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ABSTRACT

This study was conducted to determine whether efficiency in concept attainment can be increased as a function of the interaction of the use of good negative instances and increased attention as defined in terms of risk conditions. Subjects were 36 ninth-grade students of average problem solving ability as determined by IQ. Six treatment groups were formed by combining three types of series of instances, made up of good positive and good and poor negative instances, with a risk condition and a non-risk condition. It was hypothesized that if attention was increased, the combination good positive (GP) good negative (GN) series would be more efficient than GP only series or GP and poor negative PN series. It was concluded that generally a series of GP instances only are more efficient for concept acquisition than a mixed series containing either GN or PN instances. The authors discussed several areas suggested by the present study where further investigation should prove to be productive. (BW/Author)

The Effect of Risk on Concept Acquisition

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A number of studies (Smoke 1953; Hovland & Weiss, 1953; Bourne & Guy, 1968; Bourne, Ekstrand & Mongtomery, 1969) have indicated that the use of negative instances in an instructional sequence leads to less efficient concept acquisition than the use of positive instances. Studies reported by Freiberg and Tulving (1961) and by Fryatt and Tulving (1963) have demonstrated that as practice with negative instances increases the acquisition of conjunctive concepts becomes as efficient as acquisition resulting from the use of only positive instances. An explanation given by these investigators for the beneficial effects of the practice is that it increases the familiarity of negative instances and in turn increases their probable use. While this explanation is acceptable, it lacks precision in that it does not provide an explanation of the specific variables related to the phenomenon of familiarity. For example, it is possible to argue that familiarity is effective in that it increases the skill of the student in using negative instances. If one assumes that the process of concept acquisition involves the generation of hypotheses with regard to the relevant attributes of the concept, and the testing of these hypotheses with additional information, then the skill which may require practice may be the generation of hypotheses from negative instances. A more probable argument is that familiarity increases the attention of learners to negative instances. If this argument is valid then it can be concluded that any experimental procedure which increases the probability that a learner will attend to negative instances in a sequence should in turn increase the efficiency of their use. Several studies (Smith, Lucaccini, & Epstein, 1967; Weiner, 1969) have demonstrated that attention to assigned tasks can be readily manipulated by creating risk conditions. It follows that if attention is one of the factors which determine the effective use of negative instances in concept learning, and that if attention can be successfully manipulated by controlling risk conditions, then the effectiveness of negative instances in concept acquisition

will be increased if their use involves risk.

A few research studies (Bourne & Guy, 1968; Bourne, Ekstrand & Montgomery, 1969; Davidson, 1969) suggest that the efficiency of concept learning is a function of the use of instances of the concept which lead to the production of the least number of irrelevant hypotheses. These studies conclude that the use of positive instances leads to the generation of fewer irrelevant hypotheses than the use of negative instances and thus are more efficient for concept acquisition. Moore & Houtz (1970) utilizing negative instances in a positive instance series achieved results comparable to the use of positive instances in a series by structuring good negative instances which made possible the reduction of the number of possible hypotheses. A good negative instance was defined as a negative instance lacking only one relevant attribute of the concept as opposed to a poor negative instance which was defined as one which was lacking two attributes, while the good positive instances shared no common irrelevant attributes with another positive instances.

The present study was completed to determine whether efficiency in concept attainment can be increased as a function of the interaction of the use of good negative instances and increased attention as defined in terms of risk conditions.

Method

Subjects

The Ss were 36 ninth-grade students of average problem solving ability as determined by average IQ (90-120). The Ss were stratified on the basis of sex and randomly assigned to each experimental treatment. The Ss were also randomly assigned to Es. Six treatment groups were formed by combining three types of series of instances, made up of good positive and good and poor negative instances, with a risk condition and a non-risk condition. The Good Positive (GP) groups received only good positive instances.

The Good Negative (GN) groups received a combination of good positive instances alternating with good negative instances and the Poor Negative (PN) groups received a combination of good positive instances alternating with poor negative instances. One group of each of the three types participated under the Risk Condition (R) while the remaining group of each of the three types participated under the Non-Risk condition (NR). Each group consisted of 3 males and 3 females.

Design

The design for this study was a 2 x 3 x 2 factorial design with Risk and Non-Risk as one dimension, and 3 types of series of instances as another and sex as the third dimension.

		Good Positive	Good Negative	Poor Negative
Risk	Male			
	Female			
Non-Risk	Male			
	Female			

Materials

Concepts were presented on a series of 3 x 5 cards. The series of cards were divided into practice illustrations, one practice "round" which consisted of eleven cards and ten game rounds. Each card represented one instance of a concept. Positive instances were indicated by the word "Yes" appearing on the bottom of the card and negative instances were identified by the word "No" at the bottom of the card. Instances consisted of a series of geometric figures. Two figures were chosen to be the relevant attributes of the concept. A different concept (set of pre-chosen figures) was used in each "round". A card representing a positive instance (labeled "Yes) included all of the relevant attributes plus several irrelevant attributes. A card representing a negative instance (labeled "No)

was missing at least one of the relevant attributes.

