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INDIVIDUAL DIFFERENCES IN CONCEPTUAL BEHAVIOUR FOLLOWING MANIPULATED CONTROLLABILITY

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Summary—Expectations of controllability are thought to influence subsequent behaviour, such that perceived non-contingency between behaviour and outcomes can produce a "learned helplessness" reaction by the organism. Since cognitive processes are implicated in this debilitation, the present study examines the influence of manipulated controllability upon the intrinsic individual differences (among females) in a disjunctive conceptual behaviour recovery task. Three-mode factor analysis is used to explore the process variability in a multivariate time-series design. Results indicate that intrinsic task processes are altered by the controllability pretreatment, but the nature of the impact reflects substantial individual differences in reaction.

INTRODUCTION

After a decade of programmatic research investigating the relationship between fear conditioning and instrumental learning, Martin Seligman, Steven Maier, and their colleagues proposed an explanation for the effects of uncontrollable aversive events on an organism. When events are uncontrollable, the organism learns that its behaviour and the expected outcomes are independent. This realization has been named the "learned helplessness" phenomenon, "learned" because the organism's expectation that an outcome is independent of responding arises out of experience, and "helplessness" because this expectation can produce motivational, cognitive, and emotional debilitation. The debilitating consequences of uncontrollable experience have been amply demonstrated in the infrahuman literature (see Maier and Seligman, 1976; or Seligman, 1975) and strongly suggested in human analogue studies (*cf.* Hiroto and Seligman, 1975). Learned helplessness, having fused the insights of experimentalists and clinicians into an elegantly simple model of behavioural vulnerability, has been implicated in ulcers, reactive depression, aged mortality, ritualistic deaths, and a wide variety of behavioural disorders (Seligman, 1975).

Perceived uncontrollability is stipulated as the required precipitator of learned helplessness. The two hypothesized characteristics of uncontrollability are (1) information about the independence of behaviour and outcomes and (2) the cognitive representation of the non-contingency. Accordingly, researchers have varied the response–outcome contingency in order to engender the expectation of uncontrollability. The traditionally employed experimental design involves three groups: an escape group who can effect termination of the aversive event; an inescape group who can respond but cannot alter their predicament; and a control group who experiences the aversiveness but is aware that no response can change the situation. The inescape and control groups are yoked to the escape group in triads, such that one subject from each of the former groups receives the same frequency and duration of the outcome as their counterpart subject in the response-contingent escape group. This triadic design was proposed by Seligman and others as a means to isolate the effects of controllability.

Despite the substantial supporting evidence for learned helplessness as an account of human debilitation, numerous studies (see Zuroff, 1980, for review) have suggested large individual differences in susceptibility and chronicity. To account for these empirical perturbations, Abramson *et al.* (1978; and also Miller and Norman, 1979) reformulated the nature of the intervening cognitive processes. In the modified model, debilitation not only depends upon perceived uncontrollability but also varies as a function of the causal attribution chosen by the individual. The introduction of an attributional process in the modulation of learned helplessness is an interesting, although complicating, development. Before bowing to its implications, it seems reasonable to seek more precise empirical evidence for its necessity. Learned helplessness is, afterall, a cognitive model, but few studies have sought to identify the process debilitation possibilities associated with the phenomenon. Individuals react to problem tasks and intrinsic task details in different ways, and these individualistic cognitive processes are very likely differentially affected by the uncontrollability experience.

Intrinsic individual differences are those which arise within the learning process as a result of the sequential pattern of acquisition rather than from the extrinsic personality or cognitive particulars of the learners. The importance of intrinsic variation is evident, Jensen (1966) having estimated that "... even under the best of conditions ... considerably less than half the true ID variance in learning can be accounted for by extrinsic factors" (p. 147). In the learned helplessness paradigm, variability attributable to the differential effects of the independent variable can only be accurately estimated if the intrinsic individual differences structure for the task is known. This is a particularly important consideration when the independent variable is presumed to impact on the intrinsic task processes, as is learned helplessness. Until the dimensions of process debilitation are articulated under various conditions, there seems little point in encumbering the original learned helplessness model with more complex constructs (particularly since the model seems to remain intact for animal behaviour).

