PREFERENCES AMONG STIMULUS MATCHES IN THE PIGEON

RICHARD PISACRETA

FERRIS STATE COLLEGE

Three pigeons were trained to peck two to five illuminated response keys. A peck to any of the keys changed the stimulus on the key. When all keys showed the same stimulus (i.e., a stimulus match), an additional key was illuminated with white light. A peck on this key produced three-second access to grain, a three-second intertrial interval, and the next trial. For most sessions, no particular stimulus match was required. Although there were often several stimuli available, each bird preferred a particular stimulus match. With up to 12 stimuli available, birds matched a particular stimulus 60% to 100% of the time.

Key words: matching behavior, response stereotypy, complex operants, key pecks, pigeon

Operants are classes of behavior that are functionally related to reinforcers (Schick, 1971). Operant classes can be defined by a functional relation between reinforcement and such properties of responding as force, duration, latency, topography, or emission rate (e.g., Antonitis, 1951; Herrnstein, 1961; Milenson & Hurwitz, 1961; Notterman & Mintz, 1965; Segal, 1972; Skinner, 1938; Stebbins & Lanson, 1962). A relationship between reinforcement and temporal and spatial patterning of behavior can also define an operant class as several recent studies have demonstrated (Catania, 1971; Hawkes & Shimp, 1975; Pisacreta, 1982; Schwartz, 1981; Shimp, 1976; Vogel & Annau, 1973; Wasserman, 1977). Hawkes and Shimp (1975) showed that temporal key-pecking patterns could be shaped by requiring pigeons to peck at increasing or decreasing rates during 5-sec trials. Schwartz (1981) required pigeons to peck two keys four times each to produce a reinforcer. Of the 70 possible two-key sequences, the birds repeated one sequence on the majority of trials. Pisacreta (1982) rewarded pigeons for pecking six to nine keys, one each, in any order. Both birds developed a stereotyped se-

quence that was emitted on the majority of trials.

The present study extends the finding of stereotypy to stimulus matching. Although variability was permitted (i.e., several possible response patterns produced reinforcement), each bird quickly settled into a dominant, stereotypical pattern of matching behavior.

METHOD

Subjects

Three naive White Carneaux pigeons, maintained at $80\% \pm 15g$ of their free-feeding weights, were employed.

Apparatus

The apparatus was a 35- by 35- by 37-cm operant chamber enclosed in a sound-attenuating hull. A 20- by 25-cm piece of one-way glass mounted on the door of the outer hull enabled observation of the entire experimental area. Figure 1 shows the intelligence panel. Other than the unusual number of pecking keys, the intelligence panel, 37 cm by 35 cm, employed standard dimensions and commercial components. Each key was 2.7 cm in diameter (BRS/LVE Model #121-16). Stimuli were rear-projected onto the keys by Industrial Electronics Engineers Inline Projectors (Model #1813-44). The operating-force requirement of each key was approximately .16 N. The horizontal and vertical distances between the keys were 8.1 and 6.4 cm, respectively, center to center. A 6-

This research was supported by a Ferris Faculty Research Grant (#03-300-6656-603-504) to Richard Pisacreta. I wish to thank Evalyn F. Segal for editing earlier drafts and Mrs. Betty Beaton for typing several drafts. Request reprints from Richard Pisacreta, Department of Psychology, Ferris State College, Big Rapids, Michigan 49307.

Fig. 1. The intelligence panel employed. The pecking keys are numbered one through 11. SP is the speaker which provided masking noise; H and SA represent the houselight and sonalert, respectively.

by 6-cm feeder aperture was centered on the wall 10 cm above the floor.

The feeder (BRS/LVE Model #114-10) provided 3-sec access to grain. The houselight, a GE #1820 lamp, provided light before and after daily experimental sessions. During sessions, illumination was provided only by the inline projectors. Response Keys 7, 8, 9, 10, and 11 were never illuminated. White noise delivered through the speaker and a ventilation fan masked extraneous noise. An E and L Instruments MMD-1 computer recorded data and controlled experimental events.

Procedure

The birds were magazine trained. Then key pecking was shaped using Key 5, illuminated with a white field (S^D). Each bird was then allowed to produce 100 food reinforcers by pecking Key 5. All subsequent sessions terminated after 42, 48, or 54 reinforcers, depending on the phase.

