

# Effects of noun imagery and awareness of the discriminative cue upon differential eyelid conditioning to grammatical and ungrammatical phrases

LOUISE C. PERRY

*University of Queensland, Brisbane, Queensland, Australia 4067*

and

DAVID A. GRANT and MARIAN SCHWARTZ

*University of Wisconsin, Madison, Wisconsin 53706*

Two differential eyelid conditioning studies employed grammatically correct and incorrect adjective-noun phrases as conditioned stimuli. For different groups of subjects, the nouns were either high or low in imagery. The hypothesis that congruency between grammatical correctness and reinforcement consequences (i.e., the aversive stimulus contingent upon presence of incorrect rather than correct grammar) would facilitate conditioned discrimination was not supported, but the hypothesis that high noun imagery would facilitate differential response to syntax received strong support. Cognitive awareness of the syntactic discriminandum was also related to effective differential responding, as well as being implicated as a mediating mechanism in the imagery effects. Finally, performance was also significantly related to conditioned-response topography, with better conditioned discrimination by voluntary-form (V) than by conditioned-form (C) responders, and also evidence of more effective utilization of contingency awareness by Vs than by Cs.

The present research had four major aims. The first aim was to determine whether a congruency effect previously obtained with arithmetic conditioned discriminanda (Fleming, Cerekwicki, & Grant, 1968; Fleming, Grant, North, & Levy, 1968) would likewise apply to verbal stimuli involving syntactic correctness as the differential cue. The arithmetic studies employed correctly and incorrectly solved arithmetic problems as differential conditioned stimuli (CSs), and found that discrimination was best when incorrect rather than correct problems were followed by aversive reinforcement, or when correct rather than incorrect problems were followed by positive reinforcement. On the basis of these data, Grant's (1972) conditioning model proposed that the learning of CS— reinforcement contingencies is facilitated to the extent that these contingencies are congruent with contingency codes already present in the long-term memory store (LTMS), in that instance, preexperimental codes relating reward and punishment to right and wrong arithmetic, respectively. This model would likewise imply that

incorrect grammar, like incorrect arithmetic, should be associated with negative consequences in LTMS, and that conditioned syntactic discrimination should therefore be better when the aversively reinforced stimuli exemplify incorrect rather than correct grammar.

A second major aim was to see whether the effectiveness of the grammaticality cue might be influenced by noun imagery level. Paivio's (1971) two-process model assigns an important mediational role to nonverbal imagery in language comprehension, memory, and production, and Paivio suggests, in fact, that imagery may serve as a basic foundation upon which syntax is built (p. 438). If imagery is in fact such a basic component in the understanding and discrimination of grammatical structure, then it should likewise be critical in a very basic type of learning situation, the classical differential conditioning situation, as well as in the verbal learning and memory paradigms employed to date. It was hypothesized, therefore, that grammaticality would be a more effective discriminandum when concrete rather than abstract nouns were used in the CS phrases.

Requests for reprints may be sent to Louise C. Perry, Department of Psychology, University of Queensland, Brisbane, Queensland, Australia 4067, or to David A. Grant, Department of Psychology, University of Wisconsin, Madison, Madison, Wisconsin 53706. This project was supported in part by Research Grant MH06972 to David A. Grant.

A secondary purpose of the imagery manipulation was to determine to what extent the excellent levels of conditioned discrimination obtained to verbal stimuli in the past (see Grant, 1972) might be due to the use of concrete words in most, if not all, instances. If imagery is a potent variable in differential conditioning

as well as in verbal learning and memory, it is possible that good differential responding to verbal CSs may in fact be dependent upon the use of high-imagery materials, and be greatly reduced or even nonexistent in the case of abstract verbal discriminanda.

