The data from this study suggest that the different instructional modes might appropriately be assigned specific instructional tasks. Some tasks undoubtedly require group interaction. Others may require more extended periods without distraction. The choice of instructional mode should be related to the effectiveness of various modes in helping children attain specified instructional objectives. Educational planners need to match instructional modes and objectives more carefully than has been typical in the past.

Summary

This study explored the differential effects of instruction in the individualized, audio-tutorial mode and the familiar teacher-directed, group mode. Also, the effects of a combination of these modes were examined, with each mode serving a specific instructional function.

The data from this study show that:

1. Pupils instructed in the individual, audio-tutorial mode were distracted overtly for a smaller proportion of instructional time than pupils who were instructed in the teacher-directed group mode.
2. Pupils who were instructed by the combination of modes defined interaction correctly on the post-test more frequently than pupils who were taught by either mode alone.
3. Pupils who were instructed individually were better able to generalize across several exemplars of interaction than pupils who received instruction in groups.
4. Regardless of treatment, no significant differences were found in pupils' ability to discriminate between exemplars and non-exemplars of interaction.
5. Pupils who received part or all of their instruction from a teacher identified interacting diads, when describing interactions, more frequently than pupils who received instruction individually.

Curriculum developers and teachers may conclude that instructional tasks should be assigned to various instructional modes depending upon the outcomes sought.

Appendix 1

Post-Test on Interaction

INTERACTION

Name _____ Grade _____

Tell what interaction is. _____

_____

_____

How do you know when interaction takes place? _____

_____

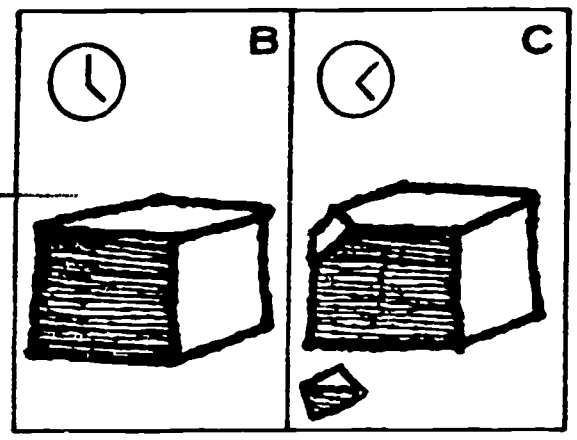
Does the picture marked A show interaction?

Yes No

How do you know? _____

_____

_____



Picture B shows a block of wood at 4:00 o'clock.

Picture C shows the same block of wood 10 minutes later.

Has any interaction taken place in the time between the two pictures? Yes No

How do you know? _____

_____

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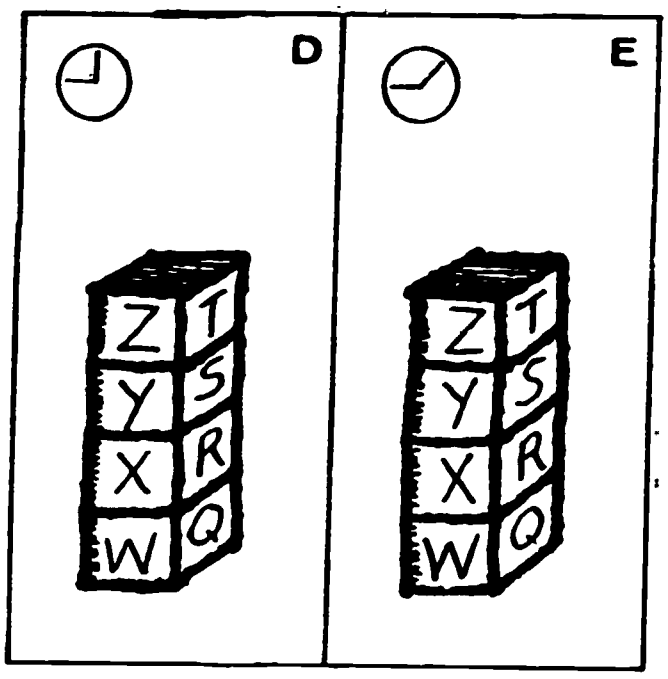


Picture D shows a stack of blocks at 9:00 o'clock.