Phase 1. Keys 1 and 2 were illuminated on each trial, a random one with red light and the other with blue. A peck to either key changed that key to the alternate color, thereby producing a stimulus match, i.e., two red or two

blue keys. When the keylights matched, they began flashing once per second and Key 5 lit with steady white light. A peck to Key 5 produced a reinforcer, followed by a 3-sec inter-trial interval (ITI) and the next trial. During the ITI the chamber was dark. Each of the three sessions of this phase ended after 42 reinforcers. (Table 1 summarizes the conditions during each phase of the experiment.)

Phase 2. Each trial began with Keys 1, 2, and 3 displaying red or blue; i.e., a random two red and one blue or two blue and one red. Reinforcement depended on the birds' making all keylights the same color. Pecks to any key changed its color to one of the alternate colors available. When all key colors matched, the lights began to flash and Key 5 was lit. A peck on Key 5 produced a reinforcer, ITI, and the next trial. Key 5 was employed so as not to directly reinforce (and hence differentially strengthen) pecking at any particular one of the matching keys or at any particular color.

The basic contingency was the same in later phases. The independent variable across the remaining phases was the number of matching keys employed, the colors initially projected on them, and the number of colors available. The colors present at trial onset were randomized, so not all colors appeared at onset of every trial.

Phase 3. Table 1 indicates that for the next five sessions Keys 1, 2, 3, and 4 were employed with red and blue stimuli.

Phase 4. Red and green stimuli were presented to Subjects B1 and B3, whereas blue and green were presented to B2.

Phase 5. For the next five sessions, three colors (red, blue, or green) illuminated Keys 1, 2, 3, and 4.

Phase 6. Two changes were introduced. Five matching keys (1, 2, 3, 4, and 6) were employed. For Subjects B1 and B2, green was never present at the beginning of a trial, nor was red for B3. Red, blue, and green were available for matching subsequently in the trial for all birds.

Phase 7. Blue and red were available for the five matching keys for B1 and B2, and blue and green for B3.

Phase 8. The same colors were presented as in Phase 7. However, the birds had to match blue. Pecks to blue keys did not change their color.

Table 1
Summary of Conditions

Phase	Number of Keys	Number of Sessions	Stimuli Available		
			B1	B2	B3
1	2	3	R,B	R,B	R,B
2	3	5	R,B	R,B	R,B
3	4	5	R,B	R,B	R,B
4	4	5	R,G	B,G	R,G
5	4	5	R,B,G	R,B,G	R,B,G
6	5	5	R,B,G	R,B,G	R,B,G
7,8,9	5	5	B,R	B,R	B,G
10,11	5	5	R,B,G	R,B,G	R,B,G
12,13	5	5	R,B,G,Y	R,B,G,Y	R,B,G,Y
14	5	5	R,B,G,Y	R,B,G,Y	R,B,G,Y
			W,V,H,X	W,V,H,X	W,V,H,X
15	3	10	+S,C,T	+S,C,T	+S,C,T
16	5	5	+S,C,T	+S,C,T	+S,C,T
17	3	5	R,B,G,Y,W,V	R,B,G,Y,W,V	R,B,G,Y,W,V
			H,X,+S,C,T	H,X,+S,C,T	H,X,+S,C,T
18	5	5	R,B,G,Y,W,V	R,B,G,Y,W,V	R,B,G,Y,W,V
			H,X,+S,C,T	H,X,+S,C,T	H,X,+S,C,T
19	3	5	R,B,G,Y,W,V	R,B,G,Y,W,V	R,B,G,Y,W,V
			H,X,+S,C,T	H,X,+S,C,T	H,X,+S,C,T
20	5	5	R,B,G,Y,W,V	R,B,G,Y,W,V	R,B,G,Y,W,V
			H,X,+S,C,T	H,X,+S,C,T	H,X,+S,C,T

The stimuli included: R(ed), B(lue), G(reen), Y(ellow), W(hite), V(ertical line), H(orizontal line), X, +, S(square), C(circle), and T(triangle). The stimuli are shown in the sequence in which a key peck would produce them.

Phases 9 and 10 replicated the conditions of Phases 7 and 6, respectively.

Phase 11. Red, blue, and green stimuli were available on the five matching keys (1, 2, 3, 4, and 6).

Phase 12. Four matching colors were available by adding yellow. Yellow was never present at the beginning of a trial.

