Effects of an increment in monetary incentive magnitude on instrumental responding and repeated increases in reward magnitude in humans

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Human Ss performed at a reliably higher level for a tone previously paired with an increase in monetary incentive magnitude and consequently positive incentive contrast effects than did individuals for a tone previously associated with the larger control groups's quantity of incentive. In Experiment 2, upward incentive contrast effects which resulted from a single increment in magnitude of monetary reinforcement were eliminated in individuals who experienced the increase in amount of money after an upshift in reward amount. These data are consistent with the notion that positive incentive contrast effects in human Ss are due to some form of appetitive motivational state.

Positive incentive contrast effects are defined when an increase in incentive magnitude results in a significantly higher level of behavior than that of a control group maintained on the larger incentive amount throughout training. A number of studies have recently demonstrated positive contrast effects with animals (e.g., Dunham & Kilps, 1969; Panksepp & Trowill, 1969; Shanab & Farrell, 1970; Shanab, Sanders, & Premack, 1969), and some researchers have found the effect with humans (e.g., Weinstein, 1970). Little information is available concerning the determinants of the phenomenon at the human or animal level. The present experiments examined the notion that upward contrast in humans is due to some appetitive emotional-motivational response.

According to this view, an increase in magnitude of reward results in an appetitive emotional response such as happiness which produces internal cues that energize the instrumental response, thus resulting in an increase in performance-positive incentive contrast effects. If this is the case, one might expect that a neutral stimulus paired with an increase in amount of reward which results in upward contrast effects will subsequently produce a higher level of performance than when the cue is initially associated with the control group's larger amount of reward. That is to say, as a result of occurring with the appetitive emotional state, the cue should subsequently elicit that emotion so that S performs a response to acquire the pleasant signal. Such results would agree with the notion

that an increase in incentive size in human Ss results in some form of appetitive, pleasant, emotional response which accounts for positive contrast effects. Experiment 1 attempted to determine the effects of an auditory stimulus paired with an appropriate increase in magnitude of reward as compared to when the stimulus is associated with the control group's larger quantity of reward on the buttonpressing behavior of human Ss.

If such an appetitive emotional account of upward contrast effects is tenable, one would expect Ss who experience an increase in amount of reward to have affective cues conditioned to the ongoing response. If this is the case, a second increase in incentive amount should produce familiar emotional cues; that is to say, Ss are now less sensitive to the facilitating effects of the emotional cues than Ss who do not experience a prior increase in amount of reinforcement. An upshift in incentive magnitude should result in a smaller increase in performance and little, if any, positive contrast effects, as compared to individuals who experience this second increase in reward quantity subsequent to no variation in reward magnitude. If positive contrast effects are attenuated or eliminated in Ss who experience an increase in incentive size previous to the reward increase experienced in the test situation, as compared to individuals who do not experience an upward shift in quantity of reinforcement before the test situation, then these results would be in accord with the idea that positive contrast effects in humans can be explained on the basis of an appetitive emotional state. Experiment 2 attempted to determine the effects of

an increase in incentive magnitude subsequent to an upshift in amount of reward as compared to Ss who experience the increase in reward magnitude after no upshift in amount of incentive.

EXPERIMENT 1

Subjects

The Ss, 50 males and 50 females, enrolled in an introductory psychology course at the University of Melbourne, were assigned randomly to each of five groups so that 10 males and 10 females appeared in each group.

Apparatus

The materials consisted of a Kodak Carousel 750 slide projector, 139.7 mm from a 152.40-mm-square piece of cardboard that served as a screen, 50.8 x 42.6 mm slides with digits printed on them (i.e., 242 x 3), and a stopwatch. The auditory signal, a 1,000-Hz 70-dB SPL tone produced by an audio oscillator, was presented through a speaker placed .3048 m directly behind the S's head. The onset of the 3-sec tone during postshift was manually controlled by E.

The other apparatus consisted of a panel, .0929 m square, with a button, response key, and 25-W light, 50.8 mm above the button. The same tone as used in the postshift was administered in this situation, .3048 m directly behind the S's head. The durations of the tone and light, 3 sec and 10 sec, respectively, were manually controlled by E.

Procedure

Each S worked the same sequence of the same 30 mental multiplication problems. One correct or incorrect answer, or 60 sec, whichever came first, was allowed for each problem, with 4 sec between problems.

The problems were worked in five situations. In one group (20-20), Ss received 20 cents after correctly or incorrectly answering Problems 2, 3, 4,

Fig. 1. Mean latency in seconds. Arrow denotes postshift. Data are presented in blocks of five trials.

