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The effect of functional cecotomy on ingestion and excretory behavior in the rat was viewed as a short term (ST) and long term (LT) stress adjustment. Findings in both ST and LT conditions were discussed in terms of the Mayerian parameters of precision, rapidity, sensitivity, and reliability. Under functional cecotomy water intake, fecal moisture content and dry fecal weight increased. Food intake remained constant. Stress adjustment in terms of the 4 parameters of ST and LT regulation were discussed as correlations and their accompanying standard errors over daily, 3-day, and 7-day time intervals. The standard errors increased with stress. The results agreed with Mayer's findings which indicated that LT regulation is less rapid and less precise than ST regulation.

Homeostasis refers to the coordinated physiological effort of maintaining various steady states which result in a condition of "equilibrium". Within this context, the internal environment of the organism is considered to be regulated. The preservation of a relative internal consistency can be viewed as representing the net effect of regulation along the three dimensions of: (1) input, viewed as gain or intake and its complementary controlling mechanisms, (2) output, losses or expenditure, and its complimentary controlling mechanisms, and (3) content, including the mechanisms for detecting content and for changes therein.

Any of the organs along the alimentary canal in the rat may effect regulation to a lesser or greater degree. The effect of one of these organs, the cecum, in regulation of food and water intake has not been investigated. Its function in the regulatory process therefore remains open to speculation. The objective of the present study will be to determine the contribution made by the cecum to the behavioral patterns of food and water intake.

The cecum is a sack like organ, located at the junction of the small and large intestine. When empty the cecum is roughly 2.5 to three cm. long and one to 1.5 cm. wide. Its interior volume ranges between .04 and .08 cc. Its gross morphology and histology are more similar to the large than to the small intestine. Yet, because of its structure and an internal enzyme distribution characteristic to itself, it is considered to be a distinct organ (Hegde and Hooli, 1970).

Functions of the Cecum

Understanding the function of the cecum in the digestive process will facilitate viewing cecum manipulation as a long-term stressor within a regulatory context. Loesche (1968) indicates that the cecum may play a part in the reabsorption of endogenous proteins. Recent work by Loeschke and Gordon (1970) indicates that the cecum assumes an active role in water reabsorption from the digestive tract. Additional findings (Loesche, 1968; Tamir and Alumort, 1970) implicate the cecum in nitrogen reabsorption. Yang, Manoharan and Young (1969) note that the intact cecum may aid in the breakdown of cellulose material, even though little if any cellulose is ever digested. Yang, Manoharan and Mickelsen (1970) seem to encapsulate the spirit of these citations by stating that the contribution of cecal acetic, propionic and butyric acid to the rate of energy metabolism amount to 4.7% of the total caloric intake. In light of these findings an alteration in cecum functioning should necessitate regulatory adjustments to account for: decreased nitrogen absorption, decreased reabsorption of endogenous proteins, decreased cellulose breakdown, and decreased water reabsorption capabilities.

These regulatory adjustments can be expected to cause some change on behaviorally measured patterns of ingestion and egestion. Water intake can be expected to increase. The organism should also compensate for decreased energy metabolism by increasing his food intake. The success or failure of any behavioral adjustment can be viewed in terms of the organisms weight change. If food intake increases, then the organism is compensating. Yet, even though compensating, if the organism loses weight, then his compensatory effort can be regarded as a failure of his regulatory capacities. The present study will view these patterns noting the effect of altered cecum functioning.

Mayer (1967), in hypothesizing the existence of a long-term regulatory mechanism and a short-term regulatory mechanism, noted that regulatory parameters when distributed, would settle to either a new value or will return again to their original value. The expected changes in ingestion and/or **egestion** patterns in the present study will be viewed and interpreted as the effect of compensatory ad-adjustments which represent the action of some underlying regulatory mechanism(s). The purpose of this thesis is to demonstrate the effect of short-term regulation (STR) and long-term regulation (LTR) in adjusting ingestive behavior under conditions of a long-term stressor (functional cecal elimination). A digression is at this point necessary to view, within the realm of regulation, the detailed behavioral and physiological considerations which make the concepts of STR and LTR useful.

Mayerian Long-term and Short-term Regulation

Three distinct types of regulation occur interchangeably in contributing to a homeostatic condition. Mayer (1955) defined a definite biometric margin or energy intake to energy output, a short-term day to day regulatory adjustment on the intake-output relation, and a long-term adjustment mechanism for body reserves or body weight regulation over extended time periods.

Short-term regulation

The day to day STR variations are sensitive to both the effects of recent stressors or stimuli, and to current ongoing reserve levels. An understanding of STR as a necessary system for the maintenance of a homeostatic condition may be enhanced by considering certain empirically and theoretically based ideas.

First, short-term regulation should be tied with metabolic processes which are immediately sensitive to the energy input-output relation. .Protein, carbohydrate and fat metabolism all could supply a base for STR. Soulairac (1967) notes - that most animals if placed in a self-regulating situation, requiring dietary selection, will spontaneously achieve a satisfactory equilibrium in their intake of these substances. This spontaneity can be viewed as normal STR functioning.

Second, to warrant consideration as a discrete mechanism, STR as a system should be able to account for variations of energy intake or yield associated with changing environmental conditions. For instance, with the onset of any sudden environmental termperature change, intake will temporarily decrease. The STR concept should also aid in the construction of an understandable metabolic interpretation of adjustment to these changing conditions. In this way a STR model could account for observed intake changes and also changes in the parameters of the STR mechanism itself.