Phase 13. Yellow was present at the beginning of some trials.

Phase 14. Trials began with various combinations of red, blue, green, and yellow on the five matching keys. A total of eight matching stimuli was available on each key later in the trial. The four additional stimuli were: white, a white vertical line, a white horizontal line, or a white X, the last three on black backgrounds.

Phase 15. The number of matching keys was reduced from five to three (1, 2, and 3). The eight familiar stimuli of Phase 14 were replaced by four novel stimuli: a white square, circle, triangle, and + on black backgrounds.

Phase 16. Five matching keys (1, 2, 3, 4, and 6) were employed with the four matching stimuli of Phase 15.

Phase 17. Trials began with combinations of just +, square, circle, and triangle displayed

on just three matching keys, but all 12 stimuli were available on the three keys subsequently in the trial (see Table 1).

Phase 18. The conditions of Phase 17 were continued with the addition of two more matching keys.

Phase 19. Various random combinations of three stimuli drawn from the pool of 12 stimuli were present at the beginning of each trial, on just three matching keys. All 12 stimuli were available subsequently in the trial.

Phase 20. The conditions of Phase 19 were continued with the addition of two more matching keys.

It should be noted that, with the exception of Phase 8, the contingencies never specified a match to any particular stimulus. There were 152 different stimulus combinations presented as the initial trial stimuli. Often the bird had to peck only one or two keys to produce a match; e.g., a trial started with four red keys and one blue key or three green and two squares.

Several aspects of the birds' behavior were of interest. Would the birds match efficiently, that is, peck the minimum number of times necessary to yield a match? Would the matching patterns produced with three keys be main-

Fig. 2. The percentage of reinforcers obtained by matching particular stimuli. The number below each panel represents the phase(s). Matched stimuli include R(ed), B(lue), G(reen), V(ertical line), Y(ellow), +, S(quare), C(ircle), T(riangle), and H(orizontal line).

tained with five keys? Would the pigeon behave conceptually (peck only odd keys) or produce a preferred match regardless of the number of keys and stimuli employed?

RESULTS

Figure 2 shows the percentage of reinforcers obtained by matching particular stim-

uli across all sessions of each phase. Each bird preferred a particular match. The preference appeared early in the first session of each phase and continued across the remaining sessions of the phase. During the first three phases, with red and blue available, Subjects B1 and B3 matched red on every trial, whereas Subject B2 matched blue 90% and 100% in Phases 2 and 3, respectively.

The nonpreferred stimulus from Phases 1, 2, and 3 (blue for B1 and B3, red for B2) was replaced with green during Phase 4. Although green was novel and their previously preferred matching stimuli were available, Subjects B1 and B2 switched to consistently matching green during this phase, whereas B3 continued to match red. All three birds maintained these preferences in Phase 5 when three colors, red, blue, and green, were available.

Phase 6 tested whether it was necessary for the preferred matching stimulus to be present at the beginning of a trial. Although red, blue, and green stimuli were available for matching, green was not presented to Birds B1 and B2 at trial onset, nor red to B3. Figure 2 shows that all three birds continued to match their preferred stimulus 90% of the time. During Phase 7, the preferred match was not possible. Green was not available for Subjects B1 and B2 nor red for B3. Subject B1 then matched red, as it had in Phases 1 to 3. Bird B2, however, matched red, not blue as it had during Phases 2 and 3, and Bird B3 matched green, which it had occasionally matched in Phase 6 (5% of the time).

Phase 8, where each bird was forced to match only blue, is not shown in Figure 2. Matching blue carried over to Phase 9 although another match (red for Birds B1 and B2, green for B3) was now possible. During Phase 10 three matches, red, blue, and green, were possible, although green was not displayed at trial onset for B1 and B2, nor red for B3 (the same conditions as Phase 6). Subjects B1 and B2 continued to match blue, whereas B3 switched to red and green. In Phase 11, combinations of red, blue, and green were displayed at trial onset, as in Phase 4. All three birds replicated their Phase 4 preferences: green for B1 and B2, red for B3. In Phase 12, red, blue, and green were available at trial onset and yellow subsequently in the trial. In Phase 13, yellow was available from trial onset. Throughout both phases, B1 and

B2 continued to match green, whereas B3 matched red.