Each of the concepts was composed of two relevant attributes. Each good positive instance contained five figures or attributes, while the good negative instance contained four attributes and the poor negative instance contained three attributes.

The good positive instances for a particular concept had no irrelevant attributes in common. Good negative instances were identical (contained the same irrelevant attributes) to the good positive instance that preceeded them in the series except that one of the relevant attributes was omitted. The poor negative instances were identical to the good positive that preceeded it in the series except that two figures were omitted, of which at least one was relevant.

The series of cards used for practice illustration were designed to help demonstrate the techniques for identifying the relevant figures. One exercise consisted of two successive good positive instances. A second exercise consisted of a simple good positive instance containing only two figures with a simple good negative containing only one figure. The third exercise consisted of a series of four instances made up of alternating good positive and good negative instances which were identical to the types of instances used in the game rounds. The fourth exercise consisted of a good positive followed by a poor negative followed by a good positive.

The series of cards used for the practice round were identical to the ones used in the game rounds. The Ss were given the same type of instances for the practice round as they later used in the game rounds.

Procedure

All Ss were instructed in the techniques of identifying the relevant attributes, or figures, of the concepts. The Ss were told to look for the attributes which positive instances held in common since they would be

relevant attributes. The Es also told Ss that they should look for the relevant figures among those that were missing from the negative instances; and, that when only one figure was missing it would be a relevant attribute. The Es told Ss that when more than one figure was missing, the one or ones that appeared in the next positive instance would be the relevant attributes.

The Es then informed Ss that the concept identification procedure would be conducted as a game and that the procedure of the game would be explained as they proceeded through the instances of the practice round. Each S was shown, one at a time, the appropriate type of instances of the practice round for the group he was in (GP, GN, PN). Each instance was shown for ten seconds and then removed from the S's view. As the practice round instances were shown, the appropriate procedure for the risk or non-risk situation was explained to the Ss.

The Ss in the risk situation were given $4.60 which they were told was theirs, and that they would be able to keep as much of it as they could avoid paying back to E as they played the game. Risk Ss were then shown two instances of the practice round, one at a time, for ten seconds each. At this point the risk Ss were given a choice of trying to identify the relevant attributes by drawing them on a piece of paper they had been given or of continuing with the next card without any attempt to identify the relevant attributes, or figures. The risk Ss were told that if they wanted to continue by seeing the next card, they would have to return 4¢ to E. The risk Ss were told also that if they correctly identified the relevant attributes, they could keep the remaining money to play the next round, and that after the tenth round they could keep all of the money that remained. The E told Ss that if they were only partially correct or were completely wrong they would have to give the E 1¢ for the wrong guess and an additional 4¢ to see the next card. The E told risk Ss that he would tell them if they were right,

partially right, or completely wrong. (An answer of partially right was given if any of the figures drawn were relevant figures).

The E gave the risk Ss the choice at this point to continue or to try to identify the relevant figures. If the relevant figures were not identified, the next card was shown and the Ss were again given the choice. Risk Ss were told that they would have this choice after each card in a round beginning with the second card shown. As soon as an S correctly identified the relevant figures for the practice round, or after the last card of the round, E asked if there were any questions. After E answered any questions which arose, he began the game with the first round, following the same procedure as in the practice round until all ten game rounds were completed.

The E told Ss in the non-risk condition that they would receive 30¢ for each concept that they correctly identified. The amount of money given was determined by taking the mean amount won per round by the Ss in the risk situation to insure that both groups would receive the same mean incentive. The E showed the non-risk Ss the first two instances of the practice round, one at a time. He told them that they now had a choice of continuing by seeing the next card or of trying to identify the relevant attributes by drawing them. The NR Ss were told that if they chose to try to identify the relevant attributes, E would tell them if they were right, partially right, or completely wrong. If they did not correctly identify the relevant attributes, they were shown the next card and this procedure was continued until they correctly identified the concept or the last card in the round was reached. At this point E answered any questions which the Ss had and then began the first round using the same procedure as for the practice round until all ten game rounds were completed.

The order of presentation of the ten concepts for both groups for the game rounds was randomly assigned for each S.

The E recorded for both risk and non-risk groups the number of instances the Ss had seen before they correctly identified the relevant attributes of the concept. If the concept was not correctly identified after all eleven instances of a round it was recorded as "not identified".

