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Hunger-motivated training as a function of the number of prior escape or avoidance trials

Gerald Ray Stoffer

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HUNGER-MOTIVATED TRAINING AS A
FUNCTION OF THE NUMBER OF
PRIOR ESCAPE OR AVOIDANCE TRIALS.

By

Gerald R. Stoffer

B. S. Washington State University, 1969

Presented in partial fulfillment of
the requirements for the degree of

Master of Arts
UNIVERSITY OF MONTANA
1971

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Harold Bald
Chairman, Board of Examiners

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Dean, Graduate School

Date
Aug. 9, 1971
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Several experimental designs have been employed to test Hull's (1943) drive summation equation. Theoretically, the effects on performance of combined relevant or irrelevant appetitive or aversive motivating conditions should be additive.

A combination of one relevant and one irrelevant drive has been used most frequently to test this hypothesis. Kendler (1945) varied amount of irrelevant drive (thirst) concurrently with a constant relevant drive (hunger). He obtained summation effects for all but the highest irrelevant drive intensity used.

Two studies (Webb, 1949; Brandauer, 1953) have shown that an operant response acquired under a relevant drive (hunger or thirst) can be energized during extinction by another drive (thirst or hunger).

Support for additive effects has also been found by Braun, Wedekind, and Smudski (1957) using cold-water-escape and irrelevant hunger, and by Amsel (1950) with irrelevant hunger and a relevant anxiety-escape condition.

Work with simultaneous drives has provided negative results. Studies employing hunger and thirst (Siegel,
1946; Bolles, 1960; Levine, 1956) have found either no effect or a retarding effect due to the presence of irrelevant motivation.

Little research has dealt with relevant drive combination effects. Additivity of water-escape and loud noise has been shown (Morey, 1934). Other investigators using shock-escape and hunger motivation (Muensinger & Fletcher, 1936), hunger and thirst (Powloski, 1953), and water-escape and hunger (Rollins, Thomas, & Remley, 1965) have not obtained summation effects.

In addition, only a few studies have been concerned with the effects of successive relevant drive combinations. According to Hull (1943), a specific response learned under one drive-incentive combination should transfer positively to a different drive-incentive combination.

Support for Hull's idea has been provided by Porter and Miller (1957) who compared the effects of training under two drives (hunger and thirst), alternately present, with the effects of training under one drive (either hunger or thirst). Summation effects were demonstrated in extinction under no drive. Bower and Kaufman (1963) found positive transfer across hunger and thirst drives through the use of a secondary motivating stimulus.

The results of the various designs (relevant and irrelevant drive combinations, relevant drive combinations,
and alternation of relevant drive combinations) are equivocal. A recent series of studies, however, has discovered a consistent transfer effect from successive combinations of relevant aversive to relevant appetitive motivating conditions. These findings are inconsistent with the summation formula as response suppression effects have occurred.

The original study (Babb, 1963) trained rats in a straight runway for 15 trials under either relevant thirst motivation or shock-escape motivation. In transfer, each of these treatments were subdivided and Ss were trained on either the same drive used in initial training or changed to shock-escape or relevant thirst. Also, two controls not given initial training were started on shock motivation and hunger motivation, respectively. Transfer results showed an immediate performance drop (combined start and run speeds) for the animals transferred from shock-escape to thirst motivation. The other treatments (and controls), however, improved steadily in transfer. An exception was the group changed from thirst motivation to shock which remained at a stable performance level in transfer. At the end of transfer all groups were significantly faster than the group trained on shock and changed to thirst.

It is unlikely that this suppression phenomenon stems
from generalization decrements due to a lack of similarity between drives. Even if there were zero generalization, the performance of the shock-to-thirst group would be at least equivalent to a thirst-motivated control group begun at transfer.

Babb and Leask (1969) confirmed the response suppression effect after transfer from shock-escape to thirst-motivated responding. Experimental Ss were given 15 shock-escape trials and transferred to: (1) relevant thirst (barrier present); (2) relevant thirst (barrier absent), or (3) regular extinction (irrelevant thirst). A control (relevant thirst) was initiated at the beginning of transfer. The barrier prevented a view from the runway of the newly introduced tray of water. The lack of differences between the barrier present and the barrier absent groups suggests that suppression is not due to water-induced stimulus change. In the first study (Babb, 1963), suppression was considered to have been partially a function of fear produced by stimulus change.