A third aim of the present research was to examine the role of the subject's cognitive awareness of the reinforcement contingencies in relationship to effective discrimination of the syntactic cue, and also in relationship to noun imagery effects. Although reported contingency awareness is known to be a potent variable in autonomic conditioning (e.g., Dawson, 1973; Grings, 1973; Lockhart, 1973), most eyelid conditioning subjects have been able to report contingencies accurately in past research, thereby making it impossible to demonstrate any relationship between awareness and skeletal conditioning (Grant, 1973). Positive awareness effects recently found with masking task procedures (Nelson & Ross, 1974) suggest, however, that awareness may well be a significant factor in more complex skeletal conditioning situations like the present one. A further purpose in including the awareness variable was to explore the relationship between awareness and imaginal processes. Does imagery exert a direct effect on discrimination that is independent of awareness, or does it facilitate discrimination via increasing awareness? These possibilities are not, of course, mutually exclusive. For instance, from verbal mediation paradigm data, Yarney (1967) has concluded that awareness may function as an intervening variable which mediates imagery effects. He found evidence for this interrelationship, as well as for direct facilitative imagery effects upon verbal transfer performance which were independent of reported awareness of the mediating relationships. The present experiment therefore sought to determine the extent to which verbal awareness and imagery may likewise have interrelated as well as independent influences upon the conditioned discrimination of grammar.

A final purpose was to investigate syntactic conditioned discrimination in relationship to the subject's characteristic conditioned-response (CR) topography, which is typically either voluntary (V) in form, with large-magnitude anticipatory eyelid closures of rapid rise time, or conditioned (C) in form, with small-magnitude, slow rise-time CRs. This variable has been demonstrated to be a critical factor in differential conditioning to symbolic discriminanda (see Grant, 1972). In particular, data showing that only Vs, and not Cs, benefit from the presence of categorical relatedness within reinforced (CS+) and within nonreinforced (CS-) word sets (Cerekwicki, Grant, & Porter, 1968; Perry, Ornstein, Watters, & Grant, 1971) has led Grant (1972) to propose that, because of the ready availability of the V-form, but not the C-form, response code, Vs have more central capacity free for CS feature processing than do Cs.

These considerations suggest that Vs may likewise be expected to process CS grammaticality to a greater extent than do Cs. If so, grammaticality should be found to be a more effective discriminandum for V- than for C-form responders.

## EXPERIMENT 1

### Method

**Design.** All subjects received a total of 80 differential conditioning trials, 40 reinforced (CS+) trials and 40 intermixed nonreinforced (CS-) trials. A CS consisting of a two-word phrase was presented on each trial. In each phrase, the adjective "One" or "Two" was paired with either a singular or a plural form of one of 20 nouns. The design was a 2 by 2 factorial. One factor was noun imagery: For half of the subjects, all phrases contained high-imagery nouns, while for the other half, all phrases contained low-imagery nouns. The second variable was the congruence between grammaticality and reinforcement contingency. For half of the subjects in the imagery condition, reinforcement was congruent with the grammaticality of the phrase in that "bad grammar," that is, ungrammatical phrases in which the adjective and noun disagreed in number (One trees, Two girl), was the CS+ for the aversive unconditioned stimulus (UCS) and "good grammar," that is, phrases in which the adjective and noun agreed in number (One cat, Two girls), was the CS-. For the other half of the subjects, the reinforcement contingency was incongruent with grammaticality, the CS+ being good grammar and the CS- bad grammar.

**Apparatus.** The equipment was similar to that used by Cerekwicki et al. (1968). The subject sat in a soundproof chamber with a ground-glass screen at the back, and wore an adjustable headset which carried the airjet and the micro-torque potentiometer that was mechanically linked to the subject's right eyelid. Each CS phrase was back-projected onto the ground-glass screen as white letters on a dark background, with the initial letter of the adjective capitalized and a period after the noun (e.g., One apples.). The letters were typed in IBM Letter Gothic, with a height of .76 deg visual angle (1.05 deg for the initial capitalized letter), stroke width of .14 deg, and phrase length of .53 deg to 1.10 deg. The CS duration was 1,200 msec, and the UCS, a 13,789.52-N/m<sup>2</sup> (2-psi), 200-msec puff of nitrogen to the cornea of the right eye, followed 1,000 msec after CS onset on reinforced trials. Intertrial intervals, programmed by a Massey Dickinson paper-tape reader, ranged from 16 to 24 sec, with a mean of 20 sec.