Results

An analysis was carried out to determine if there was homogeneity of difficulty among the 10 concepts used. A three way ANOVA with type of instance, sex, and concepts as the dimensions was carried out with the number of instances used per concept as the dependent variable. There were no significant differences among concepts ($F(3,36) = 1.14$; $p < .34$). The correlation between IQ scores and performance on the task was also computed to determine if IQ had been adequately controlled for by using Ss of average IQ. The Pearson Product Moment Correlation coefficient was .07 and was not significantly different from zero ($p < .05$).

Since there was homogeneity of difficulty among concepts and IQ was not significantly correlated with performance, an ANOVA was carried out with the original 2 x 3 x 2 factorial design. There were two levels of risk, three levels of type of instances and two of sex. Since not every concept was correctly identified by each S, an efficiency ratio (the number of instances taken on the concepts correctly identified per number of concepts identified) was used as the dependent variable. (Table 1).

Table 1

ANOVA of the Efficiency Ratio

Source	df	ms	F
Risk (R)	1	2.2102	1.799
Sex (S)	1	.0001	.000
Type of Instance (T)	2	27.4304	22.325****
R x S	1	6.5707	5.348**
R x T	2	6.6867	5.442***
S x T	2	4.9138	3.999**
R x S x T	2	3.4237	2.786*
Error	24	1.2287	

**** p< .001
*** p< .01
** p< .05
* p< .10

The main effect of type of instance was significant (p<.001) (see table 1). The Newman - Keuls posttest revealed that the group using good positive instances (GP) differed significantly from both the group using good negative instances (GN) and the group using poor negative instances (PN) (p<.01) (see table 2). Inspection of the means (see table 3) shows that the GP group performed better than the other two groups (see figure 1).

Table 2

Differences of T

GP	GN	PN
←	———	
←	———	———

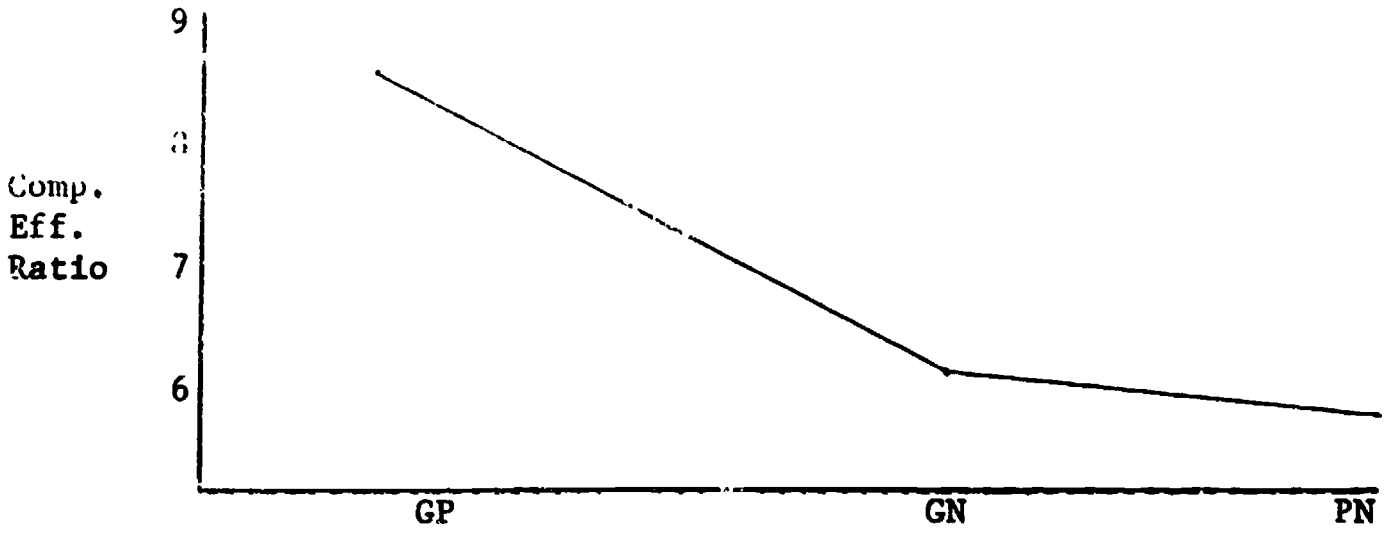
Table 3

Means of T

GP	GN	PN
3.25	5.62	6.06

Figure 1

Type of Instance



The ANOVA indicated that the interaction of risk and type of instance was also significant ($p<.01$) (see table 1). The Newman - Keuls posttest revealed that GP groups whether R or NR differed significantly from all other groups ($p<.05$), but the performance of the GP groups did not differ significantly from each other (see table 4). Inspection of the means (see table 5) indicated that in all cases the GP groups required fewer instances to acquire the concepts than the other groups. The Newman - Keuls posttest also revealed that the NR-PN group's performance differed significantly from the R-PN group's and the NR-GN group's performances ($p<.05$). However, no significant difference between the performance of NR-GN and R-GN groups was indicated (see table 4). Inspection of the means (see table 5) indicated that both the NR-GN group and the R-PN group required fewer instances to acquire the concepts than the NR-PN group (see figure 2).