Finally within the province of the proposed study, the STR concept must account for the frequent and patterned adjustments of daily feeding in response to hunger, satiation and stressor states. Mayer's (1955) definitions of rapidity, precision, reliability and sensitivity will supply the conceptual basis for the view of STR that will be presented in this study.

Rapidity. Rapidity will be defined to increase if the adjustment of energy intake to energy output improves for caculations on progressively decreasing time periods.

Precision. Precision is the inverse proportion to the difference bewteeen energy intake and output. In the current study: the weight of food, less the weight of dry fecal material per 24 hours supplies an index of precision.

Reliability. Reliability is defined as the day to day repeatability of the precision index. Precision over time typically increases in response to the effects of a long-term stimulus.

Sensitivity. Sensitivity represents the degree to which the precision value is dependent upon the size of the energy intake-output relation.

Long-term regulation

Mayer notes that the successful correction of STR errors by the LTR mechanism seems to be accomplished through the means of successive recompensations. The stable body weight or, on a more sensitive level, the recurring oscillations around some privileged value, (set point) represent successful LTR functioning. Considering that any consistent error in STR over time will be additive, the conceptual as well as practical necessity of an LTR system is easily seen. Understanding the need for the LTR concept, and its relation to the current study, may further be enhanced by viewing some of its underlying assumptions.

There must be some mechanism to account for the consistent way in which the body weight of normal individuals is maintained under a given set of circumstances and over an extended period of time.

The assignment of a new privileged body weight under exposure to some long-term stressor requires the use of a LTR mechanism by way of explanation. Kennedy (1952) has found that with prolonged cold the organism's body weight will eventually settle around a new privileged value. Functional removal of cecum from participation in the normal digestive processes may be relevant to this issue regarding the ongoing effects of long-term stimulation. If the cecum "removal" is a long-term stressor, body weight inversions might be expected to change, perhaps assuming a new privileged value.

As it has been defined, LTR must function in part through the same mechanisms as the short-term regulation or, at least, must be quantitatively responsive to its operation. Although they must of necessity be defined in a slightly different manner, Mayer argues that the LTR can be viewed along the same four dimensions that were appropriate for the STR.

<u>Rapidity</u>. Rapidity for LTR is inversely proportional to the mean time it takes for weight inversions to occur.

Precision. Precision is inversely proportional to the variance of weight which follows any observed value of body reserves. Precision during exposure to a long-term stressor, as in the current study, generally is expected to increase with time.

Reliability. Reliability represents the regularity of compensations over time, or their periodicity. It will be inversely proportional to the variation of the body weight (reserves) over the experimental period. As with precision, reliability values can be expected to increase in the present study.

Sensitivity. Sensitivity represents the distribution around the privileged dry weight for which body weight inversions have been observed. Sensitivity values are expected to decrease in response to the effects of a long-term stimulus.

In spite of the care with which these Mayerian parameters are defined, they are only gross indicators of regulation when viewed at the behavioral levels. Mayer's conceptual framework is sound, but his definitions can only be discussed in terms of cumbersome relationships. The second objective of this study is to clarify and elaborate Mayer's definitions by expressing them in the structured statistical framework of regression analysis.

Adaptation of Mayerian parameters to a regression based analysis

The function of the cecum can be viewed profitably in terms of gross mean changes, but under stress more subtle changes in ingestive and egestion behavior which represent the underlying regulatory mechanisms occur. When Mayer designated the four parameters of STR and LTR (rapidity, precision, reliability and sensitivity) their definitions were based on a single different variable for each mechanism. Mayer discussed STR in terms of mean values and percentage variation of the precision index. Long-term regulation was discussed in terms of privileged body weight values and percentage variations of inversions during the period immediately following the weight determination.

Because Mayer used single different dimensions to consider short term (ST) and long term (LT) effects and views the mechanisms on a single 24 hour time base, his obtained LT values are not directly comparable to his ST values. A clear view of the distinct mechanisms can be attained only when STR and LTR values have a common dimension such as the precision index betwen them.

If a correlational technique is employed, a single dimension can be considered comparatively in both ST and LT contexts. In the ST case the predictor can be food intake and the dimension under consideration, in this case precision, can supply the predicted values. For a comparative picture of LT functioning, a similar correlation is calculated using body weight as a predictor and precision values again as the predicted.

If correlations over changing time periods are calculated by blocking the predicted values and computing the appropriate *r*s from the repeated means for each time block, then the relative and comparable effects of STR and LTR can be determined over varying time periods. When a correlationally based framework is imposed upon a Mayerian scheme, rapidity and precision become magnitude based measures using *r*. Rapidity is viewed as a magnitude of adjustment per time period. Viewing the *r* values across time blocks will indicate the time interval over which ST and LT mechanisms are maximally operative. Precision is represented by *r* fluctuation moving across baseline (B) and experimental (E) conditions, and serves as an index of adjustment to stress. Incorporating the Mayerian scheme into a correlational framework, reliability and sensitivity become measures of variance based on the standard error (S) of the correlation. Reliability is considered as change in the S_e when moving across time blocks. Reliability in this context represents variance per unit of time and serves as the companion measure to rapidity. Sensitivity is the companion measure to precision and is found to be the change in S_e moving across experimental conditions. In this case, sensitivity indicates any stress induced change in the variance of regulatory functioning.