These authors suggested that the suppression effect may be closely tied to the thirst-water reinforcement conditions in later training. However, no significant differences in readiness to drink were found between Ss receiving prior shock-escape training and those receiving only later thirst-motivated training.
Subsequent research has also investigated the influence of several variables on transfer effects from aversive to appetitive motivation. Babb, Bulgatz, and Matthews (1969) varied shock intensity and introduced an irrelevant water incentive. Greater suppression followed initial training on high shock. Also more suppression was shown for those Ss trained with shock-escape under irrelevant drive than for the group given initial training with irrelevant water in the goal box.

The second part of their study extended the suppression effect to hunger motivation in transfer. Furthermore, irrelevant thirst or hunger in shock-escape training produced more suppression in transfer where thirst or hunger, respectively, was made relevant. The more intense shock resulted in more suppression after transfer to either thirst or hunger-motivated responding.

The third phase of this research called for initial shock-escape training under irrelevant drive (hunger), relevant hunger, or shock-escape alone. Transfer was to hunger-motivated training. Findings indicated not only that irrelevant hunger is not necessary for the phenomena to occur, but also that both the irrelevant drive, and the relevant drive, added in shock-escape, diminished early performance suppression.

The above study militated against a stimulus change
interpretation of the effect as suppression still occurred when irrelevant water was present, and after either relevant or irrelevant drives were present in acquisition. The authors report that these same results suggest that a direct association between hunger or thirst stimuli and acquisition shock is not critical to the occurrence of suppression.

Babb, Matthews, and Bulgatz (submitted, 1971) explored the effects of several additional factors on the suppression phenomenon. Experiment one was performed using alternate day presentations of shock-escape and relevant hunger motivation, and alternate day presentations of shock and no shock. Transfer to hunger-motivated training resulted in suppression for all groups receiving shock-escape training in acquisition - regardless of drive presentation and incentive treatments. Alternated groups had experience with transfer conditions prior to transfer. Therefore these results argue against a stimulus change explanation of suppression.

Experiment two was designed to replicate the alternation and simultaneous combination of shock-escape and relevant hunger using suitable relevant hunger controls for different numbers of acquisition trials. Shock intensity was also manipulated.

High shock resulted in more suppression regardless of
alternation and simultaneous conditions. Alternation, however, produced greater suppression regardless of shock intensity. This study is also inconsistent with the stimulus change hypothesis of suppression (Babb, 1963) as alternated groups evidenced even more suppression than the simultaneous ones.

The third experiment broadened the number of conditions sufficient for the effect beyond primary motivation and aversive shock. Conditioned aversive cues and aversive noise were capable of producing the effect in later hunger-motivated trials. These results are not consistent with an earlier interpretation (Babb, Bulgatz, and Matthews, 1969) of the effect in terms of overt response competition. The response learned in acquisition under conditioned stimuli or aversive noise is not apparently different from the response required under appetitive motivation in transfer. Suppression still occurred when responses presumably were not incompatible.

The most recent work (Horn, 1969) has extended the suppression effect to include high shock-escape training transferred to low hunger-motivated training. Generally, however, drive intensity changes between acquisition and transfer were not a significant factor producing response suppression.

Partially, the present study was an attempt to
determine if the suppression effect occurred after shock-avoidance acquisition training as well as after shock-escape training. Prior work by Babb and his collaborators used escape procedures - shock-escape, or, in one case (Babb, Matthews, and Bulgatz, 1971), noise-escape. This latter study did present two cs-ucs combinations in the pre-runway situation. One combination, however, was unpaired (presented randomly), and neither of the treatments provided for training of an avoidance response.

In addition, the effects of an extended number of acquisition trials on response suppression was investigated. Fifteen acquisition trials were given in all of the research on this topic except for the first two experiments in the Babb, Matthews, and Bulgatz (1971) study (30 trials) and the one by Hom (1969) (50 trials).