**Stimulus phrases.** The high- and low-imagery sets of 20 nouns used in the 80 CS phrases were selected from the extremes of the Paivio, Yuille, and Madigan (1968) norms. Their mean imagery values were 6.55 and 3.08, respectively, with mean meaningfulness values of 6.84 and 5.36. All of the nouns were common words with Thorndike-Lorge frequencies of A or AA. The word-length distribution and mean were equated for the high- and low-imagery sets (3-10 letters,  $M = 6.1$  in each set), as were the distribution and mean number of syllables (1-4 syllables,  $M = 2.1$  in each set).

**Procedure.** Conditioned stimuli from the reinforced and nonreinforced sets were randomly intermixed over the 80 conditioning trials with the restrictions that 4 CS+ and 4 CS- trials occur within each 8-trial block, and that no more than 3 CS+ or 3 CS- trials occur in succession. For the incongruent condition, reinforced and nonreinforced trials were the reverse of those in the congruent condition, so that these subjects saw the same stimulus sequence but with the opposite reinforcement contingency.

Over the 80 conditioning trials, each of the 20 nouns in an

imagery set was used four times, twice with the adjective "One" and twice with "Two," with the singular and plural noun forms orthogonal to adjective type. Thus, each noun served two times in the CS+ and two times in the CS- set (determined by whether the noun and the adjective agreed in number). To minimize intertrial interference, all 20 nouns were used before any were repeated, and occurrences of the same noun or of nouns beginning with the same letter were always separated by at least three trials. Two high-imagery phrase sequences and two low-imagery phrase sequences were constructed in this way, with half of the subjects under each imagery condition given each sequence.

Standard neutral tape-recorded instructions were employed; that is, subjects were asked not to aid or inhibit their natural eyelid responses. After the session, a questionnaire asked about the purpose of the study and inquired as to contingency awareness ("Did you notice any consistency as to when the air puff occurred? If your answer is yes, explain why.").

**Subjects.** The subjects were 40 men and 40 women students from introductory psychology classes at the University of Wisconsin. Group assignment was randomized within blocks with the restriction that the two sexes be equally distributed among the four groups.

### Results and Discussion

All eyelid closures greater than 1 mm with latencies from 200 to 1,000 msec after CS onset were considered CRs. Subjects were classified as Cs or Vs on the basis of their response topography, using the objective recruitment-time criterion proposed by Hartman and Ross (1961). Of the 20 subjects each in the high-imagery congruent, high-imagery incongruent, low-imagery congruent, and low-imagery incongruent conditions, the number of Vs was 10, 6, 9, and 10, respectively, with the remainder classified as Cs.

The significance level employed in all analyses was .05. The basic data of the experiment are presented in Figure 1. This figure shows percent CRs to the CS+ and CS- over successive blocks of eight conditioning trials, with separate curves for Vs and Cs. Each of the four experimental conditions is presented in a separate panel. Figure 1 clearly indicates that better conditioned discrimination was produced by high-imagery than by low-imagery phrases, regardless of whether the grammatically correct phrases were reinforced or nonreinforced, and regardless of response topography.

These findings were confirmed by an unweighted means analysis of variance on percent CRs to the CS+ and CS- during the last 24 trials. That is, there was no significant congruency effect. However, a facilitative effect of high noun imagery was indicated by a significant interaction between imagery and reinforcement contingency [ $F(1,72) = 5.71$ ,  $MSe = 511.38$ ]. Discrimination (greater response to the CS+ than to the CS-) was significant during the last 24 trials in the high-imagery conditions [ $t(72) = 2.68$ ], but not in the low-imagery conditions [ $t(72) = 1.02$ ].

While the imagery findings are consistent with Paivio's (1971) view on the important role of imagery in syntax, the postexperimental questionnaire results implicate verbalized contingency awareness as a major