The present study attempts a multivariate reconstruction of helplessness recovery across a series of concept identification trials. Tucker's three-mode common factor analysis methodology (1966, 1967) is applied to these data to ascertain the intrinsic individual differences of the recovery task. Earlier work (Snyder, 1976; Snyder *et al.*, 1980) has suggested a particular structure to the intrinsic individual differences in this task without pretreatment and serves as a qualitative baseline for the evaluation of process debilitation in learned helplessness.

METHOD

Sample

The subjects were 31 female introductory psychology students, all of whom volunteered for the experiment and received course credit for their participation. One subject was identified as deaf in one ear and excluded from the sample, leaving 30 subjects. Ten subjects were randomly assigned to each of three conditions according to the triadic yoked design (*cf.* Hiroto, 1974).

Task

Each subject completed two tasks, a pretreatment and a test task. For the nonescape group, the pretreatment task, based on Hiroto and Seligman's (1975) instrumental pretreatment task, consisted of 45 trials of inescapable aversive tones. Because instructions to the task implied subjects could escape the tone, subsequent failure was intended to induce helplessness.

Escape group subjects were exposed to the same tasks but could terminate the continuous tone in the pretreatment task by pressing a button on a panel four times (the button had no effect in the nonescape condition). If an escape subject failed to terminate the tone on any given trial, the tone lasted 5 sec, and its termination was signalled by a yellow light. In both cases, the light was displayed until the onset of the next trial. The intertrial interval was random within the constraints of ranging from 10 to 25 sec around a mean of 14 sec, as in Hiroto and Seligman's study.

Subjects in the nonescape and control conditions were yoked to the subjects from the escape conditions in the same triad. That is, the duration of the tone was recorded for the escape subject, and the other subjects of that triad heard the tone for the same period. While subjects in both the escape and nonescape conditions were told "there is something you can do with the button to stop it (the noise)," control subjects were told to passively sit and listen to the 45 trials.

Helplessness was monitored in all groups by a recovery test task. The test task was a concept learning task developed by Haygood and Bourne (1965), and studied by Snyder (1976) and Snyder *et al.* (1980). The 81 stimulus set consisted of a series of geometric shapes varying on four dimensions (shape, shading, size, and number) with three levels of each dimension. The correct solution was an inclusive disjunction of shape (triangularity) and shading (striped), these dimensions being randomly chosen from among the 54 possible combinations. The criterion for solution was 20 consecutively correct responses. This task was chosen because of its similarity to those previously used; it has the added advantage of placing the subject in a free responding environment, thus maximizing intrinsic variation and allowing monitoring of the recovery process at several points during the task.

Apparatus

An Interdata 5 computer controlled the apparatus for the experiment and recorded the subject's responses. Subjects were seated in a large chair inside a soundproof room $1.5 \times 2.7 \times 2.1$ (w × l × h). The response boxes were 40 cm from the front of the chair at a convenient height for the subject.

The pretreatment response box had a 9 mm diameter sprung microswitch centrally placed with two light emitting diodes placed either side of the switch to indicate whether the tone had been escaped or switched off automatically. The tone was a sine wave generated by a Level 1 TG66A oscillator, and amplified by an LM380 2W audio amplifier. The 3000 Hz, 90dB tone was calibrated with a Bruel and Kjaer 4117/2205 sound level meter (weighting network A), and was delivered binaurally through a pair of 8Ω Stereo G-208 headphones.