Table 4

Differences of T x R

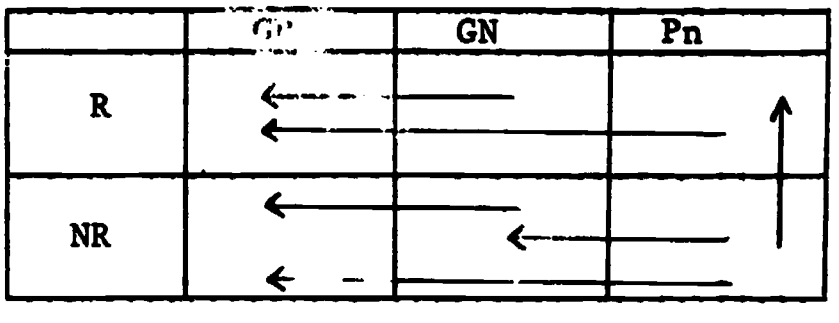


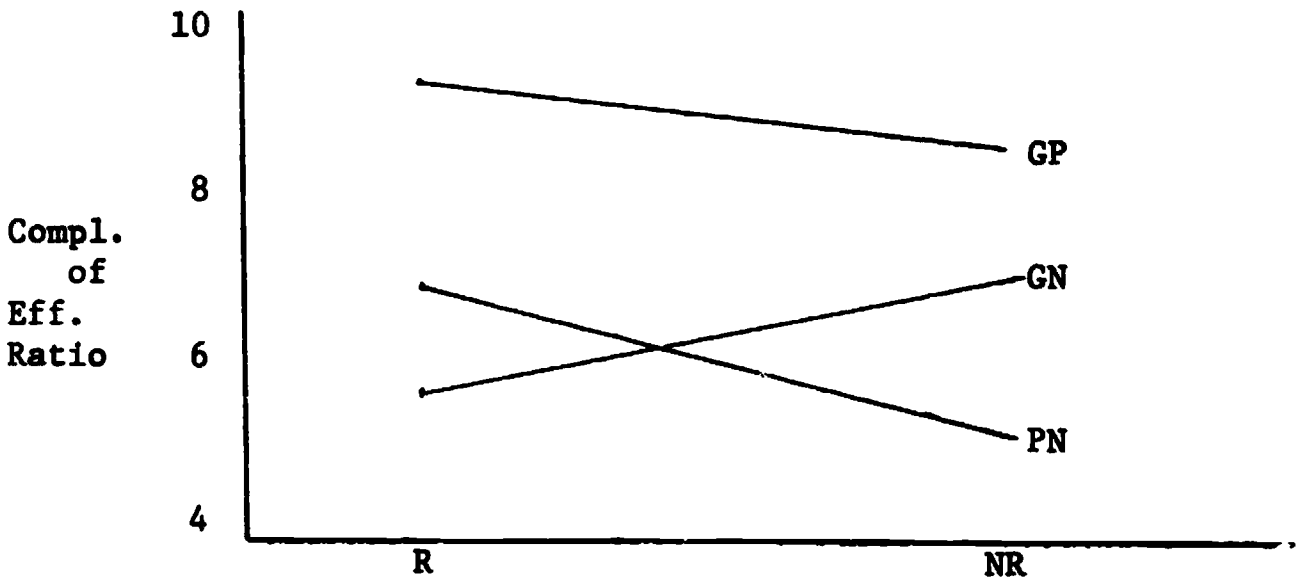
Table 5

Means of T x R

	GP	GN	PN
R	2.85	6.19	5.16
NR	3.65	5.06	6.97

Figure 2

Type of Instance x Risk



The ANOVA also indicated that the interaction of type of instance and sex was significant ($p<.05$) (see table 1). The Newman - Keuls posttest revealed that GP Ss' performance for both male and female differed significantly from all other Ss' performance ($p<.05$), but did not differ significantly from each other (see table 6). Inspection of the means (see table 7) indicated that GP Ss required fewer instances to acquire the concepts than did all other Ss. The posttest revealed that the performance of the males in the GN group differed significantly from that of the males in the PN group ($p<.06$) while there was no corresponding difference among female Ss (see table 6). Inspection of the means (see table 7) shows that the males in the GN group required fewer instances than those in the PN group (see figure 3).