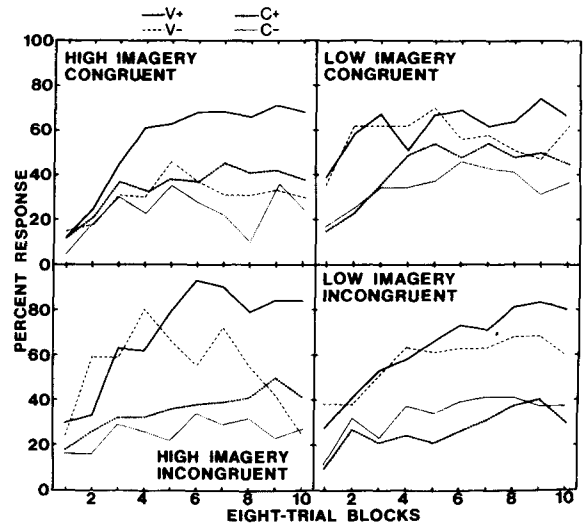


Figure 1. Experiment 1 acquisition of conditioned discrimination between grammatical and ungrammatical high- or low-imagery phrases with correct (incongruent) or incorrect (congruent) grammar reinforced. Percentages of CRs are plotted separately for Vs and Cs on successive eight-trial blocks for the reinforced (+) and nonreinforced (-) stimuli.

mediating process. A subject was classified as "aware" if he correctly related phrase grammaticality to UCS occurrence in replying to the question of whether there was any consistency as to when the air puff occurred. Eighteen Vs and 22 Cs were categorized as "aware" of the CS-UCS contingencies on this basis, while 17 Vs and 23 Cs were classified as "unaware." The CR topography characteristic of the subject was thus unrelated to his reported awareness [ $\chi^2(1) = .05$ ]. Awareness was, however, significantly related to noun imagery. Of the 40 subjects for whom the phrases contained high-imagery nouns, 62% reported awareness of the grammaticality discriminandum, whereas only 38% of the 40 subjects in the low-imagery conditions reported such awareness [ $\chi^2(1) = 5.00$ ].

Table 1 shows that awareness was also clearly related to better differential conditioning performance. Mean percent terminal discrimination scores (mean percent response to the CS+ minus mean percent response to the CS- during the final 24 trials) are presented in Table 1 as a function of the subject's response topography and reported contingency awareness. A least-squares analysis of variance on this terminal discrimination measure indicated that the discrimination of both V- and C-form responders was much better for subjects who reported awareness of the differential cue than for those who did not [ $F(1,75) = 19.83$ ,  $MSe = 792.0$ ]. In fact, although Vs showed generally better discrimination than did Cs [ $F(1,75) = 5.13$ ], it may be seen from Table 1 that, in the absence of reported awareness, virtually no discrimination at all was evident for either Vs or

Table 1  
Mean Terminal Discrimination Scores of Subjects Giving the  
Voluntary- or Conditioned-Form Eyelid CR Who Were  
Classified as Aware or Unaware of the  
Differential Stimulus

Reported Awareness	Response Topography		Row (Awareness) Means
	V	C	
Aware			
Experiment 1	49.54 (18)	19.70 (22)	33.12 (40)
Experiment 2	27.00 (20)	11.22 (27)	18.51 (47)
Unaware			
Experiment 1	1.47 (17)	2.54 (23)	2.08 (40)
Experiment 2	2.17 (10)	-2.29 (23)	-.94 (33)
Column (Topography) Means			
Experiment 1	26.19 (35)	10.93 (45)	17.60 (80)
Experiment 2	14.58 (30)	4.47 (50)	10.49 (80)

Note—Numbers in parentheses indicate the number of subjects in each condition. Terminal discrimination scores were computed by subtracting mean percent response to the CS- from mean percent response to the CS+ during the final 24 conditioning trials.

Cs ( $M_s = 1.47\%$  and  $2.54\%$ , respectively). Finally, Table 1 suggests a stronger facilitative effect of awareness upon V than upon C performance, which was verified by a significant Topography by Awareness interaction [ $F(1,74) = 8.66$ ,  $MSe = 718.6$ ]. Neither congruency nor imagery had any reliable main or interactive effects in this analysis. The absence of any imagery effects when contingency awareness was taken into account suggests that the positive effect of high noun imagery was largely an indirect one here, with the major consequence of using high-imagery nouns being to increase the probability of cognitive awareness. The finding that such awareness improved discrimination more for subjects with the V than with the C topography further suggests, however, that there may be a difference in the cognitive style of Vs and Cs such that Vs are more inclined than Cs to utilize awareness to improve conditioned discrimination.