The concept task response box had seven buttons: one for the subject to indicate whether the stimulus was an example of the concept, and one for a nonexample; one to change the slide; and four buttons to indicate self-rated confidence. Light emitting diodes indicated the choice which had been made and the corrective feedback, which was delayed until the subject had rated her confidence. All buttons were 1.2 cm in diameter. The 81 stimuli were rear projected onto a screen 1.05 m from the front of the chair by a Kodak Carousel S-AV fitted with a 24V, 150W bulb. Up to 300 examples of the stimuli could be viewed without interruption before the computer terminated the task. The sides of the squares and (equilateral) triangles and the diameter of the circles were: large figures, 4.5 cm; medium figures, 3.5 cm; and small figures, 2.5 cm.

Procedure

Subjects were ushered into the experimental room by the experimenter. All folders, pens, and so on were left with the experimenter to ensure that notes could not be made during the concept task. Subjects in the escape and nonescape groups were handed a sheet of instructions based on those used by Hiroto and Seligman (1975). Except to ensure that these instructions were understood, no discussion took place. Control group subjects were told "from time to time a loud tone will come on. When it does, please sit and listen to it."

All subjects were played a sample of the tone and asked if they wished to leave the experiment. No subject refused to continue. The experimenter then said "the first tone will come on in a few moments," and left the room.

Immediately after the pretreatment was over, the experimenter handed the subject a set of written instructions for the concept task explaining the nature of the task and the function of the response box. No questions were answered except to ensure that the subject understood the instructions. When the subject indicated she was ready to begin, the experimenter left the room to present the first slide. After the concept task had been completed, the experimenter verified that the subject had understood the procedures and fully debriefed her.

Response measures

A number of response measures are possible within a complex process such as concept acquisition. From among these, four measures were selected for analysis based on prior work with this task and hypothetical importance.

Response latency. The response latency or preresponse time is the time between the onset of the stimulus and the subject's response. Roweton and Davis (1968) found a significant inverse relationship between preresponse time and mean trials to solution in concept acquisition, both frequently used indices of learned helplessness, and speculated that this time is used by a subject to classify the immediately preceding stimulus. Thus, response latency has a dual role of measuring response initiation and cognitive process, both of which should be retarded in the helplessness individual.

Confidence interval. After making some response to the stimulus slide, the subject was requested to contemplate her confidence in the response decision. The confidence interval is the time between the response and the self-rated confidence. This was included to get some index of strategy evaluation. Helpless individuals have learned that the outcome is independent of their strategic behaviour, whereas nonhelpless individuals will use this interval to reevaluate and perhaps finetune their strategy for solution of the concept.

Postfeedback time. The postfeedback time is the time the subject spends examining the stimulus after corrective feedback has been given. It is measured in this instance from the end of the confidence interval to the initiation of a new trial by the subject. This interval is probably spent classifying the stimulus in light of the corrective feedback, a somewhat different function from the response latency (Bourne and Bunderson, 1963; Bourne *et al.*, 1965; Roweton and Davis, 1968), and was included to measure those cognitive activities. There is no analogous measure in the learned helplessness literature because subjects have rarely been placed in a free-responding environment in tests of the model, but it would seem to be an important indicator of the impact of helplessness pretreatment on strategy development.

Interresponse time. The interresponse time is the interval between correct responses. Response rate, which is inversely related to interresponse time, is considered to be the basic datum of behavioural analysis (Sidman, 1960; Skinner, 1953, 1961). Since helpless individuals are generally retarded in concept acquisition, this index should reflect this debilitation and indicate any pattern changes.

Trial blocks

The data were blocked into Vincent tenths, using Vincent's (1912) original technique. If the number of responses were not a multiple of 10, then the earlier trial blocks were based on more responses than the later ones. The measures were represented by medians within each block, and the data were transformed to log base 10 to minimize the expected skewness, typical of time data. The advantage of Vincent blocking is that it reduces the scores of fast and slow learners to comparable coordinates where differences in the form of the function can be compared.