Advantages of a correlational framework

Regulation of ST and LT mechanisms represents the net effect of many distinct variables. If all behavioral variables related to regulatory changes are viewed within the same context, ST variables with regard to intake and LT variables with regard to body weight, they will then be directly comparable. The relative contribution to the net regulatory effect can then be determined for both STR and LTR mechanisms.

Regulation for each variable is occurring simultaneously in regard to both STR and LTR. If a comparison between ST data and LT data is made with respect to changing time blocks, and if STR effects can be demonstrated to decrease with lengthening time, while a simulataneous increase is occurring for LTR values, then a definite boundary based on actual time passage can be established between the two mechanisms. They can then be shown to be discrete responses.

Method

Subjects

*S*s were six 80 day old male rats from the Sherman-Wistar strain. Two *S*s were lost to anesthesia during the first surgery. One *S* was lost in the second surgery, and one *S* was lost due to a bacteriological urinary infection after the second surgery. Of the remaining two *S*s, it was found during the second surgery that the cecum tie had slipped and that the cecum had become functional during the E period for one of the two *S*s. He was therefore eliminated from the study. For this reason, results were computed on a single *S*.

Procedure

General Procedures. Upon arrival from a commerical supply house S had a 10 day acclimation period during which time he was maintained in an identical manner to the actual study. He lived in continuous light and had ad lib access to food (Purina Laboratory meal) and tap water. The food cups (**Wah**mann LC-306) had no-spill rings and wire mesh bases attached to minimize food spillage. **Room temperature was maintained at 73° ± 3° F.**

After the acclimation period, measurements of food, water intake, weight and fecal material were taken for 30 days to establish base line for feeding, drinking and **egestion** variables. The cecum was then surgically tied off. Twenty-four hours were allowed for post-surgical recovery. At the end of six weeks the tie was removed and the isthmus between the cecum and large intestine was reopened. After another 24 hours recovery period, the third data collection period began.

This represented an A-B-A design in which functional cecotomy occurred during the "B" condition. The "A" conditions represented pre and post surgical controls. Dependent variables consisted of percentage body weight measures of food intake, water intake, dry fecal weight, moisture content of fecal material, and a precision index. The raw data for the dry fecal and moisture content measures were obtained by drying the fresh feces at 90°C for 24 hours. Wet and dry weights were then compared and the appropriate calculations were made. The precision index represented the difference between the weight of the food consumed and the dry fecal weight over a 24 hour period.

Statistical procedures. The *r*s and S_es are based on Pearson's product-moment formula. In applying Pearson's model to these data *S*s become days for purposes of time blocking. The three day and seven day calculations are based on the repeated and paired means of the predicted value over three day and seven day periods. The time block lengths were picked arbitrarily.

Surgical procedure. The *S* was food deprived for three days before the first surgery to allow his intestinal tract to clear. Ten minutes prior to ether anesthesia .15 cc Atropine was injected to reduce salivary flow and the possibility of tracheal obstruction.

A three cm. longitudinal incision was made through the skin and three muscle layers of the abdomenal wall slightly to the *S*'s right of midline. The cecum was exposed and emptied. The isthmus joining the body of the cecum and the large intestine was tied completely closed with a loop of silk thread. The thread was placed directly against the exterior cecal wall, underneath the vessels supplying blood to the cecal tissue. Care was taken to leave the vessels intact. The muscle layers and skin were then separately sutured closed with surgical silk. *S* was allowed to recover in a warm area for 24 hours with ad lib water. For the last 18 hours of recovery, *S*s had an ad lib food supply.

For the second surgery the *S* was not food deprived.

The incision and the procedure for administration of ether anesthesia was identical to the first operation. The tie closing the cecum was located, cut, and removed without damage to the cecal vascular network. Closing and recovery procedures were identical to that in the first surgery.

Results

As displayed in Table 1, mean percentage body weight values are greatest in the E condition for all variables except those of food intake and precision. The food intake value is nearly the same between the B_1 and E conditions, but decreases in the B_2 condition. The precision value steadily improves during the course of the study. The greatest change is seen between the E and B_2 condition. The greatest increases during the E condition are seen on the water related dimensions of water intake and fecal moisture. The standard deviations increased during the E condition for all variables.

Short term regulatory parameters are depicted in Table 2. The precision is seen to increase with stress for all time blocks. The *r* for the daily B_1 and B_2 conditions are significant, as are all *rs* within the experimental condition at $p < .01$. The three day *r* value in the B_2 condition is significant as well ($p < .05$). The rapidity change is less across time in the stress condition. Sensitivity $\left(\frac{1}{\bar{S}_e}\right)$ the degree to which variance is related to precision magnitude is seen to decrease with stress for all time blocks. Reliability $\left(\frac{1}{S_e}\right)$, the variance measure accompanying rapidity,

Table 1

Mean percent body weight values and standard deviations for 5 key variables in the 3 experimental conditions