While the overall degree of discrimination achieved in the experiment was reliable, as indicated by significantly more response to the CS+ than to the CS- during the last 24 trials [ $F(1,72) = 26.58$ ], the discrimination level (19%) was very low in comparison to that in other conditioning work with conceptual discriminanda (e.g., 46% in Cerekwicki et al., 1968; 50% in Perry et al., 1971; 35% in Watters, 1970; 38% in Zajano, Grant, & Schwartz, 1974). In addition, while final response levels were generally higher for Vs than for Cs [ $F(1,72) = 13.47$ ,  $MSe = 1,683.13$ ], topography also interacted with reinforcement contingency [ $F(1,72) = 5.26$ ], such that significant discrimination was present only for Vs [ $t(72) = 2.65$ ] and not for Cs [ $t(72) = 1.04$ ]. In order to determine whether the poor level of conditioned discrimination may have been due to interference produced by use of the same 20 nouns in both CS+ and CS- capacities, a second experiment

was conducted in which a different noun was employed in each of the 80 CS phrases.

## EXPERIMENT 2

### Method

**Design and stimulus materials.** The design was a 2 by 2 factorial identical to Experiment 1, that is, high or low noun imagery by congruent or incongruent grammaticality-reinforcement contingency. However, instead of employing a set of 20 nouns for the 80 differential conditioning trials with each noun present (in a different phrase form) on four separate occasions, a different noun was used on each of the 80 trials. Thus, the CSs were phrases which varied from trial to trial but which always consisted of the adjective "One" or "Two" paired with a different singular or plural noun.

As in Experiment 1, the nouns were all high-imagery for one group of subjects and low-imagery for a separate group. The 20-noun sets of Experiment 1 were used together with an additional 60 nouns from each imagery extreme selected in a similar manner from the Paivio et al. (1968) norms. The mean imagery values for the 80-noun high-imagery and low-imagery sets were 6.32 and 3.27, respectively, with mean meaningfulness values of 6.49 and 5.21. Of the 80 nouns in each imagery set, 29 had Thorndike-Lorge frequencies of A or AA, and the mean frequency of the remainder was 14.3 for both sets. As before, the high- and low-imagery sets were closely equated in word length (3-12 letters,  $M = 7.31$  in each set) and the number of syllables (1-5 syllables,  $M = 2.52$  for the high-imagery set; 1-4 syllables,  $M = 2.56$  for the low-imagery set), although the average values were slightly higher than in Experiment 1, due to the large number of words required.

**Apparatus, procedure, and subjects.** Apparatus and procedure were identical to those of Experiment 1. Four different 80-phrase list forms were employed for each imagery condition, such that each noun appeared in every possible phrase form in one of the four list variations. The subjects were 48 women and 32 men students from introductory psychology classes at the University of Wisconsin. Group assignment was randomized within 16-unit blocks (all combinations of imagery by reinforcement contingency by four list forms). After the conditioning session, all subjects were given an extended version of the Experiment 1 questionnaire, in that after the same general and awareness questions, the subject was asked to write down as many of the nouns as he could recall and to put a check mark by the ones followed by an air puff.

### Results and Discussion

Subjects were again divided into Vs and Cs on the basis of CR topography, as outlined in Experiment 1. Of the 20 subjects each in the high-imagery congruent, high-imagery incongruent, low-imagery congruent, and low-imagery incongruent conditions, 11, 10, 6, and 3 were Vs, respectively. Figure 2 shows the percent response of Vs and Cs to the CS+ and CS- for successive eight-trial blocks in Experiment 2, with each experimental group presented in a separate panel. It may be seen that the pattern of performance was essentially the same as that in the original study. Thus, despite the use of a different noun in each of the stimulus phrases, differential responding was still generally poor. Evidently, then, the minimal effectiveness of the present grammatical discriminandum cannot be attributed to interference effects from use of the same set of nouns in both the reinforced and nonreinforced