Phase 14 made eight matching stimuli available. Figure 2 shows that all three birds matched vertical line on 60 to 85% of the trials. B1 and B2 continued to match green on 20% and 35% of the trials, respectively.

Phase 15 made four novel stimuli available and yielded matching behavior unlike that seen in earlier phases: The birds matched all four stimuli. B1 matched all four about equally often; B2 matched square on 75% of the trials; B3 matched + and square on 50% and 30% of the trials, respectively. During Phase 16, matching the square came to dominate the behavior of B2 and B3, whereas B1 matched + and triangle on a total 75% of the trials.

Phase 17 made all 12 matching stimuli available. B2 and B3 reverted to matching green and red respectively, as they had in Phases 11 to 13, before form stimuli were introduced. B1 matched a horizontal line on 60% of the trials. These matching preferences increasingly dominated in the last three phases. During Phase 20, when 12 stimuli were available on each of the five keys, the dominant match occurred on all trials. Birds never matched white or X on any trial of the experiment.

Each phase offered multiple ways for the birds to collect reinforcers. Some response patterns were more efficient than others, that is, required fewer key pecks to produce a match. For example, if a trial presented four red and one green key, as was possible in Phase 11, then pecking the green key once would produce a red match and would be the most efficient way to collect a reinforcer. Pecking the four red keys twice each, in order to produce a green match, would also meet the requirements but with eight times the minimum number of responses necessary. Figure 3 shows the percent efficiency (unfilled data points) during the last three sessions of each phase. Percent efficiency was calculated by dividing the minimum number of matching pecks required during all trials of a session by the total number of matching pecks emitted, then multiplying by 100. The figure also shows the percentage of reinforcers produced by way of the preferred match (filled data points). (Phase 1 is not shown because a peck to either key produced a match, i.e., efficiency was perforce 100%.)

In general, the figure shows that as the num-

Fig. 3. Percent efficiency and percent of dominant matches plotted as a function of the number of keys and matching stimuli available. Filled circles, squares, and triangles represent matching data. Unfilled points show efficiency data. ST refers to the number of matching stimuli available. KY indicates the number of keys used during each phase.

ber of keys and stimuli available increased, efficiency decreased. This is to be expected because the trials were designed to allow efficient overall responding only by matching each available stimulus on at least one trial of a session. Emergence of one dominant match necessarily lowered efficiency on many trials. Figure 3 shows that during Phases 2 and 3, Birds B1 and B3 maintained efficiencies better than 70%. Subject B2's efficiency was slightly lower. The efficiency of Subjects B1

and B3 dropped during Phase 4. Both birds tended to perseverate on a key, rotating through all the stimuli available on the key several times before switching to another key. Perseveration decreased in Phase 5, producing an increase in efficiency. Efficiency decreased during Phase 6 primarily because of the introduction of a fifth matching key and the unavailability of each bird's preferred matching stimulus at trial onset. Efficiency improved during Phase 7 when one less matching stim-

ulus was available. Efficiencies did not reach 100% during Phase 8 (forced blue matching) because each bird pecked keys that were already blue before switching to nonblue keys and producing a match.

Phase 9 reinstated the conditions of Phase 7. In general, the birds showed efficiencies in Phase 9 similar to those of Phase 7. Phase 10, relative to Phase 6 (with the same conditions), revealed improved efficiency by all birds. An increase in dominant matching during Phase 11 reduced efficiencies. Since B1 and B2 predominantly matched green during Phase 12 and seldom responded to yellow (which was never present at trial onset), their efficiencies remained high. Bird B3 had to respond often to yellow in order to produce red matches. Therefore, its efficiency dropped almost 20% during Phase 12. The introduction of yellow at trial onset in Phase 13, and the birds' failure to match yellow, explains their low efficiency. Persistence of dominant matching when eight matching stimuli were available during Phase 14 insured low efficiencies. Novel form stimuli produced poor efficiencies in Phases 15 and 16. Finally, efficiencies varied across the last four phases primarily as a function of the number of available stimuli: 36 (12 stimuli on each of three keys) in Phases 17 and 19, 60 (12 stimuli by five keys) in Phases 18 and 20; and the reemergence of dominant matches.