$\overline{X}$ (S.D.)	B_1	E	B_2	Index
Water intake	11.41 (.70)	16.73 (3.15)	8.08 (1.11)	$\frac{\text{ml. HOH}}{\text{g. bod. wt.}}$
Fecal moisture	.86 (.25)	3.27 (1.24)	.53 (.22)	$\frac{\text{g. HOH}}{\text{g. bod. wt.}}$
Food intake	7.78 (.69)	7.77 (1.34)	5.42 (.40)	$\frac{\text{g. Food}}{\text{g. bod. wt.}}$
Fecal dry	1.89 (.27)	2.62 (.48)	1.32 (.17)	$\frac{\text{g. Fecal dry}}{\text{g. bod. wt.}}$
Precision ($\frac{1}{X}$)	5.91 (.62)	5.15 (1.21)	4.09 (.44)	$\frac{\text{g. Food - g. Fecal dry}}{\text{g. bod. wt.}}$
Number of observations	18	39	21	

Table 2

Parameters for STR mechanism displayed in terms of Pearson r values and their associated S_es

r (intake-precision)	B_1		E		B_2	
	r	S_e	r	S_e	r	S_e
daily	.91^{xx}	.24	.94^{xx}	.42	.93^{xx}	.16
3 day	.42	.21	.72^{xx}	.60	.44^{x}	.22
7 day	.02	.08	.67^{x}	.51	.38	.16
d. f.	16		37		19	

x $p<.05$

xx $p<.01$

is seen to increase as the time block lengthens. In the E condition, the reliability is depressed and bottoms at the three day level with higher values occurring on both the daily and seven day levels. An identical, but less accentuated reliability pattern is seen in the B_2 condition.

Table 3 depicts LT parameters. Precision is seen to increase with stress for all time blocks except those of E and B_2 at the seven day level. The values at the B_1 seven day level and B_2 daily level are significant ($p < .05$). The rs in the E condition and those remaining in the B_2 condition are significant as well ($p < .01$). Rapidity, as would be expected from a long term regulatory mechanism, increases as the time block length increases. Maximum rapidity in all experimental conditions occurs at seven days, while the minimum rapidity values are found at the daily time block level. Sensitivity ($\frac{1}{S_e}$) as with its ST counterpart is related to the magnitude of the precision value. The S_e for all time block levels increases in the E condition under stress. Long-term reliability ($\frac{1}{S_e}$), determined by viewing the S_e across time blocks, progressively improves as the time interval lengthens since the standard error decreases over time.

Discussion

The function of the cecum in the digestive process

Definite and patterned changes occurred in ingestive and **egestive** behavior after tying the cecum. The fact that a modification of behavior did occur indicates that:

Table 3

Parameters for LTR mechanisms displayed in terms of Pearson r values and their associated S_es

$r_{(body\ weight-precision)}$	B_1		E		B_2	
	r	S_e	r	S_e	r	S_e
daily	.07	.60	-.48 xx	1.05	.47 xx	.38
3 day	.03	.23	-.71 xx	.60	.61 xx	.20
7 day	.50 x	.07	-.81 xx	.46	.94 xx	.06
d. f.	16		37		19	

x $p < .05$
xx $p < .01$

1) the cecum is a functional organ in the rat and, 2) that cecum manipulation can be considered as a LT stressor and is comparable to the other more popular techniques of stressing an organism such as temperature manipulation (Kennedy, 1952), and exercise manipulation (Mayer, 1954). The results depicted in Table 1 and Figure 1, as were predicted from the findings of Loeschke and Gordon (1970), indicate that the major role of the cecum seems to be connected with water reabsorption. With functional cecotomy, an increase in drinking represented the most pronounced ingestive change. The most pronounced egestive change was seen as an increase in the moisture content of the feces during the E condition.

In Figure 1 the increasing precision value of the organism under stress can be attributed to a constant or slightly decreasing intake value accompanied by an increasing fecal dry weight value of the E condition. The changing dry fecal weight values with functional cecotomy indicate the slight role of the cecum in energy metabolism and the decreasing basal metabolic rate of the organism due to aging effects. In the present study using rather gross behavioral measures, the findings of Loesche (1968), Tamir and Alumant (1970), and Yang et al (1970) concerning the role of the cecum in energy metabolism are supported.