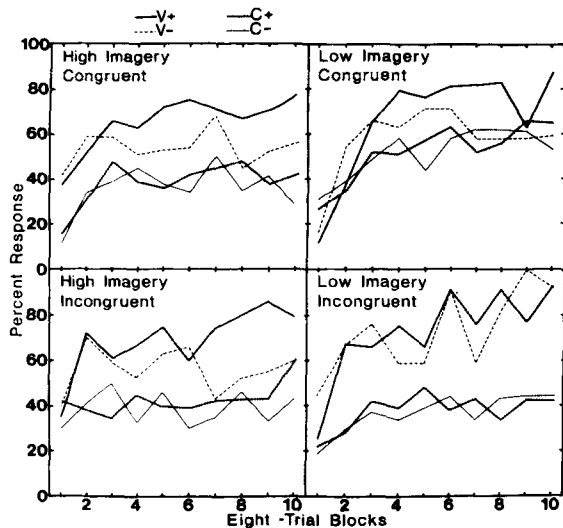


Figure 2. Experiment 2 acquisition of conditioned discrimination between grammatical and ungrammatical high- or low-imagery phrases with correct (incongruent) or incorrect (congruent) grammar reinforced. Percentages of CRs are plotted separately for Vs and Cs on successive eight-trial blocks for the reinforced (+) and nonreinforced (-) stimuli.

sets. It would clearly be premature, however, to consider grammaticality a uniformly weak discriminandum without further research, as greater differential responding might well occur under other parametric variations (e.g., with longer CS and interstimulus durations).

Congruency between grammaticality and reinforcement contingency had no significant main or interactive effects, as in Experiment 1. As before, however, discrimination was clearly improved by the use of high-imagery nouns in the stimulus phrases. This imagery effect was verified by the unweighted-means analysis of variance on terminal percent response to the CS+ and CS-, which indicated an interaction between imagery and reinforcement contingency [ $F(1,72) = 4.20$ ,  $MSe = 367.57$ ]. Thus, high imagery facilitated discrimination in Experiment 2 as in Experiment 1. The only other significant effects were a main effect of topography, with generally higher response levels for Vs than for Cs [ $F(1,72) = 10.16$ ,  $MSe = 1,674.62$ ], and a main effect of reinforcement contingency, indicating significant discrimination between the CS+ and the CS- in the experiment overall [ $F(1,72) = 10.50$ ].

Postexperimental reported awareness of the grammaticality discriminandum was analyzed in the same way as in Experiment 1. Of the 80 subjects, 47 were classified as aware, a proportion similar to that in Experiment 1. As before, awareness was not related to response topography [of the 47 aware subjects, 20 were Vs and 27 Cs;  $\chi^2(1) = 1.24$ ]. The relationship of awareness to imagery level was in the same direction

as in Experiment 1, but the frequency differences did not reach significance [ $\chi^2(1) = 2.527$ ]. However, for the two experiments combined, the greater frequency of aware subjects in high-imagery than in low-imagery conditions was highly significant [ $\chi^2(1) = 7.28$ ].

The relationship of awareness to conditioned discrimination is presented in Table 1. It may be seen that differential responding was again better for aware than for unaware subjects. An exact least-squares analysis of variance on discrimination which included the imagery, topography, and awareness variables (congruency could not be included due to insufficient observations in several cells) verified an imagery main effect [ $F(1,72) = 7.33$ ], as well as a main effect of awareness [ $F(1,72) = 7.29$ ]. However, in contrast to Experiment 1, topography had no significant main effect or interaction with awareness.

Finally, examination of stimulus-noun recall indicated that recall was generally very low ( $M = 3.04$ ). An imagery by congruency by topography least-squares analysis indicated that recall was better for high- than for low-imagery stimuli [ $F(1,76) = 9.07$ ,  $MSe = 5.14$ ,  $M_s = 3.9$  and  $2.2$ , respectively], but that it was not significantly affected by either congruency or response topography. Two additional analyses, which examined the influences of awareness and topography in relationship to imagery in one case and in relationship to congruency in the second case, likewise revealed only a main effect of imagery upon recall [ $F(1,76) = 8.85$ ,  $MSe = 5.14$ ].

