Incorporating quantitative information into a linear ordering*

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Ss were required to learn linear orderings of four terms ($A > B > C > D$). Each pair of terms was described as being either "just barely," "moderately," or "very much" different on some meaningful dimension. Two distinct strategies for coding this information were observed. Some Ss varied the spacing of the terms along some continuum (e.g., A_B_C_D), while others spaced the terms evenly along a continuum and inserted verbal tags to represent the quantitative information (e.g., A just barely B moderately C very much D). The former strategy was consistently found to be superior. Performance did not vary as a function of the quantitative difference between the terms.

In an attempt to understand the strategies Ss employ when trying to remember meaningful verbal material, Potts (1972) had Ss learn two four-term linear orderings. Such a relation can be characterized as $A > B > C > D$. The terms of the relations were ordered along a meaningful dimension, and the ordering of the terms was established by presenting the adjacent pairwise relationships between these terms in the context of a meaningful paragraph. Thus, the presented information was of the form "The fish was friendlier than the frog, the frog was friendlier than the duck," etc.

Though a four-term ordering can be broken into six pairs of terms, the three pairs which describe the relationships between the adjacent elements of the ordering are both necessary and sufficient to describe the ordering completely. These pairs ($A > B$, $B > C$, and $C > D$) will be referred to as *adjacent pairs*. The *remote pairs* ($A > C$, $B > D$, and $A > D$) describe relationships between nonadjacent terms in the ordering. The relations employed were transitive, so each of these remote pairs could be deduced from some subset of the adjacent pairs. Potts found that responses to the remote pairs were both faster and more accurate than responses to the adjacent pairs. This was true even when the remote pairs were never presented and, thus, had to be deduced from the adjacent pairs.

Huttenlocher (1968) has argued that, in attempting to solve a three-term series problem, Ss arrange the terms of the ordering in an "imaginary space." Potts's result could be accounted for by arguing that this space represents an interval scale and that the difference between two items on the critical dimension (e.g., friendliness) is represented by the distance separating the corresponding terms on this interval scale. In what follows, this model will be referred to as a *rating scale theory*. Having established this scale, it is reasonable to suppose that Ss will tend to forget the exact location of any particular item on the scale. Assume that Ss make an

error on a particular pair whenever the displacement of the two terms comprising that pair is sufficiently large that the two terms cross on the scale. Clearly, the farther apart on the scale two terms are, the farther the displacement would have to be before the terms would cross. Hence, this model would predict that proportion correct on a pair should be a monotonic increasing function of the distance separating the two terms of the pair. Since the terms of a remote pair would have to be placed further apart on the scale than the terms of any adjacent pair necessary to deduce it, this model would necessarily predict that proportion correct should be higher on the remote pairs than on the adjacent pairs.

If this view is correct, then it is reasonable to argue that, when the difference between two terms in an ordering is described as being very large, proportion correct on the pair comprised of those terms should be higher than when the difference is described as being very small. Experiment I was designed to test this prediction.

EXPERIMENT I

Method

Subjects. Ss were 88 Dartmouth College undergraduates enrolled in a sophomore perception course. Forty-eight of these Ss were retested 1 week after the original session.

Materials and Design. The critical paragraph employed in the present experiment was similar to the one described in Potts (1972) and consisted of two four-term linear orderings. The first of these orderings arranged a set of forest animals linearly according to intelligence; the second ordered a set of pond animals according to friendliness. Both orderings were established by presenting the three adjacent pairs comprising that ordering. These pairs were presented in the order $C > D$, $A > B$, $B > C$. A version of this paragraph is presented in Table 1.

For one of the two relations in each paragraph (the "smarter than" relation in Table 1), A was described as being just barely smarter (friendlier) than B, B was described as being moderately smarter (friendlier) than C, and C was described as being very much smarter (friendlier) than D. In what follows, this relation type will be characterized as "A.B..C...D." The other relation (the "friendlier than" relation in Table 1) was similar, except that A and B were described as being "very much" different, while C and D were described as being "just barely"

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Table 1
Sample Paragraph Used in Experiment I

In a small forest just south of nowhere, a deer, a bear, a wolf, and a hawk were battling for dominion over the land. It boiled down to a battle of wits, so intelligence was the crucial factor. The wolf was very much smarter than the deer, the bear was just barely smarter than the hawk, and the hawk was moderately smarter than the wolf. On a small pond in the middle of the same forest, another contest for dominion was being waged. The contenders were a frog, a clam, a duck, and a fish. In this case, however, the battle was to be decided by an election, and friendliness was the crucial factor. The clam was just barely friendlier than the duck, the fish was very much friendlier than the frog, and the frog was moderately friendlier than the clam. In the end, each of the battles was decided in its own way and tranquility returned to the area.

different. This relation type will be characterized as "A...B...C.D." The "smarter than" relation was always presented first in the paragraph, and the order of presentation of the two relation types was counterbalanced.