The proposed manipulation was designed to provide information concerning what is learned in aversive training and transferred to appetitive learning. Mowrer (1960) has suggested that two different things are learned in aversive training. First, there is fear conditioning, and secondly, instrumental response learning which serves to terminate fear. Thus, in aversive conditioning it is reasonable to assume that fear conditioning may take place more rapidly than escape or avoidance response learning. Therefore, it is possible that suppression effects found in previous research using a small number of acquisition
trials were partially due to some interaction of acquired fear with conditioned appetitive states.

The use of a large number of initial learning trials should increase response learning. These effective responses may reduce the amount of fear over time. In addition, fear responses may tend to "habituate" over increased trials. If these assumptions are true, then response suppression should be lessened for groups given extended acquisition training.

This prediction was tested using a shock-escape, and a shock-avoidance group of rats. Half of each group were given either 15 or 45 acquisition trials and transferred to 22-hr. relevant hunger-motivated responding.
Chapter 2

METHOD

Subjects

Ss were 45 naive, male rats of the Long-Evans strain. They were approximately 90-130 days of age on the first day of pretraining.

Apparatus

A four-foot runway with one-foot start and goal box extensions, stainless steel grid floor, and clear Plexiglass guillotine-type doors and top were used. The walls of the runway were painted a flat medium grey. Start box and alley widths were five inches but the goal box was ten inches wide. The goal box contained a two-inch high barrier placed six inches in front of the rear wall. Runway height was five inches. Floor rods were separated by 1/4 inch. Hunter infrared light relays, silent timers, an Applegate constant current shock generator, and a Davis shock scrambler were used to measure speed and to energize the start box and runway grids. A Grayson-Stadler 455c white noise generator produced a 68db (20 KC) sound. The peak ambient noise level was 60db.

Procedure

Pretraining. Each S was given three minutes of
handling each day for five days. Then for seven days Ss were placed on 22-hour food deprivation and individually given three minutes access each day to a tray of food on a metal table. The time for each S to begin eating was recorded. Pretraining was conducted in a room separate from that in which the experimental sessions were held.

**Acquisition.** Experimental trials began the second day following pretraining. Hunger deprivation was discontinued and Ss randomly divided into either shock-escape or shock-avoidance groups. Each of these groups were given five trials per day totaling either 15 or 45 trials. The treatment groups - 15 escape trials, 45 escape trials, 15 avoidance trials, and 45 avoidance trials - will be designated as E-15, E-45, A-15, and A-45, respectively. The 15 trial groups started training on the seventh day of the 45 trial groups' training.

For the shock-escape groups, 1 milliamp shock was applied simultaneously with the opening of the start box door and terminated as S entered the goal box. A white noise was presented simultaneously with the opening of the start box door but preceding shock (1 milliamp) three seconds for the shock-avoidance conditions. Shock and noise both terminated when S entered the goal box.

The start box door was opened at random intervals (15, 20, 25, or 30 sec.) after S had been placed in the start box.
The times were the same for all Ss on any particular trial, however. At the end of each run, Ss were allowed to remain in the goal box 30 seconds before being returned to individual retaining cages to await the next trial. The intertrial interval was approximately eight minutes.

Transfer. Shock motivation was discontinued and all Ss transferred to 22-hour relevant hunger-motivated training. Shock-training for these groups began the second day after the conclusion of acquisition training and continued for 65 trials at the rate of five trials per day. In addition, a 22-hour relevant hunger-motivated control group (hereafter designated as C) began training in transfer. Reinforcement consisted of a 30-second retention in the goal box with a tray of Purina Laboratory Chow for all animals. The noise was presented simultaneously with the opening of the start box door and terminated when S entered the goal box.
Chapter 3
RESULTS

Generally, control Ss ran and started significantly faster than all experimental groups. Only one significant main effect (conditions) occurred, and no interactions were statistically significant on all the analyses. Thus, E-15, E=45, A-15, and A=45 all ran and started at about the same speed, and all were slower than the control group.

Transfer starting and running times were transformed into speed measures by taking the reciprocal of the median of each successive five trials for each S and multiplying by 100. All analyses were two-tailed and p values of 0.05 were accepted as significant. Separate analyses of variance using a factorial with single control technique (Winer, 1962) were performed on transfer days 7-13 for start and run speeds. These trials marked the beginning of relative suppression and its later stabilization. Also, analyses of variance were conducted for transfer days 6-8, 9-11, and 9-13, on start speeds. Individual comparisons were made using an analysis of variance technique adapted from Dunnett (1955).