DISCUSSION

Clark & Sherman (1970) presented pigeons with two keys—a sample key and a comparison key. Both keys were dark at trial onset. A peck to the sample key illuminated it with red or green. A peck to the comparison key produced red or green on the key. Additional pecks resulted in the random alternation of red and green illumination. The birds' task was to peck the comparison key until its color matched the color present on the sample key. A peck to the sample key when both keys showed the same color produced a reinforcer. Mismatches darkened both keys and recycled the trial. The birds matched the sample on over 90% of the trials. The present study extended Clark and Sherman's work by: 1) increasing the matching stimuli available to 12; 2) increasing the matching keys to five; 3) allowing the birds to match any stimulus avail-

able on any key, i.e., "free choice" matching instead of "forced choice" matching.

The present results indicate that, given the opportunity, pigeons will show matching preferences. Each pigeon matched a particular stimulus on 80 to 100% of the trials of a given phase. The birds did not peck the keys in a particular sequence and returned to a key that already showed a preferred stimulus during less than 2% of the trials across phases. Perseveration on a key (rotating through all the stimuli available on the key several times before switching to another key) was infrequent across sessions and seemed to result from pecking bursts during some trials (or possibly attempts to produce preferred but unavailable stimuli).

The data also suggest a hierarchy of stimulus preferences. Pigeon B1 matched red during the first three phases, when the alternate was blue, but matched green during Phases 4, 5, 6, 11, 12, and 13, although red was available. B1 predominantly matched a vertical line in Phase 14 although red and green were both available. Later (Phases 17 to 20) B1 matched a horizontal line even though red, green, and vertical line were still available. Similarly, B2 matched blue during the first three phases, then duplicated B1's behavior by matching green during Phases 4, 5, 6, 11, 12, and 13; and predominantly matched a vertical line during Phase 14. Unlike B1, however, B2 returned to matching green during the last three phases. Bird B3 matched red during all phases that permitted it except Phase 14, in which it, too, matched a vertical line on the majority of trials. In summary, the data suggest a matching hierarchy of horizontal line, vertical line, green, then red for B1; green, vertical line, then blue for B2; and red followed by vertical line for B3.

A parsimonious interpretation of the data might treat matching as a case of behavior under the control of second-order or chained schedules. A schedule is chained if a response in one link produces the S^D for the behavior in the next link. A schedule is second-order if several performances, each with its own conditioned reinforcer, are required to produce a primary reinforcer (e.g., Bigelow, 1971; Findley, 1962; Kelleher, 1966; Kelleher & Gollub, 1962). In the present procedure, the temporal sequence of events involved: 1) producing matching stimuli on all available keys, 2)

matching stimuli flash and Key 5 lights, 3) pecking Key 5 to produce food. The schedule can be considered a two-component chain. The contingencies in the first component, however, are a second-order schedule in the more general sense. In the first link, pecking a matching key until it showed the preferred matching stimulus may be considered one performance. N such performances were required to light Key 5. To use Kelleher's (1966) terminology, the present procedure can be considered a $[FRx(VR)]$ (FR1) second-order schedule. The variable ratios (VRs) are the number of responses required to produce the bird's preferred stimulus on one key; the fixed-ratio (FR) value x represents the number of matching keys; the FR1 is the requirement on Key 5, whereon a peck produced food. Furthermore, the appearance of the preferred stimulus also functioned as an S^D to switch to another key.

Another factor that may be relevant to the present case involves response stereotypy. Schwartz (1981, 1982) demonstrated that if a sequence of responses produces a reinforcer, and variability is permitted, pigeons and humans typically develop stereotyped response sequences. In the Schwartz studies, pigeons and humans were required to respond on each of two keys, four times each, to produce a reinforcer. The birds and the college students came to emit a particular sequence on the majority of the trials. Pisacreta (1982) rewarded pigeons for pecking once on each of six to nine keys, with no constraint on the order in which keys were pecked. The contingencies produced stereotyped sequences that occurred on over half the trials. Furthermore, reinforcers can maintain inefficient forms of an activity. Specifically, when repetitive behavior is reinforced, organisms may emit response sequences that are not efficient but nevertheless yield intermittent reinforcers. The human subjects in the Schwartz (1982) study reported that the particular sequence they consistently emitted was necessary to produce reinforcers. Schwartz (1982) concluded that:

It thus seems as though an automatic effect of contingent reinforcement is the creation of stereotyped units of behavior that occur on trial after trial even though the reinforcement contingency does not require it. In short, reinforcement seems to teach organisms to repeat precisely what has worked in the past. (p. 26)

The emergence of matching preferences and accompanying poor efficiencies in the present study may also be a case of response stereotypy. The results may indicate that effective matching (pecking only the least frequent stimulus types on each trial) did not occur either, because it was not specifically required. Efficient matching, however, might require "cognitive" strategies beyond the capability of the pigeon (Premack, 1978).