<u>Patterns of regulatory stress adjustment</u>

The use of a correlational technique to study Mayer's

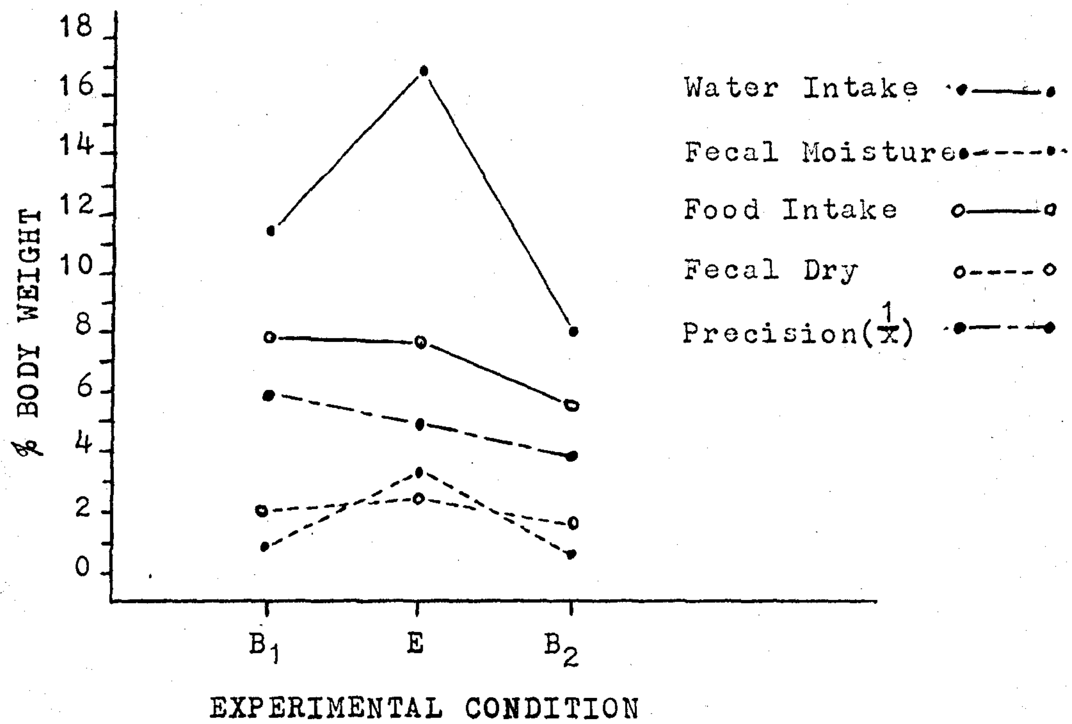

Figure 1. Mean percent body weight values for 5 key variables in the 3 experimental conditions.

four dimensions of ST and LT regulation yield results that are in agreement with his findings and indicate some previously ignored relationships.

Rapidity. The primary behavioral differences between ST and LT regulatory mechanisms become apparent in Figure 2. For STR in the base line conditions as well as in the experimental conditions, r values decline rapidly over time. Rapidity is greater under stress conditions than under nonstressful conditions. Practically negligible STR effects in baseline are seen at seven days while LTR effects achieve maximum at seven days. In contrast to STR baseline, LTR baseline effects are negligible at both one and three days. In the baseline condition there seems to be a discrete temporal boundary between STR functioning and LTR functioning which occurs between three and seven days with both ST and LT values equal, but at moderately low levels. In viewing the E groups, this boundary, while still visible, is much less accentuated.

Both the STR and LTR rapidity curves experience a slope reduction under stress. This slope loss reflects the overlap between mechanisms that occurs under stress and it can be discussed further in terms of a precision adjustment.

Precision. Precision as seen in Figure 3 represents the magnitude of stress adjustment or the difference in r values between baseline and the experimental conditions. An increasing r value with stress represents increasing precision since r represents the actual precision