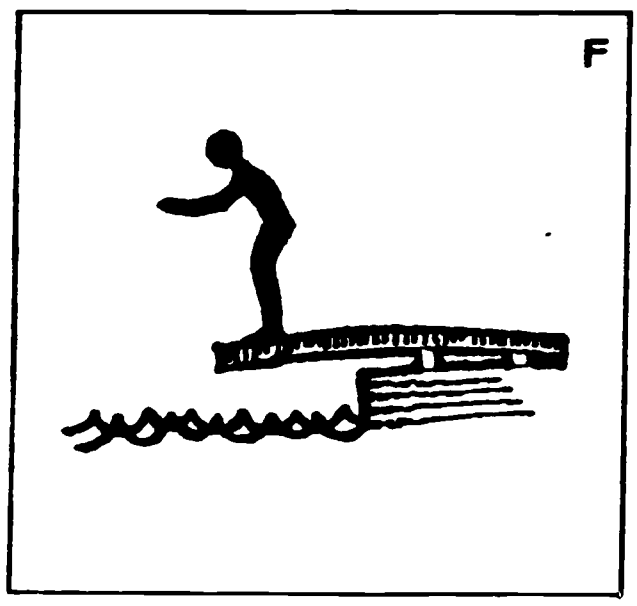
Picture E shows the same stack of blocks 10 minutes later.

Has any interaction taken place in the time between the two pictures?

Yes No

How do you know? _____

_____



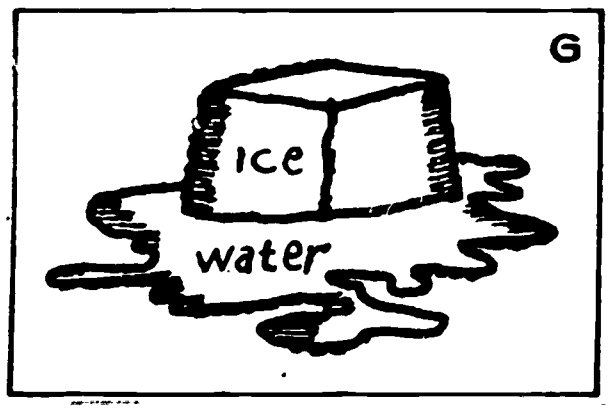
Picture F shows a boy on a diving board. Does it show interaction?

Yes No

How do you know? _____

_____

_____



Does the picture marked G show interaction? Yes No

How do you know? _____

_____

_____

Appendix 2

Pupil Responses on Post-Test: Evidence of Interaction

Table A

Evidence of Interaction: Candle

Pupil Response Categories	A-T Taught N=15	Teacher Taught N=15	Combination N=14	Uninstructed N=15
References to flame and wax	3	7	8	0
References to flame	6	5	1	3
References to wax	4	2	2	4
Other	2	0	2	1
Unclassifiable or no response	0	1	1	7

Table B

Evidence of Interaction: Cut Block

Pupil Response Categories	A-T Taught N=15	Teacher Taught N=15	Combination N=14	Uninstructed N=15
Describes changes from first to second scene	4	4	4	2
Describes only second scene	7	6	7	8
References to time change	2	1	1	2
Other	1	3	0	0
Unclassifiable or no response	1	1	2	3

Table C

Evidence of No Interaction Having Occurred:
Stack of Blocks

Pupil Response Categories	A-T Taught N=15	Teacher Taught N=15	Combination N=14	Uninstructed N=15
No observable change	13	11	10	11
References to time change	0	1	1	3
Other	2	3	3	1

Table D

Evidence of Interaction: Diver

Pupil Response Categories	A-T Taught N=15	Teacher Taught N=15	Combination N=14	Uninstructed N=15
References to boy bending board	0	1	4 (2)	0
References to boy	7 (7)	7 (6)	3 (2)	9 (7)
References to board	0	0	2 (1)	0
No evidence of interaction	5	3	3	1
Other	3	1	2	3
Unclassifiable or no response	0	3	0	2

Number in parenthesis indicates children who fabricated evidence or made predictions beyond data presented (i.e., boy is going to jump).

Table E

Evidence of Interaction: Ice

Pupil Response Categories	A-T Taught N=15	Teacher Taught N=15	Combination N=14	Uninstructed N=15
Ice changing to water	3	7	5	4
Ice melting	10	7	6	9
Other	1	1	1	1
Unclassifiable or no response	1	0	2	1

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