Table 6

Differences of T x S

	GP	GN	PN
MALE	← ←	←	←
FEMALE	← ←		

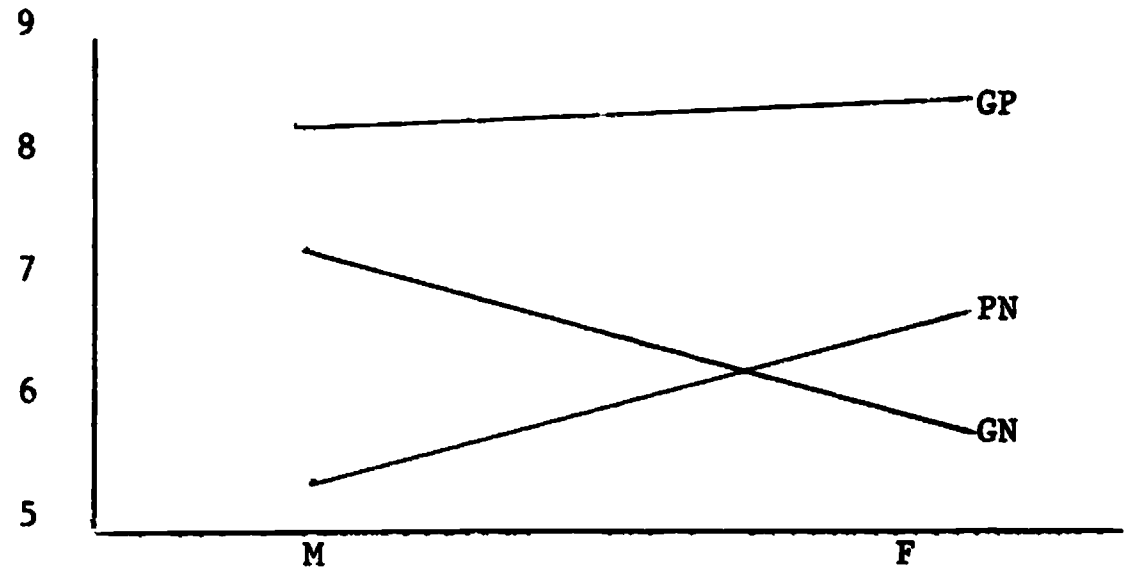
Table 7

Means of T x S

	GP	GN	PN
MALE	3.29	4.97	6.68
FEMALE	3.22	6.28	5.44

Figure 3

Type of Instance x Sex



The interaction of risk and sex was also identified as being significant ($p<.05$) by the ANOVA (see table 1). The Newman - Keuls posttest indicated that the performance of the male R Ss differed significanlty from NR Ss ($p<.05$), while

there was no corresponding difference among female groups (see table 8). Inspection of the means (see table 9) revealed that male R Ss required fewer instances than the male NR Ss (see figure 4).

Table 8

Differences of R x S

	Male	Female
R	↑	
NR	↑	

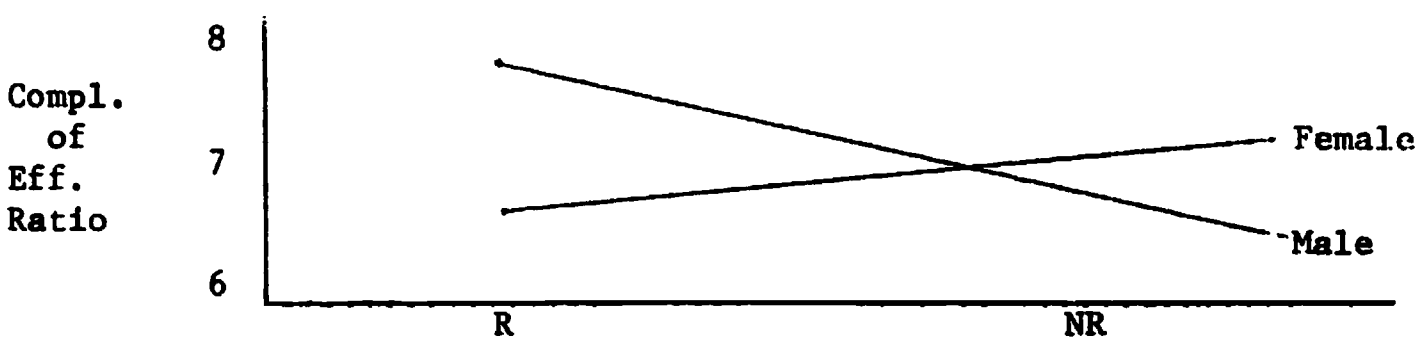
Table 9

Means of R x S

	Male	Female
R	4.30	5.16
NR	5.65	4.80

Figure 4

Risk & Sex



The three-way interaction of risk, type of instance and sex was shown to be significant at the .10 level by the ANOVA (see table 1). The Newman - Keuls posttest indicated that the mean of the male NR-PN group differed significantly from the means of the male NR-GN and male NR-GP groups and from