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Fig. 2. Mean percentage buttonpresses for the experimental, 2-20T, and control, 20-20T, groups.

6, 11, 14, 15, 18, 23, 24, 25, 26, and 28; another group (2-20) received 2 cents through Problem 14, followed by an increase in incentive magnitude to 20 cents on Problem 15 and on the previously designated remaining problems; in a third condition (2-20T), individuals received 2 cents through Problem 14, followed by an increase to 20 cents plus the 3-sec tone on Problem 15 and thereafter; other Ss (20-20T) received 20 cents through Problem 14 and then 20 cents plus the tone for the remainder of the session, Problems 15, 18, 23, 24, 25, 26, and 28; finally, some Ss (N) were exposed to no reward or tone throughout the 30 problems.

Ss were read the following instructions: "This is an experiment in abstract problem solving, the ability to rapidly work problems involving abstract reasoning. You will be given some problems to work. Each one consists of a three-digit number multiplied by a one-digit number. You are to mentally, without pencil and paper, in your head, multiply the numbers as quickly as you can and tell me your answer. You will receive money after some answers. The speed and accuracy with which you answer, relative to other Ss, will earn you more money. In other words, you are being rated against other Ss." The E, seated beside the S, manually administered the rewards, the tone, operated the slide projector, and recorded latencies with the stopwatch. When E handed S money in the postshift phase, the tone was sounded.

After Problem 30, there was a 5-min rest period for the 20-20T and 2-20T Ss, followed by 30 trials with the buttonpressing apparatus with a constant 60-sec intertrial interval (the time between tone offset and light onset or light offset and light onset.) The S was seated in front of the panel with the speaker behind his head. The E was seated beside S. Sixty seconds after the instructions were read, the

light was activated. If S made no buttonpress, the light was terminated 10 sec after its onset; if S pressed the button during the light, the light was discontinued, the postshift tone was given for 3 sec, and a response was scored for the trial. If the button was depressed in the intertrial interval, a response was not scored and S had to respond or not respond at the start of the trial. Responses were manually recorded by E.

The 20-20T and 2-20T individuals were read the following instructions: "This part of the study is concerned with decision-making processes, the ability to make up one's mind clearly and firmly as to what shall be done and the way to do it. You will receive a series of lights. When the light is on, it is possible to turn on a tone by pressing the button in front of you. If you do not press the button during the light, no tone will occur, the light will terminate, and the sequence will start again."

Results

Latency means (the time between slide onset and the first answer, correct or incorrect) were examined in the analysis of the pre- and postshift results.

Figure 1 suggests that the N individuals reacted more slowly than all other Ss, 2-20T and 2-20 reacted more slowly than 20-20T and 20-20, respectively, while the shift groups responded at about the same speed, and the control conditions, 20-20T and 20-20, reacted about equally fast.

The mean latency from Problems 1-14 differed significantly among the five groups by an analysis

of variance, $F(4,95) = 2.86$, $p < .05$. By Newman-Keuls comparisons, the differences between N and each other group and between 2-20T and 20-20T, and 2-20 and 20-20 were each statistically reliable ($p < .05$), while the differences between the shift groups and the control groups were each not significant ($p > .05$).

Figure 1 indicates that on Problem 20, the 2-20T and 2-20 groups each reduced their mean latency to an equal level below their control conditions, 20-20T and 20-20, respectively (positive incentive contrast effects). The mean latency from Problems 20-30 differed significantly among the four incentive groups by analysis of variance, $F(3,76) = 3.24$, $p < .05$. By Newman-Keuls comparisons, the differences between 2-20 and 20-20 and between 2-20T and 20-20T were each reliable ($p < .05$), while the differences between 2-20 and 2-20T, and 20-20 and 20-20T were each not statistically reliable ($p > .05$).

The mean percentage of buttonpresses per session (number of presses/ 30×10) was one response measure examined in the analysis of the pressing data.

Figure 2 displays mean percentage presses as a function of shift-control group. Examination of Fig. 2 indicates that Ss who received the tone paired with an increase in incentive size responded more for the signal than did individuals in the control condition.

An analysis of variance revealed a significant difference between the two groups, $F(1,38) = 5.62$, $p < .05$.

Another measure examined in the

Fig. 3. Mean latency in seconds. Arrow denotes postshift. Each data point is a block of five trials.

analysis of the buttonpressing data was the mean latency of the first response in the 30-trial session. The measure (data not presented here) yielded results similar to the percentage presses. That is to say, 2-20T took less time to emit the first buttonpress in the session than did 20-20T. The mean latency of the first press per session differed significantly between the two groups by an analysis of variance, $F(1,38) = 7.38, p < .01$.