Three-mode common factor analysis

The data matrix, X_{IJK}, is arranged in three observational modes: (I) persons by (J) response measures by (K) trial blocks. Typically, in order to examine the individual differences in X_{IJK}, a classical factor analysis would be applied to the correlation matrix, $R\,(JK \times JK)$, which has been calculated from a strung-out, two-mode data matrix, $X\,(I \times JK)$. This would lead to a factor pattern of the combination variables, $F\,(JK \times M$, where $M < JK)$. However, Tucker's three-mode common factor analysis (Snyder and Law, 1979; Tucker, 1966), when applied to the same combination variable correlation matrix, will exploit more fully the information in the inherently three-mode observational data.

For each observation, Tucker's three-mode common factor analysis model is given as:

$$x_{ijk} = \sum_m \sum_p \sum_q a_{im} b_{jp} c_{kq} g_{mpq} + u_{ijk}, \tag{1}$$

where x_{ijk} is a score on the disjunctive concept task for individual i on response measure j for trial block k; a_{im} reflects the influence of the individual differences factor m on individual i; b_{jp} reflects the influence of the response measures factor p on response measure j; c_{kq} reflects the influence of the trial blocks factor q on trial block k; and u_{ijk} is the uniqueness associated with that score. Each g_{mpq} is an entry in a reduced three-way core matrix bounded by the derivational modes, M, P, and Q; its value specifies the interrelationship among these three different domain factors.

Standardizing the raw scores across i for each jk combination and calculating the correlations, the Tucker model becomes, in matrix form:

$$R\,(\text{with communalities}) = (\text{B}^*\text{C})\text{GA}'\text{AG}'(\text{B}'^*\text{C}'), \tag{2}$$

where * denotes the direct or Kronecker product (see Tucker, 1966, for details); $A\,(I \times M)$, $B\,(J \times P)$, and $C\,(K \times Q)$ are the basic derivational modes associated with the individuals, response measures, and trial blocks observational modes; and $G\,(PQ \times M)$ is the interactional, three-mode core matrix. In this case, the factor coefficients for individuals in matrix A are not determinate and $A'A = I$ is assumed. The dimensionality of A and its interactional impact are contained in the core. The derivational modes, B and C, and the core are related to a traditional factor analysis as follows:

$$F = (B^*C)\,G, \tag{3}$$

where B and C are column-wise sections of orthonormal matrices and because of the use of correlations, describe deviations from average performances; and F is the factor pattern of the combination variables. Core, thus, weights each pq combination value in order to reproduce the individual differences factor loading associated with the particular combination variable. The larger the influence of the separate mode idealized dimensions in the combination variable individual differences factor, the higher the weight given in the core. These interactional weights in core are calculated by:

$$G = (B'^*C')\,F, \tag{4}$$

because $B'B = I$ and $C'C = I$. Calculation details are given in Snyder *et al.* (1979).

The basic three-mode structure for the Haygood and Bourne task used in this study has been determined (Snyder, 1976) and replicated (Snyder *et al.*, 1980). In the present study, an independent variable, contingency (or controllability) experience, was introduced to examine its impact on the individual differences in task solution. The analysis follows as before except that now we look to the core to observe shifts in the individual differences interactions which may reveal the influence of the independent variable on the basic structure. An implied hypothesis by Seligman and other "helplessness" researchers is that individual differences are inconsequential and that the phenomenon can be defined solely in terms of between group differences.

RESULTS

The three-mode common factor analysis results are presented in terms of the measures and trial blocks factor matrices, and the three-mode core matrix. The number of factors for each mode was determined from the earlier work of Snyder (1976) and Snyder *et al.* (1980).