REFERENCES

- Antonitis, J. J. Response variability in the white rat during conditioning, extinction, and reconditioning. *Journal of Experimental Psychology*, 1951, **42**, 273-281.
- Bigelow, G. Fixed-ratio reinforcement of spaced responding. *Journal of the Experimental Analysis of Behavior*, 1971, **16**, 23-30.
- Catania, A. C. Reinforcement schedules: The role of responses preceding the one that produces the reinforcer. *Journal of the Experimental Analysis of Behavior*, 1971, **15**, 271-287.
- Clark, H. B., & Sherman, J. A. Effects of a conditioned reinforcer upon accuracy of match-to-sample behavior in pigeons. *Journal of the Experimental Analysis of Behavior*, 1970, **13**, 375-384.
- Findley, J. D. An experimental outline for building and exploring multi-operant behavior repertoires. *Journal of the Experimental Analysis of Behavior*, 1962, **5**, 113-166.
- Hawkes, L., & Shimp, C. P. Reinforcement of behavioral patterns: Shaping a scallop. *Journal of the Experimental Analysis of Behavior*, 1975, **23**, 3-16.
- Herrnstein, R. J. Stereotypy and intermittent reinforcement. *Science*, 1961, **133**, 2067-2069.
- Kelleher, R. T. Conditioned reinforcement in second-order schedules. *Journal of the Experimental Analysis of Behavior*, 1966, **9**, 475-485.
- Kelleher, R. T., & Gollub, L. R. A review of positive conditioned reinforcement. *Journal of the Experimental Analysis of Behavior*, 1962, **5**, 543-597.
- Millenson, J. R., & Hurwitz, H. M. B. Some temporal and sequential properties of behavior during conditioning and extinction. *Journal of the Experimental Analysis of Behavior*, 1961, **4**, 97-106.
- Notterman, J. M., & Mintz, D. E. *Dynamics of response*. New York: Wiley, 1965.
- Pisacreta, R. Some factors that influence the acquisition of complex, stereotyped, response sequences in pigeons. *Journal of the Experimental Analysis of Behavior*, 1982, **37**, 359-369.
- Premack, D. On the abstractness of human concepts: Why it would be difficult to talk to a pigeon. In S. H. Hulse, H. Fowler, & W. K. Honig (Eds.), *Cognitive processes in animal behavior*. Hillsdale, N.J.: Erlbaum, 1978.
- Schick, K. Operants. *Journal of the Experimental Analysis of Behavior*, 1971, **15**, 413-423.
- Schwartz, B. Control of complex, sequential operants by systematic visual information in pigeons. *Journal of Experimental Psychology: Animal Behavior Processes*, 1981, **7**, 31-44.

- Schwartz, B. Reinforcement-induced behavioral stereotypy: How not to teach people to discover rules. *Journal of Experimental Psychology: General*, 1982, **111**, 23-59.
- Segal, E. F. Induction and the provenance of operants. In R. M. Gilbert & J. R. Millenson (Eds.), *Reinforcement: Behavioral analyses*. New York: Academic Press, 1972.
- Shimp, C. P. Organization in memory and behavior. *Journal of the Experimental Analysis of Behavior*, 1976, **26**, 113-130.
- Skinner, B. F. *The behavior of organisms*. New York: Appleton-Century, 1938.
- Stebbins, W. C., & Lanson, R. N. Response latency as a function of reinforcement schedule. *Journal of the Experimental Analysis of Behavior*, 1962, **5**, 299-307.
- Vogel, R., & Annau, Z. An operant discrimination task allowing variability of reinforced response patterning. *Journal of the Experimental Analysis of Behavior*, 1973, **20**, 1-6.
- Wasserman, E. A. Conditioning of within-trial patterns of key pecking in pigeons. *Journal of the Experimental Analysis of Behavior*, 1977, **28**, 213-220.

Received October 29, 1981

Final acceptance April 19, 1982