the mean of the male R-PN group ($p<.10$), (see table 10.) Inspection of the means (see table 11) shows that the performance of the male NR-GN, male NR-GP and male NR-PN groups is better than that of the male NR-PN group. The Newman - Keuls posttest also indicated that the performance of the female R-GN group differed significantly from that of the female R-GP and female R-PN groups ($p<.10$), (see table 10). Inspection of these means shows that the female R-GP and the female R-PN groups took fewer instances than the female R-GN group (see table 11).

Table 10

Differences of R x T x S

		GP	GN	PN
R	Male			
	Female			
NR	Male			
	Female			

Table 11

Means of R x T x S

		GP	GN	PN
N	Male	3.01	5.08	4.83
	Female	2.70	7.29	5.48
NR	Male	3.57	4.85	8.54
	Female	3.73	5.27	5.40

Discussion

This study was designed to investigate the efficiency of concept acquisition as a function of GP, or combinations of GP and GN or GP and PN instances under risk and non-risk conditions. It was hypothesized that if attention was increased, the combination GP-GN series would be more efficient than GP only series or GP and PN series. Previous research (Smith, Lucaccini, & Epstein, 1967; Weiner, 1969) suggests that a risk condition heightens attention. Therefore, it was hypothesized that the efficiency of the alternating GP and GN series would increase under risk and would be the most efficient type of series under the risk conditions.

The first hypothesis states that: Ss in the GN groups use fewer instances than (a) Ss in the GP groups; and, (b) Ss in the PN groups. The results of this study, while not supporting part (a) of the hypothesis are consistent with most of the previous research involving the use of positive and negative instances (Hovland & Weiss, 1953; Fryatt & Tulving, 1963; Davidson, 1969). Specifically, the performance of the GP groups was significantly different from and better than that of the GN groups. The first hypothesis is based on the results of the Moore and Houtz study (1970) where the series containing the carefully defined GN instances were used as efficiently as the series containing only GP instances. The results of the present study do not support part (b) of the hypothesis either, since the performance of the GN Ss was not significantly different from that of the PN Ss (see table 2). An explanation for the lowering of the efficiency of performance for the series containing the negative instances may be that negative instances tend to distract Ss' attention from the positive instances, which may be more useful in terms of generating productive hypotheses as to the relevant defining attributes of the concept. Specifically, it may be hypothesized that the use of negative

instances increases the probability of generating a greater number of unproductive hypotheses because of the uncertainty of the relevance of the missing attributes. Thus the insertion of negative instances into a series may cause Ss to consider more unproductive hypotheses which may hinder their focusing on the productive ones.

A second hypothesis states that Ss in the GN groups use fewer instances than Ss in the PN groups. The results of this study support this hypothesis (see table 2). The performance of Ss in the GP group was significantly different from and better than that of PN Ss. These results are consistent with previous research including the Moore and Houtz study (Hovland & Weiss, 1953; Fryatt & Tulving, 1963; Davidson, 1969; Moore & Houtz, 1970).

A third hypothesis is that Ss under risk conditions use fewer instances than those under non-risk conditions. This statement is not generally supported by the data in that no significant difference was found between the performance of the R and NR groups (see table 1). However, partial support for this hypotheses can be found in the three-way interaction of risk, type of instance and sex. In table 10 it can be observed that the performance of male Ss in R-PN group differed significantly from that of male Ss in the NR-PN group. These results suggest that risk has an effect on the efficiency of concept acquisition only under the conditions where male Ss are using PN instances. This outcome is discussed more fully in connection with other hypotheses.

No directional predictions were made as to differences in performance as a function of sex, since there was insufficient data from previous research on which predictions could be based. The data indicated that there was no significant differences in performance between males and females (see table 1). Generally differences in sex do not effect the efficiency of concept acquisition. It will be pointed out later, however, that sex as it interacts with risk and

type of instance does effect the efficiency of concept acquisition.

The fifth hypothesis states that under risk conditions Ss in the GN group use fewer instances than either: (a) Ss in the GP group; or (b) Ss in the PN group. No support for this hypothesis can be found. The results indicate that under risk conditions the performance of the GP group was significantly different from and more efficient than that of the GN group, while there was no significant difference in performance between the GN and PN groups under risk conditions (see table 4). One possible explanation for these results is that the negative instances may have distracted the Ss attention from the more useful positive instances as explained in the discussion of the first hypothesis, causing the series containing negative instances to be less efficient than the series containing only positive instances. It could also be inferred from the results of this analysis that GN and PN instances are equally distracting.