## GENERAL DISCUSSION

There were several major findings in the present research. First, there was no evidence in either experiment of a congruency effect such that incorrect grammar was superior to correct grammar as a CS+ for the aversive UCS. The fact that it made no difference whether the consequence-congruent (bad grammar) or -incongruent (good grammar) stimulus set was reinforced contrasts with the Fleming, Grant, North, and Levy (1968) finding of a superiority of incorrectly solved over correctly solved arithmetic problems as the aversively reinforced CS+. Evidently, subjects are able to perceive the difference between grammatically correct and incorrect phrases without coding the incorrect phrases as "wrong" or "bad" in the same way that incorrect arithmetic is coded as "wrong" or "bad." Recent word association data (Perry & Perry, Note 1) support this interpretation, in that appropriate structural correctness labels of "right" or "wrong" (or synonyms for these) were very infrequent free associations for phrases (occurring 1% and 7% of the time for grammatical and ungrammatical phrases, respectively), but common associations for arithmetic problems (accounting for 31% and 45% of responses to correctly

and incorrectly solved problems, respectively). A definitive resolution of this question, however, would require further research which directly manipulated the associative strength of correctness labels to conditioning discriminanda. This would be a valuable next step.

A second major finding was that noun imagery was clearly an important factor affecting the ease of discriminating syntax. Regardless of whether good or bad grammar was the CS+, differential response to grammaticality was consistently better in the high-imagery than in the low-imagery conditions. These data thus support Paivio's (1971) contention that imagery is an important basic component in syntactic as well as in lexical processing. The results also suggest that much of the past success in differentially conditioning the eyelid response to verbal stimuli may have been due to the use of concrete words, and that conditioned discrimination would be likely to be much poorer with abstract verbal discriminanda.

The contingency awareness data are important in shedding some light on the specific mechanisms involved in the present imagery effects. A mediating awareness component is strongly implicated by several aspects of the data. In particular, the absence of any imagery effects in the Experiment 1 analysis incorporating the awareness variable [main effect imagery:  $F(1,75) = 1.92$ ,  $p > .10$ ] suggests that, at least under certain experimental conditions, high noun imagery may facilitate conditioned discrimination primarily in an indirect rather than direct fashion, by promoting cognitive awareness of the reinforcement contingencies. The fact that the proportion of aware subjects was consistently greater in the high-imagery than in the low-imagery conditions further supports this view. These results are also consistent with Yarmey's (1967) verbal mediation paradigm data and his suggestion that the additional nonverbal cues provided by high-imagery nouns serve to promote cognitive awareness as well as effective mediated performance. That involvement of an awareness intermediary does not necessarily preclude independent imagery effects is indicated by the significant main effects found for both variables in Experiment 2.

The finding that cognitive awareness was associated with higher levels of syntactic discrimination in both experiments represents one of the few instances in which a relationship has been demonstrated between awareness and skeletal conditioned discrimination. Together with other recent evidence of awareness effects (Nelson & Ross, 1974), the present data imply that, for those conditioning situations of sufficient complexity to produce variation in awareness, awareness must now be recognized as a relevant and potent variable in skeletal as well as autonomic conditioning. In fact, contingency awareness would appear to be a necessary condition for differential responding to syntax in the

present situation, in that subjects unable to report the CS-UCS contingency showed no conditioned discrimination even after 80 trials. The specific way in which awareness functions here requires some clarification, however. Nelson and Ross (1974) have recently proposed that attentional or cognitive activity involving the stimulus contingencies which takes place during the conditioning trials themselves, rather than knowledge of the contingencies *per se*, is the critical factor which enhances differential responding. The present data support and extend this viewpoint in indicating stronger awareness effects for Vs than for Cs. Even given the presence of contingency awareness, Vs tended to achieve better discrimination than did Cs, particularly in Experiment 1. These data suggest a topography-related difference in cognitive style such that Vs are more inclined than Cs to utilize contingency awareness in improving differential responding during the conditioning trials themselves. One factor which thus appears to affect the actual degree of contingency-related cognitive activity within ongoing conditioning trials is CR topography, with more such activity present for those aware subjects with the V topography.