The overall F for the control versus all other groups on days 7-13 was significant for start speeds ($F = 6.24; df; = 1,40; p < .05$) and for run speeds ($F = 19.23; df; = 1,40; p < .05$).
Individual comparisons indicated that group C ran significantly faster than E-15 (t = 4.73; df = 5,40; p < .01), E-45 (t = 2.68; df = 5,40; p < .05), A-15 (t = 3.13; df = 5,40; p < .01), and A-45 (t = 3.40; df = 5,40; p < .01), and started faster than A-45 (t = 3.15; df = 5,40; p < .01). No other source of variation (trials, aversive condition, or interaction) was significant.

**TABLE 1**

**MEANS OF START AND RUN SPEEDS ON TRANSFER DAYS 7-13**

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>RUN SPEED</th>
<th>START SPEED</th>
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</thead>
<tbody>
<tr>
<td>C</td>
<td>77.16</td>
<td>265.64</td>
</tr>
<tr>
<td>E-45</td>
<td>56.89</td>
<td>215.49</td>
</tr>
<tr>
<td>A-15</td>
<td>53.44</td>
<td>204.82</td>
</tr>
<tr>
<td>A-45</td>
<td>51.43</td>
<td>166.48</td>
</tr>
<tr>
<td>E-15</td>
<td>41.32</td>
<td>225.26</td>
</tr>
</tbody>
</table>
FIG. 1. RUNNING SPEED AS A FUNCTION OF TRIALS IN TRANSFER.
Fig. 2. Starting speed as a function of trials in transfer
The overall F for the control versus all others for start speeds was also significant on transfer days 6-8 ($F = 5.86; df = 1.40; p < .05$), 9-11 ($F = 7.71; df = 1.40; p < .01$), and 9-13 ($F = 7.26; df = 1.40; p < .05$). Main effects were shown for type of aversive condition on days 6-8 ($F = 14.73; df = 1.40; p < .01$). E-45 started much faster than A-45 ($F = 15.00; df = 1.40; p < .01$). C started faster than A-15 ($t = 2.60; df = 5.40; p < .05$) and A-45 ($t = 3.97; df = 5.40; p < .01$).

On transfer days 9-11 C started faster than E-45 ($t = 2.42; df = 5.40; p < .05$) and A-45 ($t = 2.80; df = 5.40; p < .05$). C was faster than A-45 ($t = 2.89; df = 5.40; p < .05$) on days 9-13. No other overall F's were significant for analyses of start times on days 6-8, 9-11, or 9-13.
Chapter 4
DISCUSSION

The present study replicates the basic suppression effect found in transferring rats from shock-escape to appetitively-motivated responding. It further extends the generality of previous findings. Prior shock-avoidance as well as shock-escape is subject to the transfer decrement. Extension of acquisition training does not change suppression effects.

In general, the control animals ran and started faster than all experimental treatments. Treatment groups all ran and started at about the same speed.

Since E-45 and A-45 ran and started at about the same suppressed speeds as E-15 and A-15, two conclusions follow: Either (a) the suppression effect includes extended acquisition training, or, (b) the response strength was not stronger for the Ss with more trials. An examination of acquisition data (see Appendix) revealed no differences in running speeds between A-15 and A-45 and between E-15 and E-45. Acquisition starting speeds, though, were faster for the groups given 45 trials.

No run speed differences occurred because all Ss appeared to run quite early (i.e., within 15 trials) at a ceiling level. Thus, running response strength was close
to maximum for all Ss. Consequently, both of the above conclusions are probably "correct". However, the postulated response strength notion was abandoned due to the observed similarities in running speeds between Ss given 15 and 45 acquisition trials. Also, differences in acquisition starting response strength were not related to differences in suppression of starting speeds.

Classically conditioned "fear" may serve an important theoretical function in describing suppression, however. It has been used recently (Grossen et al., 1969) to account for the depression of shuttle-avoidance behavior by a CS paired with food. Grossen et al. (1969) suggested that the mediational properties of a CS+ (food-paired) was inherently incompatible with the anticipatory properties of a signal controlling avoidance.