A set of 24 test sentences was used to test Ss' knowledge of the ordering information contained in the critical paragraph. Half of the sentences were true; half were false. The 12 true sentences were statements of the 12 pairs which comprised the two relations in the paragraph. Each of the 12 false sentences corresponded to one of the true sentences but had the order of the terms reversed. The sentences were listed on two pages of a computer printout, with 12 sentences per page. The order of presentation of the test sentences was randomly permuted for each S, the only restriction being that the two sentences (one true and one false) corresponding to the same pair never both appeared on the same page.

A set of six sentences was used to test Ss' knowledge of the magnitude of the differences between the various pairs of terms. Each of these sentences consisted of a statement of the ordered relationship between one of the six adjacent pairs (three for each of the two orderings). A blank space was inserted in place of the quantitative information. Thus, such a test sentence would be of the form "The frog was _____ friendlier than the duck." Ss were to insert the appropriate terms ("moderately," "just barely," or "very much") in the blanks.

Procedure. The first session lasted approximately 20 min. Ss were run in a large group and no apparatus was necessary. The study and test materials were printed on separate sheets of paper which were stapled together to form a booklet. Each S was given one of these booklets prior to the beginning of the session. Ss were cautioned not to turn any pages in the booklet unless explicitly instructed to do so and never to look back to a previous page. Before beginning the session, Ss were given a practice paragraph to study. Following a short test on this practice paragraph, Ss began the main task.

Ss read two paragraphs in succession. The first of these was the critical paragraph containing the two linear orderings. Ss were given 1½ min to study this paragraph. They were allowed to take notes if they desired but were told that they would not be allowed to use these notes to answer the test questions. The second paragraph was used for the purpose of introducing a delay between the study period and the test on the critical paragraph. After studying this filler paragraph for 30 sec, Ss were given as long as they needed to respond to the 24 test sentences pertaining to the critical paragraph. Ss were then tested for their knowledge of the magnitude of the quantitative differences between the various pairs of terms.

After being tested, Ss were given two additional tasks to perform. First, the critical paragraph was returned and Ss were asked to take notes on the information contained in the paragraph. They were told that these notes should be brief but should include all the relevant information in the paragraph. Ss

were given as much time as they needed to complete this task. In addition to providing an indication of the coding strategies Ss were using, this task also served to give Ss additional exposure to the critical paragraph. It was hoped that this would serve to aid performance on the delayed test that was to be administered 1 week later.

Finally, Ss were asked to indicate their interpretations of the magnitude of the differences represented by the terms "moderately," "just barely," and "very much." To accomplish this, Ss were given a sheet of paper which described the following relation: "A is moderately different than B, B is just barely different than C, and C is very much different than D." They were told to place the letters A, B, C, and D on a 20-point scale in such a way that the difference between two terms was reflected by the spatial distance between those two terms on the scale.

One week after the original session, 48 of the Ss returned and were given a surprise retest on the 24 sentences describing the ordering information in the critical paragraph.

Results and Discussion

Except where noted, statistical analyses were performed using two-tailed sign tests for matched samples. Proportions correct on both the immediate and the delayed tests for pairs described by small quantitative differences and pairs described by large quantitative differences are presented in Table 2. Table 2 also presents proportions correct on the adjacent and remote pairs for both tests. The pairs (one adjacent and one remote) representing small quantitative differences are $A > B$ and $A > C$ in the relation type $A . B . . C . . D$, and the pairs $C > D$ and $B > D$ in the relation type $A . . . B . . C . D$. The pairs representing large differences are $C > D$ and $B > D$ in relation type $A . B . . C . . D$ and the pairs $A > B$ and $A > C$ in relation type $A . . . B . . C . D$. This particular choice of pairs insured that quantitative difference was not confounded with particular pair tested (e.g., since the difference between the terms B and C was always constant, inclusion of this term would result in the confounding of the effects of distance with serial position). Also, with this choice of pairs, the test of the effect of distance was orthogonal to the comparison between adjacent and remote pairs.