The sixth hypothesis states that under risk conditions the Ss in the GP group use fewer instances for concept acquisition than Ss in the PN group. The fact that the performance of the R-GP group was significantly more efficient than that of the R-PN group as observed in the comparisons of the two-way interaction of risk and type of instance (see table 4) supports this hypothesis. These results are consistent with Moore & Houtz (1970) which showed that GP instances were more efficient than PN instances.

No support for either the fifth or sixth hypothesis was observed in the three-way interaction, since the performance of male Ss in the R-PN group, the group for which risk has an effect, does not differ significantly from either male Ss in the R-GP or R-GN groups (see table 10). One possible explanation for these findings is presented later as part of the discussion of the interaction of risk, type of instance and sex.

A seventh hypothesis states that for those Ss under the NR conditions the performance of the GP and GN groups do not differ significantly. No support can be found for this hypothesis in the results of the interaction of risk and type of instance. These results indicate that the performance of the NR-GP group was significantly different from and more efficient than that of the NR-GN group (see table 4).

The eighth hypothesis which also referred to the Ss under the NR conditions, states that the GP and GN groups use fewer instances than the PN group. The results of the interaction of risk and type of instance support the hypothesis, since the performance of both the NR-GP and NR-GN groups was more efficient than that of the NR-PN groups (see table 4).

The seventh and eighth hypotheses are based on the results of the Moore and Houtz study (1970). The results of the present study which supports the eighth hypothesis are consistent with the results of Moore and Houtz. The apparent discrepency between the results of the present study and those of Moore and Houtz connected with the performance of GP and GN groups (seventh hypothesis) may be in part due to procedural differences. In the present study all Ss were permitted to identify the relevant attributes of the concept whenever they felt that they could. However, in the Moore and Houtz study all Ss were required to wait until they had seen all instances of the concept before they could attempt to identify the relevant attributes. It is possible then that the Ss in the GP groups in the Moore and Houtz study were able to correctly identify the concept earlier than they did, but they were not given the opportunity. After all the instances had been shown in the Moore and Houtz study the Ss in the GN group may also have been able to identify the relevant attributes correctly. In the Moore and Houtz study there was no means of identifying at which point in the series each S actually acquired

the concept. In the present study the results might possibly be explained as being caused by the differences in the probability of generating productive solution hypotheses associated with the different types of instances. Perhaps the probability of generating productive hypotheses is greater for GN instances than for PN instances, but that the probability associated with GP instances is greater than that for either type of negative. Since the GN instances are only lacking one attribute as compared to the preceding positive instance, the Ss may be more certain that the missing attribute is relevant than they are when using PN instances where two attributes are missing. This greater certainty that the Ss using GN instances may experience might lead to the generation of more productive hypotheses in terms of identifying the relevant attributes of the concept.

Although no specific directional predictions were made as to the outcome of the interaction of type of instances and sex, significant differences do exist in this interaction (see table 6). It was found that males in the GN group perform more efficiently than males in the PN group, while there was no difference between the performance of females in the GN and PN groups. One possible explanation for the more efficient performance of males in the GN group may be that males are more analytic in their problem solving styles than females (Smith, 1933). This analytic approach may assist the males in discriminating between the relevant and irrelevant information in the good negative instances, while the females may be unable to make this discrimination viewing the instances as a whole. The males therefore would be more likely to select the productive solution hypotheses than the females. If the GN instances have a greater potential for leading to the generation of productive hypotheses than the PN instances, the males may be more likely to benefit from this than the females for whom the difference between productive and non-productive hypotheses is not as easily identified.

No directional predictions were made about the interaction of risk and sex, but the results indicate that differences did occur (see table 8). The male Ss under R conditions performed more efficiently than the male Ss under NR conditions, while no difference occured between the performance of female Ss under R and NR conditions. The fact that males performed more efficiently under R than NR conditions can possibly be explained in terms of the expected role of males in society. The competitive risk taking role is generally more acceptable for the male to assume than the female. Some research (McKee & Leader, 1955; Bandura, Ross & Ross, 1961) has shown that males are more competitive and aggressive than females. The males then might be expected to perform best under the risk condition, which is most like the competitive, aggressive behavior with which males normally identify.