In summary, then, the present research found no evidence of a congruency effect for phrase grammaticality, contrasting with arithmetic problem data, and indicating a need for an experiment in which the associative strength of "right" and "wrong" labels to the differential CSs is directly manipulated. Second, clear facilitative effects of noun imagery upon syntactic discrimination were demonstrated, supporting Paivio's (1971) view of the major role of imagery in syntactic processing. Third, cognitive awareness of the stimulus-reinforcement contingencies was shown to have a strong direct relationship to effective conditioned discrimination, and was also implicated as a mediating mechanism in imagery effects. Finally, CR topography was identified as a variable related to the degree of utilization of contingency information during conditioning trials, with such knowledge likely to be utilized more by voluntary-form than by conditioned-form responders.

#### REFERENCE NOTE

1. Perry, L. C., & Perry, D. G. *Semantic differential and word association responses as a function of correctness of adjective-noun phrase grammaticality and arithmetic problem solutions*. Unpublished manuscript, 1976.

#### REFERENCES

- CEREKWICKI, L. E., GRANT, D. A., & PORTER, E. C. The effect of number and relatedness of verbal discriminanda upon differential eyelid conditioning. *Journal of Verbal Learning and Verbal Behavior*, 1968, 7, 847-853.
- DAWSON, M. E. Can classical conditioning occur without contingency learning? A review and evaluation of the evidence. *Psychophysiology*, 1973, 10, 82-86.

- FLEMING, R. A., CEREWICKI, L. E., & GRANT, D. A. "Appropriateness" of the stimulus-reinforcement contingency in instrumental differential conditioning of the eyelid response to the arithmetic concepts of "right" and "wrong." *Journal of Experimental Psychology*, 1968, **77**, 295-300.
- FLEMING, R. A., GRANT, D. A., NORTH, J. A., & LEVY, C. M. Arithmetic correctness as the discriminandum in classical and differential eyelid conditioning. *Journal of Experimental Psychology*, 1968, **77**, 286-294.
- GRANT, D. A. A preliminary model for processing information conveyed by verbal conditioned stimuli in classical differential conditioning. In A. H. Black & W. F. Prokasy (Eds.), *Classical conditioning II: Current research and theory*. New York: Appleton-Century-Crofts, 1972.
- GRANT, D. A. Cognitive factors in eyelid conditioning. *Psychophysiology*, 1973, **10**, 75-81.
- GRINGS, W. W. Cognitive factors in electrodermal conditioning. *Psychological Bulletin*, 1973, **79**, 200-210.
- HARTMAN, T. F., & ROSS, L. E. An alternative criterion for the elimination of "voluntary" responses in eyelid conditioning. *Journal of Experimental Psychology*, 1961, **61**, 334-338.
- LOCKHART, R. A. Cognitive processes and the multiple response phenomenon. *Psychophysiology*, 1973, **10**, 112-118.
- NELSON, M. N., & ROSS, L. E. Effects of masking tasks on differential eyelid conditioning: A distinction between knowledge of stimulus contingencies and attentional or cognitive activities involving them. *Journal of Experimental Psychology*, 1974, **102**, 1-9.
- PAIVIO, A. *Imagery and verbal processes*. New York: Holt, Rinehart, & Winston, 1971.
- PAIVIO, A., YUILLE, J. C., & MADIGAN, S. Concreteness, imagery, and meaningfulness values for 925 nouns. *Journal of Experimental Psychology Monograph Supplement*, 1968, **76**(1, Part 2).
- PERRY, L. C., ORNSTEIN, P. A., WATTERS, W. C., & GRANT, D. A. Effects of number and type of verbal conditioned stimuli upon differential eyelid conditioning. *Journal of Verbal Learning and Verbal Behavior*, 1971, **10**, 459-469.
- WATTERS, W. C. *Transfer of the eyelid response differentially conditioned to sets of conceptually related verbal stimuli*. Unpublished Master's thesis, University of Wisconsin, Madison, 1970.
- YARMEY, A. D. Word abstractness, awareness, and type of design in verbal mediation. *Psychology*, 1967, **4**, 24-32.
- ZAJANO, M. J., GRANT, D. A., & SCHWARTZ, M. Transfer of differential eyelid conditioning: Effects of semantic and formal features of verbal stimuli. *Journal of Experimental Psychology*, 1974, **103**, 1147-1152.

(Received for publication January 4, 1977;  
revision accepted March 1, 1977.)