The superiority of the remote pairs is readily apparent. The difference between proportion correct on the adjacent vs remote pairs was significant for both the immediate and delayed tests ($z = 2.71$, $p < .01$ and $z = 2.23$, $p = .03$, respectively). This replicates the results of Potts (1972). A rating scale theory would attribute this difference to the fact that the terms of the remote

Table 2
Proportions Correct for Experiment I

Test	Quantitative Difference		Type of Pair	
	Small	Large	Adjacent	Remote
Immediate	.757	.753	.741	.776
Delayed	.758	.755	.753	.798

pairs are placed farther apart on Ss' imaginary scale than the terms of the adjacent pairs.

This explanation seems unlikely in light of the comparison between the pairs described by small and large quantitative differences, however. Examination of Table 1 shows that, for both immediate and delayed tests, performance is virtually unaffected by the quantitative difference between the terms ($z = .12$, $p = .90$ and $z = .18$, $p = .86$ for the immediate and delayed tests, respectively). The very small effect which was obtained was in a direction opposite that predicted by the rating scale theory.

By examining the sheets on which Ss indicated their interpretation of the quantitative differences, it is possible to estimate what the actual spatial distance between the terms of each of the six pairs would have been if Ss had actually used a rating scale to encode the quantitative information. According to this estimate, the average distance separating pairs of terms described by small quantitative differences was indeed very small compared to the average distance separating pairs of terms described by large quantitative differences. The average distance separating the terms of adjacent pairs was also smaller than the average distance separating the terms of remote pairs, but the difference was not as large. Hence, if Ss were coding quantitative information by varying the spacing of items along some imaginary line and proportion correct on a pair was a monotonic function of the distance separating the terms of that pair, then the effect of quantitative difference should have been larger than the effect of adjacent vs remote pairs. Instead, the difference in proportion correct between adjacent and remote pairs was highly significant, while there was virtually no difference between pairs described by small quantitative differences and pairs described by large quantitative differences.

It should be noted that Ss were given a limited amount of time to study the critical paragraph. This was necessary in order to avoid ceiling effects. One could argue that the predicted effects of quantitative information would have appeared had Ss been given more time to study the information. This is unlikely, however, for after the first test Ss were again given the critical paragraph and were told to take notes on it. They were given as long as they liked to complete the task. The results on the delayed test given 1 week later matched very closely the results on the immediate test.

There are two possible explanations for the failure of the rating scale theory. The first is that Ss may not have coded the quantitative information by altering the spacing of the items; the second is that, though Ss may have coded the information in this manner, proportion correct may not be directly related to distance.

Upon examination of Ss' posttest note sheets, the author noted two basically different types of code for the quantitative information. Some Ss ordered the terms along a line with varied spacing between the items. This *spacing* strategy is the one described by a rating scale

theory. Other Ss ordered the terms along a line with equal spacing between the four terms. Quantitative differences were coded by labeling the gap between each pair of terms with the appropriate verbal tag, "moderately," "just barely," or "very much" (or some abbreviation of these words). A judge who was unfamiliar with the design of the experiment classified each S's note sheet. Of the 78 Ss who correctly ordered the terms of both relations, 22 used the spacing strategy and 30 used the verbal tag strategy. Five additional Ss coded the quantitative differences in both ways, and 21 Ss used a strategy that could not be unambiguously classified into either of these categories. In a majority of these questionable cases, Ss spaced the terms equally along a line, separating them by "greater than" signs. Quantitative information was coded by varying either the size or number of the "greater than" signs.