The four response measure components are shown in Table 1. In this mode, no reduction in dimensionality was attempted in order to fully exploit any unique variance present in the measures mode. The first component was marked by all four time measures and was named the *Time Component*. The second component was marked by response latency and negatively, by postfeedback time, and named the *Bipolar Latency Component*. These components match the first and third components found in the earlier

Table 1. Learned helplessness unrotated measures component matrix

Measure	I	II	III	IV
Response latency	75	61	12	20
Confidence interval	83	−26	44	−15
Post feedback time	82	−42	−20	29
Interresponse time	87	13	−34	−30

Decimal points omitted (e.g. 75 = 0.75); salient loadings underlined.

studies. The third component was marked by the confidence interval and negatively, by the interresponse time, and named the *Interresponse A Component*. The fourth component was marked negatively by the interresponse time, and named the *Interresponse B Component*. This component matches the fourth component found in the earlier studies.

Common factor analysis of trial blocks resulted in three factors accounting for 80% of the total variance (see Table 2). The first was marked by later trial blocks and was interpreted as the *Late Stage Factor*. The second was marked by the middle trial blocks and was interpreted as the *Middle Stage Factor*. The third was marked by the early trial blocks and was interpreted as the *Early Stage Factor*. Again, these results seem to replicate earlier findings with this disjunctive concept task.

The core matrix (Table 3) is bounded by the four response measures components, the three trial blocks factors, and four individual differences factors. Salient values in the core matrix indicate interactional processes associated with the individual differences in the fixed sample. Within the model, these values specify the set of linear equations necessary to reproduce the original three-mode relationships.

Although no precise estimates for factor scores are available (as indicated earlier), an approximation was calculated as suggested by Tucker (1966, p. 310). For the four individual differences factors, the mean factor scores for the three contingency-experience groups consistently differed in the following order: escape group was higher than the control which was in turn higher than the nonescape group. Thus, between group variance was operating in all underlying dimensions and no specific helplessness dimension emerged.

DISCUSSION

Using the Tucker three-mode common factor analysis approach to disentangle the individual differences in the complex recovery task, four generalized performance factors, representing 77% of the total individual differences task variance, were identified. Four

Table 2. Learned helplessness varimax rotated trial blocks factor matrix

Trial block	Rotated factors I	II	III
1	23	05	90
2	17	41	79
3	32	50	55
4	30	79	23
5	57	61	28
6	64	55	27
7	68	59	17
8	79	41	14
9	83	34	24
10	88	13	29

Decimal points omitted (e.g. 32 = 0.32); salient loadings underlined.

Table 3. Learned helplessness rotated core matrix

Component measure	Trial block factor	Individual differences factor I	II	III	IV
Time	late	237	196	74	137
	middle	174	140	77	73
	early	92	55	178	107
Bipolar latency	late	−83	50	22	53
	middle	−64	38	50	−58
	early	−55	−02	62	−47
Interresponse A	late	−15	31	04	−18
	middle	−25	70	28	05
	early	16	33	−04	−29
Interresponse B	late	16	−04	−15	−07
	middle	16	−15	22	10
	early	13	−05	−04	36

Decimal points omitted (e.g. 237 = 2.37); top third rank-ordered values underlined.

response measure components and three trial block factors were found to underlie the four individual differences functions. Several salient interactions were detected in the three-mode core, which imply the necessity of an interactional account of helplessness.

Derivational modes

Despite procedural differences, the derivational mode results are consistent with those found in earlier studies with this task. The pattern, order, and magnitude of factor loadings are very similar to those found for the corresponding response measures and trial blocks analyses in other samples. Multidimensional results for the derivational modes indicate different response patterns across the measures indices and pattern shifts across the trial blocks. By implication the response patterns are interpreted as concept identification strategies and the pattern shifts as strategy shifts. Averaged data for the separate response measures collapsed over the trial blocks would not have adequately reflected the individual process data in this sample. The stable underlying structure derived from the Tucker analysis provides a reasonable mapping of the observable individual performances for the evaluation of antecedent influences.