This notion of "inherent incompatibility" is consistent with Mowrer (1960) who believed that CS's based on shock interact subtractively with CS's based on food. Verification of Mowrer (1960) was obtained by Anderson et al. (1967). Following food training in an alley, rats were classically conditioned using shock. Ss ran more slowly in the presence of the CS during retraining. Greater conditioned suppression was reported when the CS was paired with a stronger shock.

Furthermore, the idea of a subtractive interaction
between conditioned anticipatory states based on food and shock may account for the CER phenomenon (Estes and Skinner, 1941). The conditioned suppression refers to the use of a shock-paired CS to produce a decrement in ongoing appetitive responding.

In fact, Estes (1969) interprets his own CER findings in terms of an "algebraic" summation of drive elements. Thus, the addition of negative amplifier input (i.e., from the conditioned stimulus preceding shock) will reciprocally inhibit the positive drive system which had facilitated the ongoing appetitive operant. Consequently, the positively motivated response will be decreased in probability of occurrence.

Additional research is also inconsistent with Hull's (1943) general energizing factor and its inefficacy in interpreting response suppression. Bull (1970) has observed a decrease in rates of avoidance responding when a CS (food-paired) was compounded with the cue for avoidance in transfer tests. These results (and their interpretation) are similar to those obtained by Grossen et al. (1969) above. Bull (1970) postulated a subtractive interaction between conditioned appetitive and aversive motivational states.

Suppressed avoidance behavior (described above) and suppressed appetitive behavior (found in the CER and in all
the studies by Babb and his associates) seem to have com-
mon foundations. Both appear when conditioned appetitive
and aversive motivations were used.

Estes (1969) has espoused a competition of motives
concept to describe the effects of different motives on
behavior. He assumes that behavior is maintained through
the summation of discriminative or conditioned stimuli with
the input of amplifier elements from drive sources. Negat-
tive drive systems (including the anticipation of pain)
reciprocally inhibit amplifier input from positive drive
sources.

A similar conflict of motives was used by Babb et al.
(1969) to account for their suppression findings. Runway
stimuli have been associated with shock (i.e., become con-
ditioned aversive stimuli) and, in transfer, with food or
water (i.e., become conditioned appetitive stimuli). Thus,
a possible conflict between conditioned appetitive and
aversive stimuli exists in the start box and runway.

It is important to note that Babb and his associates
have eliminated a response competition notion. Babb et al.
(1971) achieved strengthening of running behavior by using
an aversive CS as the motivating stimulus. This CS had
been previously paired with shock. Response suppression
still occurred, however, when Ss were transferred to the
appetitive phase. Thus suppression of appetitive responding
can't be based on overt incompatible responses elicited by runway CS's. This possibility exists in the CER procedure. Conditioned suppression in the latter may result from responses (i.e., freezing) incompatible with ongoing appetitive responding.

Suppression effects occur when irrelevant hunger or thirst is present in the shock-escape phase (Babb, 1963; Babb et al., 1969; Babb and Leask, 1969). However, irrelevant drives in acquisition are not necessary for the occurrence of suppression (Babb et al., 1969). Irrelevant drives are unnecessary because the basis for an appetitive-aversive motivational conflict is already complete with the relevant shock-escape and later hunger-motivated responding. The addition of irrelevant appetitive drives may only serve to reduce the conflict by "weighting" the appetitive (approach) component. Babb et al. (1969) supported this contention. Relevant (and irrelevant) acquisition hunger led to reduced suppression in early transfer.

Response suppression also occurs when shock-escape is replaced by noise-escape (Babb et al., 1971). Apparently noise can serve the same function as shock (i.e., as the aversive component in conflict).

The effect occurs in the case of transfer from shock-escape (or shock-avoidance) to hunger-motivated training (Babb et al., 1969; Babb et al., 1971; Hom, 1969; this
paper) and from transfer to thirst-motivated responding (Babb, 1963; Babb et al., 1969; Babb and Leask, 1969; Babb, et al., 1971). Again, both hunger and thirst can serve as appetitive components.