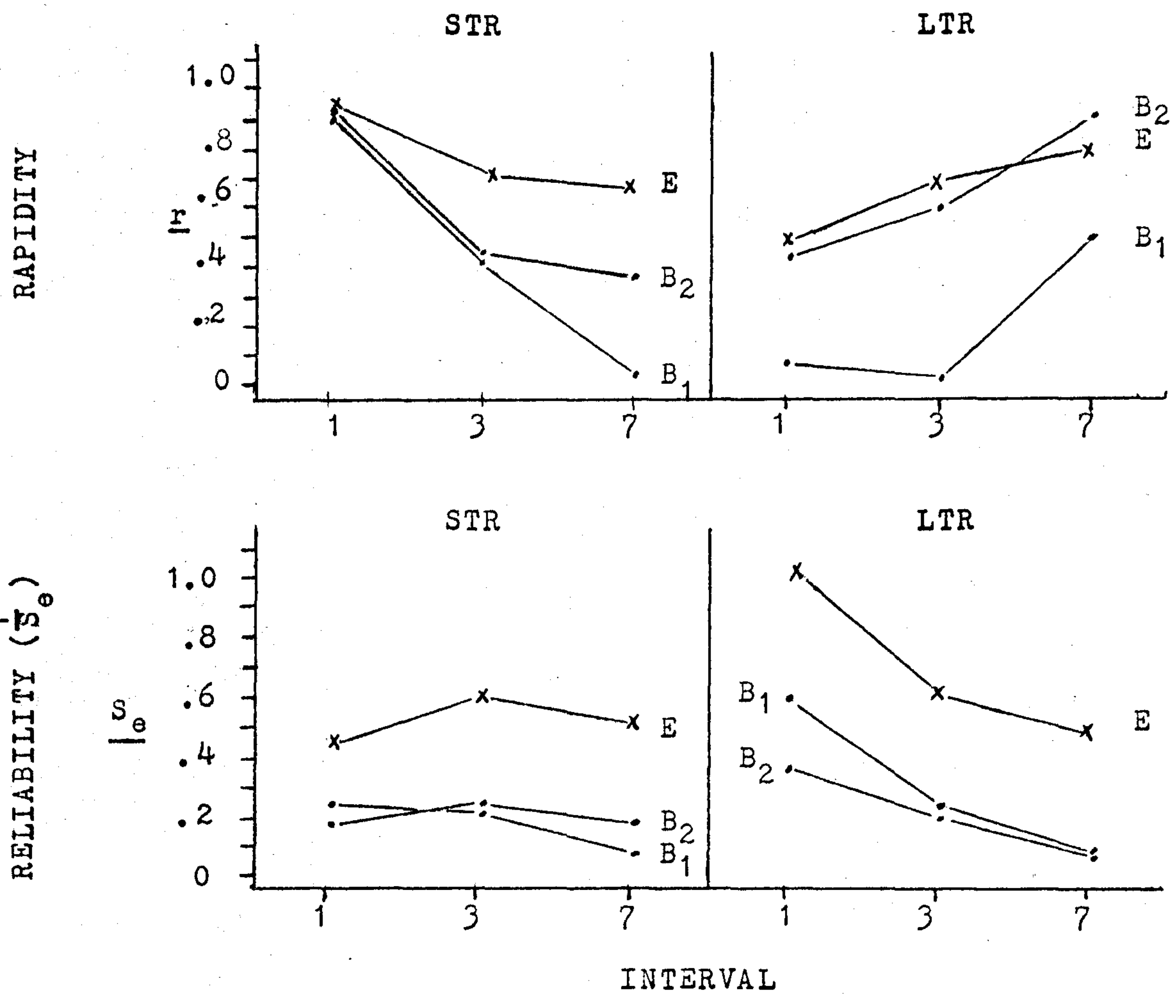

Figure 2. Contrast in STR and LTR mechanisms on rapidity and reliability parameters over differing time intervals for all experimental conditions.

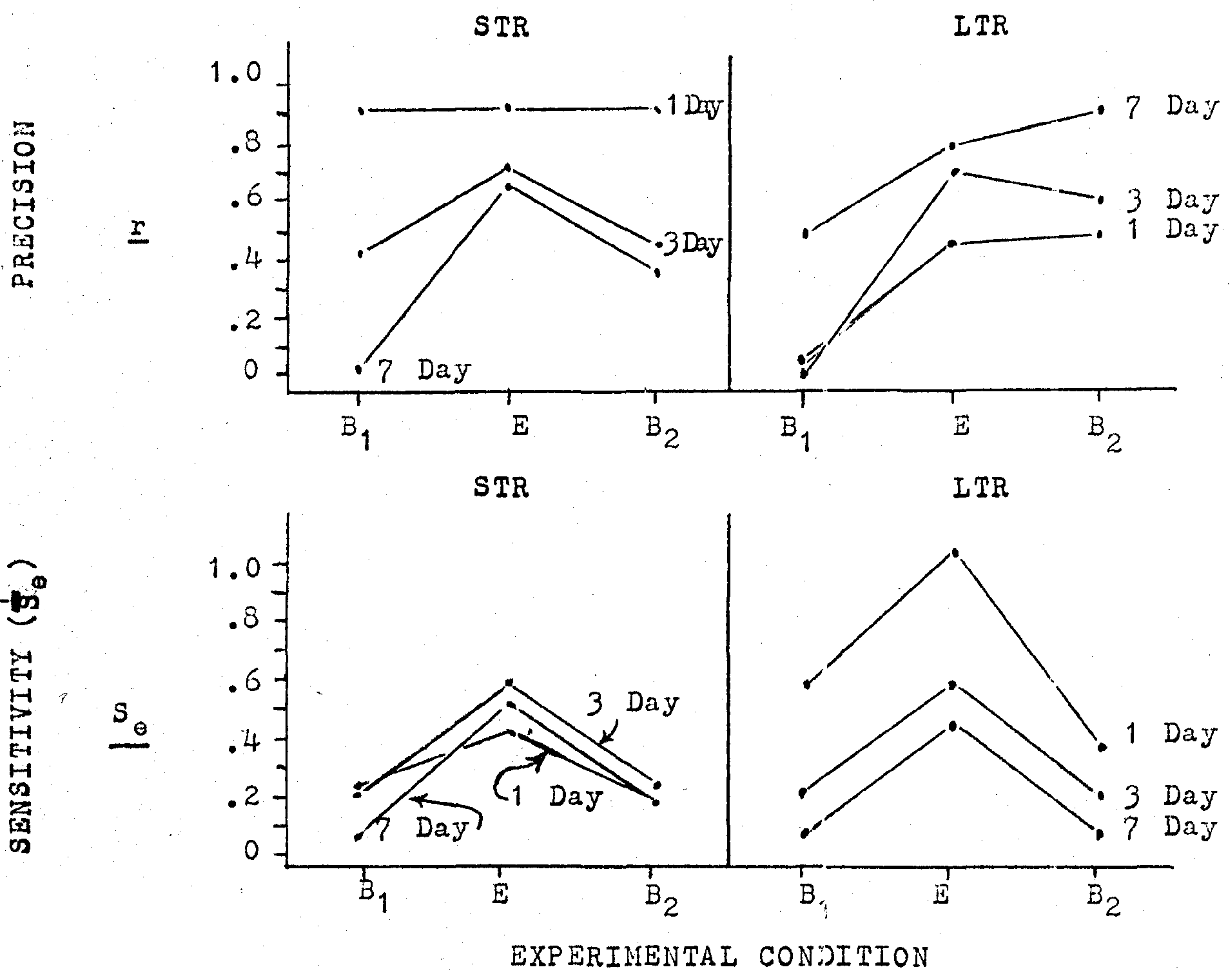

Figure 3. Contrast in STR and LTR mechanisms on precision and sensitivity parameters over experimental conditions for all time intervals.

magnitude. Defining precision in this way, we see that when the effects of stress are viewed, greatest STR precision occurs over short time intervals while greatest LTR mechanism precision occurs over longer time intervals.