Core

The interactional core was dimensioned as four response measure components by three trial block factors by four individual differences factors. Although earlier studies with this task have found relatively straightforward interactions among these modes, the core entries in this case imply considerable impact by the independent variable on the intrinsic response pattern. Interpretation of the core is complicated by the need to qualitatively compare this core with those calculated from other homogeneous, but nontreated, samples. Recognizing the need for caution, these differences appear dramatic enough to risk speculative remarks about the interactional values.

High interactional values for the Time Component across all trial block and individual differences factors reflect the between-groups differences due to the helplessness treatment, a fact substantiated by the estimated mean factor score differences for each factor among the treatment groups. Despite the stability of the task intrinsic variance, helplessness permeates all interactions in the underlying structure, as implicitly hypothesized by Seligman.

Differences in the core among the individual differences factors centre around the Bipolar Latency Component, which accentuates strategy development processes associated with the preresponse and postfeedback intervals. Roweton and Davis (1968) have suggested that a lengthened preresponse interval might "allow profitable information processing, such as relating one or more current hypotheses to the available stimulus and the *Ss* hypotheses" (p. 642). Long latencies would therefore be indicative of a strategy evaluation process in which the presented stimulus is categorized in terms of some concept identification strategy. The postfeedback interval, on the other hand, is used to "mull over" (rehearse, memorize, assimilate) information from the preceding task-related experience (Bourne, 1966). A long interval here would be indicative of a strategy or hypothesis generation process.

ID Factor I (Column 1 of the core) is marked by high negative interactional values between the Bipolar Latency Component and the three acquisition phases, particularly the middle and late stages. This pattern emphasizes the use of the postfeedback time; individuals implicated by this factor may be finding it more difficult to assimilate the information presented into a coherent hypothesis and so, continue to search for the commonality between relevant attributes. ID Factor IV displays a similar pattern for the early and middle phases, but reverses to reflect the use of the preresponse interval in the late phase, suggesting a shift from hypothesis generation to hypothesis refinement (with the stimulus available). ID Factor III is marked by positive interactional values between the Bipolar Latency Component and the three acquisition phases, particularly the early stage. This may reflect early hypothesis testing, carefully selecting a response to test the preceived alternatives. ID Factor II also has positive interactional values between the Bipolar Latency Component and the middle and late acquisition phases, but is marked by positive values on Interresponse A, particularly in the middle phase. These individuals are perhaps reconsidering their response in terms of the stimulus in order to assess personal confidence in their choice. This reevaluation leads to a decreased gap between correct responses.

These process patterns are associated with high overall time interactions, which couple the ID factors' interpretation to the helplessness effect. Four independent individual differences response patterns are found related to uncontrollability. Earlier work had identified three acquisition phases marked by the Time Component; but with the uncontrollability experience, the phases are less clear and marked by a differential use of either the preresponse, confidence, or post feedback intervals. Individual differences patterns change as a function of the differentiable emphases on these separate time intervals. The relationship between the intrinsic task processes and the extrinsic pretreatment is reflected in these individualized reactions. Thus, helplessness interferes with concept identification, either by impairing hypothesis development or by inhibiting response selection, but the impact of the uncontrollability experience is not the same for everyone.

Implications

The implications of these findings for the learned helplessness hypothesis are two-fold. Firstly, the presence of intrinsic individual differences variance may go part way in explaining the apparently disparate findings in the literature. Some studies have found deficits, others enhanced performance, and still others no differential effects in task performance following exposure to uncontrollability (see Roth, 1980, for a review of the findings; also, *cf.* Sidman, 1960, pp. 145–190, for the influence of intrinsic sources as error variance in Fisherian designs). Secondly, these findings emphasize the need to explore individual differences, both intrinsic and extrinsic, in the influences of uncontrollability before accepting the complicating inclusions suggested by the various conceptual reformulations. The intrinsic processes and their extrinsic roots (in personality and cognition) must be more thoroughly investigated before anomalous results are shunted into an illusive attributional framework.

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