Two studies (Babb, et al., 1969; Babb et al., 1971) observed that higher shock intensities in acquisition led to greater suppression in transfer. An above study (Anderson, et al., 1967) reported a similar increased suppression of appetitive responding when CS's paired with strong shock were presented. The "CS's" in the response suppression research are simply normal runway cues. In these studies a higher shock intensity should "weight" the aversive (avoidance) component of the conflict. Thus, more suppression is expected since avoidance is increased.

In addition to the typical suppression effect, hunger-motivated responding will produce suppression of responding based on aversive motivation (Babb, et al., 1971). This finding is consistent with above data reported by Grossen et al. (1969) and Bull (1970). A conflict interpretation may be applied to all these studies. It is only necessary to combine the appetitive and aversive components at some point in the experiment. The behavior consequences (suppression) are identical to those produced by the typical suppression paradigm.

Finally, suppressive effects have been found when
shock-escape and hunger-motivated responding was given simultaneously or on alternate days (Babb et al., 1971). Opportunities for the development of conflict of incompatible motivations were clearly present.

Therefore, suppression found in transfer from escape (and avoidance) behavior is believed to be a special case of the effects of conditioned appetitive and conditioned aversive motivation.

These particular motivational combinations are assumed to interact in a non-additive manner (Babb et al., 1969; Babb et al., 1971; Bull, 1970; Estes, 1969; Grossen et al., 1969; Mowrer, 1960). The suppression mechanism is an assumed reduction in positive amplifier element activity by shock (Estes, 1969), or, similarly, an assumed competition between conditioned aversive and appetitive stimuli (Babb et al., 1969; Babb et al., 1971).

Subsequent research might manipulate the relative strengths of the conflict components through a variety of operations. For example, certain drugs (i.e., tranquilizers) might be used to reduce the avoidance component.

Ader et al. (1957), Miller et al. (1957), and Torres (1961) have labeled one tranquilizing agent (chlorpromazine) a "fear-reducer". Thus, if chlorpromazine is given just prior to transfer, expected suppression will be less, relative to placebo controls. The author is currently investigating this possibility.
Two groups of rats were subjected to either a shock-escape or a shock-avoidance procedure. Half of each group were given either 15 or 45 acquisition trials and subsequently transferred to 22-hour relevant hunger-motivated responding. In addition, a 22-hour relevant hunger-motivated control group began training in transfer.

Animals given extended acquisition trials were expected to show less suppression in the transfer (appetitive) phase. It was assumed that these Ss would possess less fear. Conditioned fear was considered essential for the transfer phenomenon to occur.

Results did not support these assumptions. Generally, control Ss started and ran significantly faster than all experimental groups, which all started and ran at about the same (suppressed) speeds. Thus one cannot assume that extended training in acquisition reduced fear.

Consequently, the notion of suppression based on a conflict between conditioned aversive (fear) and conditioned appetitive motivations may be worthwhile. The same results extend the suppression effect to animals given extended acquisition trials. Further, the effect is demonstrable with shock-avoidance as well as with shock-escape acquisition procedures.
APPENDIX

ACQUISITION DATA:

Analyses of variances and individual comparisons of acquisition data followed the methods in Winer (1962, pp. 228-239). The tests were performed using all 15 trials for E-15 and A-15, but only the last 15 trials for E-45 and A-45. These trials were chosen because the comparison of E-15 and A-15 with the speeds of E-45 and A-45 on final trials should reflect any effect from extended training.

Main effects were shown for run speeds on the condition factor \( F = 4.78; \, df = 1,32; \, p < .05 \). The only significant individual comparison was between E-15 and A-15 \( F = 5.67; \, df = 1,32; \, p < .05 \).

Main effects were shown for start speeds on the conditions variable \( F = 11.61; \, df = 1,32; \, p < .01 \) and the trials variable \( F = 27.94; \, df = 1,32; \, p < .01 \). Individual comparisons showed significant differences between E-45 and A-45 \( F = 13.26; \, df = 1,32; \, p < .01 \), between E-15 and E-45 \( F = 24.69; \, df = 1,32; \, p < .01 \), and between A-15 and A-45 \( F = 6.28; \, df = 1,32; \, p < .05 \). No interaction effects occurred. See Table 2 for the means of start and run speeds on the last three acquisition days.
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