Thus, it would appear that Ss do not all use the same strategy in attempting to incorporate quantitative information into a linear ordering. Some appear to vary the spacing of terms as predicted by the rating scale; some do not. A question immediately arises as to whether the note sheet performance correlates with criterion performance. Of those Ss who participated in the delayed test (which was administered 1 week after they took the notes described above), 13 coded the quantitative differences by altering spacing and 13 used verbal tags. Neither group showed the predicted high proportion correct on those pairs separated by large spatial distances. Hence, even among Ss who coded the quantitative information by varying spacing, no evidence was found to indicate that proportion correct is a monotonic function of distance. Interestingly, however, overall proportion correct for those Ss who coded the quantitative differences by altering spatial distance was substantially higher ($p = .872$) than overall proportion correct for those Ss who coded the quantitative differences using verbal tags ($p = .724$). The difference, tested using a Mann-Whitney U test, was significant ($U = 43.5$, $p < .05$).

Unfortunately, the correlational nature of this result prevents one from concluding that the spacing strategy is superior. It may merely be the case, for example, that the more competent Ss tend to use that strategy.

EXPERIMENT II

Experiment II was designed to determine if altering the spacing of items is a more efficient way to code quantitative information than is the use of verbal tags. Ss were divided into groups according to the instructions they were given. One group was told to code quantitative information by altering spacing, another group was told to use verbal tags, and a third group was given nonspecific instructions.

Method

Subjects. Ss were 57 Dartmouth College undergraduates who

Table 3
Number of Subjects Using Various Strategies in Each
of the Three Instruction Conditions*

Instruction	Coding Strategy Used			
	Spacing	Tag	Both	Ambiguous
Spacing	14	0	4	1
Tag	1	7	3	4
Control	2	6	1	6

*This table does not include the eight Ss (two in the spacing and three each in the tag and control conditions) who did not order the items along a line but instead listed the three pairwise relations.

participated to fulfill a course requirement. Each S participated in one 30-min session.

Materials and Procedure. The materials and procedure employed in the present experiment were identical to those employed in Experiment I except for the modifications described below.

In addition to the practice paragraph, each S studied a series of eight critical paragraphs. Each paragraph consisted of a single four-term linear ordering similar in structure to the ones employed previously. The order of presentation of the three adjacent pairs comprising an ordering was varied across paragraphs. Ss were given 40 sec to study each paragraph. They studied all eight paragraphs before answering any questions.

After studying the eight paragraphs, Ss were given eight sets of test sentences, each set listed on a separate computer printout. The first set consisted of the 12 sentences (six true and six false) testing the six pairwise ordinal relationships in the first paragraph, the second tested the ordinal relationships in the second paragraph, etc. The order of presentation of the sentences was permuted for each paragraph and for each S. Following this, they were given one of the paragraphs to take notes on and were then given a 20-point rating scale which they were to use to indicate their interpretation of the quantitative differences. Hence, the testing sequence was identical to the sequence employed in Experiment I.

Design. Ss were run in groups of five or less. Each group was randomly assigned to one of three conditions according to the instructions they received. All groups were told that there were two types of information in the paragraphs: information about the ordering of several items along some dimension and information about the quantitative differences between the items. This was clarified by providing an example of the two types of information as it appeared in the practice paragraph.

Ss in the *spacing* condition ($N = 21$) were instructed to create an image of the terms ordered along an imaginary line and to code quantitative differences by altering the spacing of the terms.

Ss in the *tag* condition ($N = 18$) were instructed to create an image of the terms ordered, and equally spaced, on an imaginary line and to code quantitative differences by using verbal labels.

Ss in the *control* condition ($N = 18$) were given nonspecific instructions, merely being told to be sure to try to remember both types of information.¹

Results

Proportions correct on the remote and adjacent pairs were .890 and .837, respectively. This difference was highly significant ($z = 5.37$, $p < .001$). Proportions correct on pairs described by large and small quantitative differences were .880 and .845, respectively. Though in the predicted direction, this difference did not approach significance ($z = .99$, $p = .30$). Thus, the present results are in agreement with the previous ones in failing to

provide evidence for the rating scale theory.

Ss' note sheets were classified into four categories: those using altered spacing on a line to code quantitative differences, those using verbal tags, those using both spacing and tags, and those using a method of coding which did not fit clearly into any of the above categories. This classification was again performed by an independent judge who was unfamiliar with the design of the experiment. The number of Ss in each condition falling into each of these categories is given in Table 3. A Fischer exact probability test used on the number of Ss using varied spacing vs the number using verbal tags indicated a significantly different pattern of responses between the spacing and the tag conditions ($p < .01$) and between the spacing and the control conditions ($p < .01$). The tag and control conditions did not differ significantly in their pattern of responses ($p > .10$). Assuming that the note sheets to some extent reflected the strategies employed by Ss in studying the material, it would seem that instructions did serve to alter Ss' coding strategies.