For the STR mechanism the greatest precision adjustment to stress occurred at the seven day interval. The slope fluctuations are less on the daily and three day curves than on the seven day STR precision curve. Practically no precision adjustment occurred in the daily condition.

For the LTR condition, as could be expected from the literature (Mayer, 1955), the greatest precision adjustment or poorest precision in response to stress occurred over the shorter time periods.

The boundary between STR and LTR mechanisms seems to be sensitive to stress effects. The temporal divisions between ST and LT regulation is obvious when viewing rapidity in the B_1 condition of Figure 2, but in the E condition the ST and LT mechanisms are seen to overlap. The loss of a discreet temporal boundary between the two mechanisms in the E condition can be attributed to a stress induced precision adjustment. Recognizing this, one is faced with the possibility that ST and LT mechanisms interact under stress. This question is not resolvable in the present study and has not been approached in the current literature.

The effect of the increased stress induced precision in removing STR-LTR rapidity boundaries may represent an adaptive advantage. It allows the organism to meet ongoing stress by using both STR mechanisms and LTR mechanisms. Over extended stressed time periods, STR mechanisms may more appropriately be labeled STR-LTR mechanisms. In this case, LTR under stress would consist of a component whose origins were in STR. Over extended non-stressful conditions no such component would be acting in LTR.

To this investigator's knowledge, this phenonmenon has not been directly studied. To fully understand LTR we should know quantitatively what portion (if any) of LTR regulation under stress represents the effect of STR functioning. Short term precision adjustments change in a very orderly fashion with increasing time. What time interval and stress magnitude is necessary to demonstrate a maximum ST precision adjustment? Does ST precision adjustment under stress represent an interaction between time and changing stress magnitude at all? These questions indicate a possibly profitable direction for future research to follow.

Reliability. Both ST and LT reliability ($\frac{1}{S_e}$) increase over time, see Figure 2, but with increased time because of the blocking procedure, the variance of the predictor value is decreasing and a reduced S_e can be expected to occur as a statistical artifact. For the ST mechanism, daily reliability would be expected to be superior to that over longer time periods. Short term results indicate just the opposite, that reliability improves with increasing time. In the ST case, the expected findings may be obscured by the statistical artifact.

Long term reliability increases with time just as did ST reliability. This increase is expected both from Mayer (1955) and conceptually. If an animal is regulating over a long time base, the greatest reliability (least variance) is expected to occur over the period in which the animal is regulating. It should not be forgotten that these LT patterns may be accentuated by an artifact.

Stress decreases reliability in both the ST and LT mechanisms. For the ST under stress, greatest reliability was seen at the daily level; this is to be expected if the ST mechanism is maximally operative at one day, as is indicated by the rapidity values. For the LT mechanism, greatest reliability occurred at seven days and stress induced reduction was nearly equal over all time periods. Stress effects with regard to variance will be discussed further as sensitivity.

Sensitivity. In Figure 3 the effect of stress can be seen to decrease sensitivity ($\frac{1}{S_e}$) by increasing the $\underline{S_e}$. This stress induced sensitivity decrease holds for both ST and LT regulatory mechanisms. The magnitude of the $\underline{S_e}$ change which represents sensitivity seems to be constant regardless of the mechanism or the time interval under study. Sensitivity is equally effected by stress in all conditions.

In concluding this section it should be mentioned that these findings serve to indicate the validity of viewing regulatory adjustment using Mayer's parameters in terms of a correlationally based framework. Although defined differently than the Mayerian definitions in the introduction, the correlationally based precision, rapidity, sensitivity and reliability dimensions behave in the same manner as their Mayerian counter parts. Long term regulation is generally less rapid, and less precise than short term. The distributions of both parameters respond to stress with increased variance measures. The increasing stress induced variance of the rapidity and precision dimensions can be viewed in terms of reliability and sensitivity changes. Short term and LT precision change with time. Sensitivity decreases with stress. Short term rapidity decreases with time, LT rapidity increases with time. Reliability for both LT and ST increases with time.

<u>Additional considerations concerning the necessary length over which to study LTR</u>

The seven day time block in the current study represented an arbitrary maximum time period. It was hoped that seven days would be long enough to demonstrate the contrast between STR and LTR mechanisms in action. Viewing precision and rapidity as magnitude measures, seven days was long enough to demonstrate a change. As seen in Table 2, the STR rapidity curve is based on positive correlation values, while the LTR curve is based on an inverse relation (Table 3). The negative values for LTR rapidity indicate that the organism is in a state of transition and that when considered over seven days, LTR has not achieved equilibrium.

Fenton (1953), Lundbacke and Stevenson (1947), Mayer (1954), Adolph (1947) and Kennedy (1952) found that when regulations were temporarily disturbed, animals would after varying time lapses settle to equilibrium again. In some cases the equilibrium position was equivalent to the one held before disruption, in other cases it was different. In the current study the subject settled at different higher values (Table 1). As can be seen from Figure 4, roughly 20 days were required to reach the new value. The fact that the animal was gaining weight over this period was adjusted for by transforming all data and presenting it in terms of percentage body weight. Since all calculations were based on transformed data, the negative sign found in the LTR rapidity values in Table 3 represents the ongoing 20 day adjustment before equilibrium was reached. At seven days it can be seen in Figure 4 that precision values have not stabilized, but appear to still be increasing. This serves to indicate that LT functioning may be operating over a longer time period than previously supposed, at least under a stressful condition.