EXPERIMENT 2

Experiment 1 demonstrated that a neutral stimulus paired with an increase in incentive size subsequently produces a higher level of behavior than when the cue is initially paired with the larger magnitude of reward. These data are in accord with the idea that positive incentive contrast effects in human Ss are due to an appetitive motivational state. Experiment 2 further examined this emotionality hypothesis by attempting to determine the effects of an increase in amount of reward subsequent to an upshift in reinforcement quantity, as compared to Ss who are exposed to the increase in magnitude of incentive subsequent to no upshift in reward size.

Subjects, Apparatus, and Procedure

The Ss, 40 male and 40 female undergraduate students enrolled in an introductory psychology course at the University of Melbourne, were assigned randomly to each of four groups with 10 males and 10 females in each group. The details of the pre- and postshift materials were the same as those in Experiment 1.

Each S worked the same sequence of the same 45 mental multiplication problems. Levels of reward were 50, 20, and 2 cents delivered for the first correct or incorrect answer. There was one no-reinforcement group, two shift groups, and one unshifted group. The unshifted group (50-50-50 cents) was run throughout the session without changing magnitude of reward. Reward occurred on Problems 2, 3, 4, 6, 11, 14, 15, 18, 20, 23, 24, 25, 26, 28, 30, 35, 40, and 42. Of the remaining two shifted groups, the 2-20-50 Ss experienced an increase in incentive size to 20 cents on Problem 20 and another increase to 50 cents on Problem 30, while the 20-20-50 Ss experienced an increase in

amount of incentive to 50 cents on Problem 30.

The two shifted and one unshifted groups were read the same instructions used in Experiment 1. In the instructions to the N-N-N individuals, reference to monetary rewards was omitted.

Results

The same measure of Experiment 1 was examined in Experiment 2.

Figure 2 indicates that from Problems 1-19, 50 cents resulted in faster responding than any other group, 20 cents produced quicker responding than 2 cents or N, and 2 cents resulted in smaller response latencies than no reward at all. The mean latency from Problems 1-19 differed reliably among the four groups by an analysis of variance, $F(3,76) = 2.93, p < .05$. By Duncan's multiple comparisons, the differences between 50-50-50 and each other group, 20-20-50 and 2-20-50, 20-20-50 and N-N-N, and 2-20-50 and N-N-N, were each significant ($p < .05$).

Figure 3 indicates that on Problem 25, 2-20-50 reduced their mean latency below the level of the 20-20-50 Ss (positive contrast effects). The mean latency from Problems 25-30 differed significantly between the two groups by analysis of variance, $F(1,38) = 5.13, p < .05$.

From Fig. 3, it appears that on Problem 35 the 20-20-50 Ss reduced their mean latency to a level below the 50-50-50 individuals (positive incentive contrast effects), while the 2-20-50 Ss reduced their mean latency to the level of the 50-50-50 individuals. The mean latency from Problems 35-45 differed reliably among the 2-20-50, 20-20-50, and 50-50-50 groups by an analysis of variance, $F(2,57) = 5.62, p < .01$. By Duncan's comparisons, the difference between 2-20-50 and 50-50-50 was not reliable ($p > .05$), while the difference between 20-20-50 and 50-50-50 was highly significant ($p < .01$).

DISCUSSION

Experiment 1 indicates that humans perform at a higher level for a tone previously paired with an increase in incentive magnitude and consequent positive contrast effects than for a tone associated with the larger monetary quantity of reward. This result, as already discussed, is

consonant with the notion that an appropriate increase in incentive magnitude in human Ss produces some appetitive motivational state, which accounts for upward contrast effects.

The finding that performance on Problems 20-30, 20-20, and 20-20T was at the same level indicates that the tone had no significant effect on performance.

The positive contrast effects obtained in the first experiment are in agreement with most studies which have increased incentive magnitude with human Ss (e.g., Weinstein, 1970).

The findings in Experiment 1 for Problems 1-14 are that: (1) all groups performed faster than N, and (2) the groups receiving 20 cents performed faster than their respective control conditions. These findings indicate that (1) 20 cents delivered after answers served as reinforcing events, and (2) 20 cents is a discriminably larger amount of reward than 2 cents, where different magnitudes of incentive are defined in terms of the significantly different levels of performance they produce.

Experiment 2 demonstrated that positive contrast effects obtained with an increase in incentive size subsequent to no increment in reward are eliminated in Ss who receive the increase in incentive magnitude subsequent to an increment in quantity of reward. As discussed previously, these data support an appetitive motivational account of positive incentive contrast effects in human Ss.

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