Table 4 presents the overall proportions correct and standard error of the mean for the ordinal information and for the quantitative differences as a function of instruction condition. The data were analyzed using two one-way analyses of variance. The main effect of instructions was significant for the ordinal information [$F(2,54) = 3.16$, $p = .05$] and approached significance for the quantitative information [$F(2,54) = 3.02$, $p = .06$]. Since only 18 binary scores comprised each S's proportion correct on the quantitative information (as opposed to 72 for the ordinal information), the standard deviation of these scores was quite large and, hence, the test was not very sensitive.

A two-way analysis of variance revealed that the interaction between instruction condition and type of information was not significant [$F(2,54) = 2.33$, $p = .11$]. Because of the serious inequality of variance between the scores on the two types of information, however, this result must be interpreted cautiously.

Discussion

The present results indicate that, at least for the materials and procedures used in the present experiment, altering the spacing of the terms on an imaginary line is a more effective strategy for learning a linear ordering containing quantitative information than is the use of verbal tags inserted between items on an imaginary line.

Table 4
Proportions Correct for the Ordinal and Quantitative
Information in Experiment II*

Type of Information	Instruction Condition		
	Spacing	Tag	Nonspecific
Ordinal	.903 (.017)	.856 (.022)	.825 (.029)
Quantitative	.556 (.043)	.407 (.043)	.497 (.043)

*Standard errors of the means are given in parentheses.

Instructions to vary spacing resulted in better memory for both ordinal and quantitative information.

The relationship between the tag and control conditions is less clear, since for ordinal information Ss in the tag condition performed better than Ss in the control condition, while for quantitative information this relation was reversed. If reliable, this would be a theoretically interesting result. However, in view of the nonsignificant interaction of Instruction Condition by Type of Information and considering the note sheet performance, which seemed to indicate that Ss in these two conditions tend to use similar strategies, it seems more likely that these obtained differences were due to chance.

In view of the substantial number of Ss who spontaneously arrived at the spacing strategy in Experiment I, it was surprising that so few of the control Ss adopted this strategy in the present experiment. This may have been due to the limited amount of time allowed for studying each paragraph. Experiment III was designed to clarify the relation between the tag and control Ss and to explore the possibility that the amount of time the control Ss are given to study the paragraphs affects their ability to develop effective strategies for encoding the information and, hence, affects their performance relative to the other conditions.

Experiment III was also designed to eliminate a possible confound in the previous experiment. It is possible that the instruction conditions differentially affect Ss' tendency to take notes and that it is the taking or not taking of notes that is directly responsible for the obtained differences in proportion correct. To eliminate this possibility, Ss in the present experiment were not allowed to take notes. Because of this, however, the times used in Experiment III are not directly comparable to the times used in the previous experiment.

EXPERIMENT III

Method

Subjects. Ss were 91 Dartmouth College undergraduates who participated to fulfill a course requirement. Each S participated in one 30-min session.

Materials and Procedure. The materials and procedure were similar to those employed in the previous study. The modifications are described below. In the previous study, the difference between terms B and C was always described as "moderate." This enabled the test of the effects of distance to be orthogonal to the effects of type (adjacent vs remote) of pair. In the present experiment, all six possible combinations of the particular quantitative relation ("moderately," "just barely," and "very much") and the particular adjacent pair were employed. Also, since the present study was concerned with overall performance rather than performance on particular pairs, the order of presentation of the test questions was permuted only across the eight different paragraphs. For a particular paragraph, each S received the same permuted order. Finally, Ss in the present experiment were not allowed to take notes as they studied, and both the posttest note taking and the rating scale task were eliminated from this study.