Although no directional predictions were made about the interaction of risk, type of instance and sex, this interaction gives support to several other hypotheses as well as being of great interest by itself. Three statistical differences were identified. First is the fact that males in the R-PN group performed more efficiently than males in the NR-PN group. The explanation that males are more responsive to competittive situations than females combined with the explanations that (1) males are more analytic than females and (2) negative instances tend to be distracting, suggest an explanation for the performance of the male PN groups. Specifically, the combination of the males heightened attention and their analytic abilities may have led to a selective use of negative instances as a function of the differing amounts of distraction that the different types of negative instances may have produced. The significant increase in efficiency of the PN series under risk perhaps may be attributed to the Ss rapid adaptation to a strategy of attending to only the GP instances. While the fact that no change in performance occurs between R and NR for Ss in the GN groups may be

attributed to the use of the same strategy under both conditions.

If the PN instances lead to the generation of a greater number of non-productive solution hypotheses than either the GN or GP instances the probability of being reinforced for using that type of instance, by correctly identifying the relevant attributes, may be decreased for the Ss using the PN instances. Possibly with heightened attention due to risk, male Ss may distinguish between the reinforcing and non-reinforcing type of instances and thus attend more to the reinforcing type (i.e., the GP and GN instances) and ignore the non-reinforcing ones (i.e., the PN instances). Thus the probability of greater attention to the more productive GP instances is increased through the disuse of the PN instances. It would follow that Ss using such a strategy may perform more efficiently than Ss attending to both the GP and PN instances.

No difference occured between the performance of Ss in the R-GN group and those in the NR-GN group. One possible explanation for this may be that the GN instances may lead to the generation of fewer non-productive solution hypotheses than the PN instances, thus possibly establishing a more intermittent pattern of reinforcement associated with their use. If this is the case, then even under risk the Ss may continue to use the GN instances because they have been reinforced for using them and therefore the Ss may not recognize that the GN instances are distracting the attention from the more efficient GP instances.

Risk may have also increased the attention of the Ss using the GP series, but there is no sufficient means of observing any effects on performance since there is a ceiling effect imposed by the nature of the task. Specifically, Ss in the GP groups were generally using the minimum number of instances logically required to identify the relevant attributes under both the R and NR conditions.

The second difference identified in the three-way interaction is that under non-risk conditions males in the GN group perform more efficiently than males in the PN group (see table 11). If males are more analytic than females, as mentioned previously, they might be able to discriminate more easily between the productive and unproductive hypotheses which a particular instance might lead them to generate. If this is true, then they might be able to use the GN instances more efficiently than the PN instances if, as discussed earlier, the GN instances lead to the possibility of generating a greater number of productive hypotheses than the PN instances.

The third difference identified is that under risk conditions the female Ss in the PN group perform more efficiently than the female Ss in the GN group (see table 11). A possible explanation for these results may be that if females are more analytic in their thinking than males, they may not be able to discriminate between the productive and unproductive hypotheses concerning the relevant attributes. When the female Ss are placed under the condition of risk it may heighten their anxiety to the extent that it interferes with their ability to discriminate between productive and unproductive hypotheses. Thus they may be distracted more by the unproductive hypotheses. In turn, this may lead to less efficient performance for female Ss using the GN instances which may lead to the generation of both productive and unproductive hypotheses. However, the performance of the female Ss in the PN group may not be effected since they may discontinue using the PN instances because they are not reinforcing as explained above in connection with the male Ss performance with PN instances.

It can be concluded that generally a series of GP instances only are more efficient for concept acquisition than a mixed series containing either GN or PN instances. It can also be concluded that if risk is involved under the conditions that the Ss are male and they are using PN instances, efficiency

of concept acquisition will be increased. However, if risk is used under the conditions that the Ss are female and they are using GN instances the efficiency of concept acquisition will be reduced.

The present study suggests several areas where further investigation would be productive. Since the reinforcement for using different types of instances may be dependent on the probability that they lead to the generation of productive hypotheses and the pattern of reinforcement may in part determine the efficiency of concept acquisition, further investigation to determine which aspect may lead to the generation of productive and unproductive hypotheses may be useful in developing more efficient negative instances. Also the effects of risk on the efficiency of a GP series of instances was not adequately determined since under both the risk and non-risk conditions the Ss used the minimum number of instances logically needed to identify the relevant attributes. A design which would increase the ceiling on the measurement of efficiency of a GP series would add to the understanding of the effects or risk. Perhaps this ceiling effect could be eliminated by using more difficult concepts which would require more instances to lead to acquisition under non-risk conditions.

This study also suggests that Ss in a risk situation may change their strategy of using instances for concept acquisition. The present study did not provide any means for observing any changes in strategy. Provisions for studying strategies for use of instances in future studies may provide the basis for a more careful analysis of effects of risk on concept acquisition. It is also suggested that if the results of this study are to be applied to practical situations, such as classroom learning, additional research should be conducted to determine if the same effects can be obtained with meaningful concepts.

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