One further indication of extended LT functioning appears as a discontinuity of the LTR rapidity pattern in Figure 2. Rapidity in the B_2 condition is greater in magnitude than in the E condition for all time blocks under study. This could represent residual stress effects occurring during

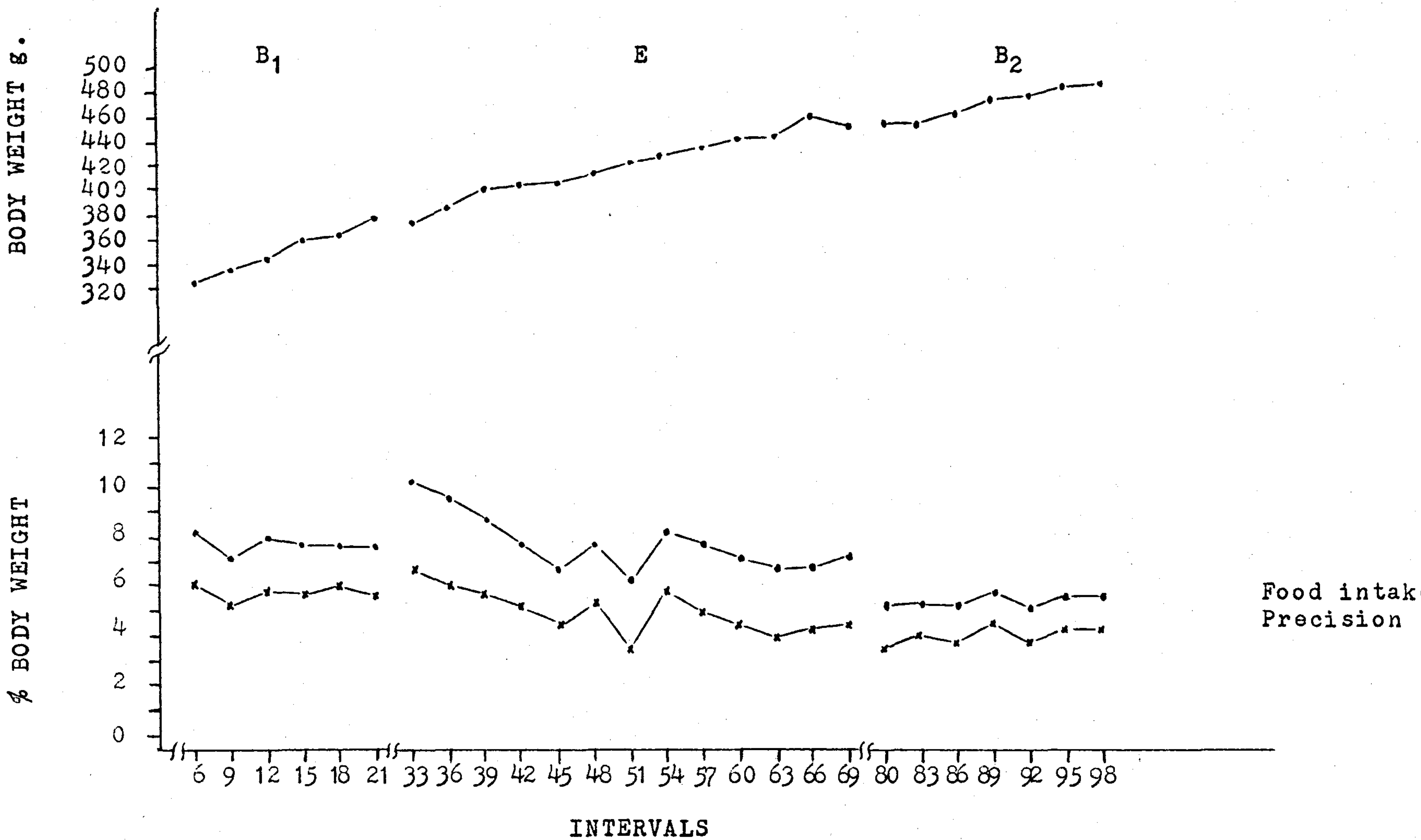

Figure 4. Comparison of food intake and body weight values with precision during 3 experimental periods

the transition period in which the organism is returning to his unstressed privileged value. The fact that the <u>r</u>s for the seven day E and B_2 conditions were not significantly different ($p > .05$) indicates that twenty-one days may not be long enough for the organism to exhibit normalcy during B_2. This explanation is particularly plausable when one considers the fact that B_1 may represent the only stable regulation period in the entire study. The possibility is very real that the E and B_2 conditions could more accurately be considered as transition periods.

Comprehensive studies of LTR could use the correlational technique described in this paper, but would employ a maximum time block of roughly 20 days in length. Under these conditions, a peak of LTR functioning may be found. Perhaps the STR-LTR stress induced boundary shift discussed in this paper is accompanied by a stress induced peak shift in LTR. It has already been shown that stress adjustment can be viewed in terms of a subtle and interrelated adjustment of both regulatory mechanisms. At any rate, provocative questions concerning the compensatory functioning under stress of the LT mechanism have been raised, and it is clear that the ST and LT scheme of regulation is not a fully developed model.

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