Design. Ss were again run in small groups, with assignment of each group to a particular condition being random. The three

Table 5
Proportions Correct on the Ordinal
Information in Experiment III*

Rate Per Paragraph	Instruction Condition					
	Spacing		Tag		Nonspecific	
30 Sec	.853	(.026)	.816	(.027)	.799	(.021)
45 Sec	.900	(.024)	.773	(.035)	.883	(.041)

*Standard errors of the means are given in parentheses.

instruction conditions were factorially crossed with two rates of presentation. For the slow rate, Ss were allowed to study each paragraph for 45 sec. At this rate of presentation, there were 18, 16, and 9 Ss in the spacing, tag, and control conditions, respectively. For the fast rate, Ss were allowed to study each paragraph for only 30 sec. At this rate, there were 13, 15, and 20 Ss in the spacing, tag, and control conditions, respectively.

Results

The data were analyzed using two two-way (instruction by time) unweighted means analyses of variance. Aside from the fact that overall performance was better at the slow rate than at the fast rate, there were no significant differences among the six conditions on the test on the quantitative information.

The mean proportions correct for the ordinal information in the six conditions is given in Table 5, along with the standard error of the means for each of the groups. The superiority of the spacing instructions was again found. The main effect of instructions was significant [$F(2,85) = 4.06, p = .02$]. At the slow rate of presentation, performance in the control condition was very close to performance in the spacing condition, both being noticeably superior to performance in the tag condition. Increasing the rate was extremely detrimental to the control condition, however (and somewhat less so to the spacing condition), while having virtually no effect on the tag condition. Since even in the worst condition performance is near 80%, it seems unlikely that this represents a floor effect. The interaction of Instruction Condition by Rate approached significance [$F(2,85) = 2.56, p = .08$].

CONCLUSIONS

Strategies for Encoding Quantitative Information

As might be expected, Ss do not all use the same strategy in attempting to incorporate quantitative information into a linear ordering. While there are almost certainly a variety of such strategies, two seem especially prevalent: coding quantitative information by altering the spacing of items along a line and coding quantitative information using verbal tags. The former strategy was consistently found to be superior; Ss instructed to use the spacing strategy performed better than Ss instructed to use the tag strategy. Performance of Ss instructed to use the spacing strategy was also consistently superior to performance of Ss who were not given specific instructions.

Rate of Presentation

Since the interaction of Instruction Condition by Rate of Presentation only approached significance, any conclusions regarding the differential effects of rate of presentation must be considered tentative. The proportions correct appear to indicate that the difference between the two types of instruction is maximized when Ss are given a long time to study the material. Ss instructed to use the spacing strategy appear to be able to use this time effectively; Ss instructed to use the tag strategy do not seem to benefit from the extra time.

Performance appears to be most sensitive to the amount of time allowed for studying the material when Ss are not instructed regarding what strategy to use. Given sufficient time, Ss perform quite well, almost as well as Ss given the spacing instructions. When given a limited amount of time to study the material, however, performance is quite poor, sometimes even worse than performance of Ss given the tag instructions.

Effect of Spatial Distance

The present experiments failed to provide any support for the hypothesis that proportion correct on a pair is a monotonic increasing function of the distance separating the terms of that pair on some imaginary interval scale. Proportion correct on pairs whose terms were described as being very different did not differ from proportion correct on pairs whose terms were described as being barely different. Proportion correct on the remote pairs was reliably superior to proportion correct on the adjacent pairs, however, in spite of this failure to find

any effect of quantitative information. Hence, it seems unlikely that the superiority of the remote pairs can be accounted for solely in terms of the large quantitative difference separating the terms of those pairs.

This should not be construed as a general disconfirmation of the rating scale theory, however. Though it seems unlikely that this theory is sufficient, in and of itself, to account for the superiority of the remote pairs observed in the present experiment, this does not mean that quantitative difference has no effect at all. In fact, there are some strong indications that, under some conditions, such an effect can be demonstrated. Moyer (1973), for example, has shown that the time required for Ss to determine which of two animals is larger is an inverse function of the size difference between the animals. Further experimentation is required to determine those conditions which lead to a distance effect and those which do not.

REFERENCES

- Huttenlocher, J. Constructing spatial images: A strategy in reasoning. *Psychological Review*, 1968, 75, 550-560.
- Moyer, R. S. Comparing objects in memory: Evidence suggesting an internal psychophysics. *Perception & Psychophysics*, 1973, 13, 180-184.
- Potts, G. R. Information processing strategies used in the encoding of linear orderings. *Journal of Verbal Learning & Verbal Behavior*, 1972, 11, 727-740.

NOTE

1. Verbatim copies of the instructions available on request.

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