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REPETITION EFFECTS AND SIGNAL CLASSIFICATION STRATEGIES IN SERIAL CHOICE-RESPONSE TASKS

BY

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Repetition-effects (Bertelson, 1965) were examined in three serial self-paced choice-response tasks in which each response was made to all members of a class of more than one signal, and in one task in which eight different responses were each made to one of eight different signals. Three kinds of transition between successive responses occur in such tasks: transitions between *Identical responses* where the same signal and response are immediately repeated, transitions between *Equivalent responses* where the same response is made to a new signal and transitions between *New responses* where neither signal nor response are repeated. The relative reaction-times for these three classes of events were found to vary as a function of stimulus information load, as a function of response information load and as a function of the level of practice which subjects attained in the task in question. These variations allow some comment on the utility of recent models for serial and parallel stimulus analysis as explanatory constructs for the repetition-effect.

INTRODUCTION

In serial choice-response tasks human subjects respond faster if a given signal, and the response to it, are immediately repeated than if they have to identify a new signal and to program a new response (Hyman, 1953). This has become known as the "repetition effect" (Bertelson, 1961; 1965).

A similar, facilitating effect is observed when subjects make successive, different movements with the same limb to successive, different signals (Rabbitt, 1965). It is therefore likely that two sets of factors contribute to the "repetition effect" observed by Bertelson and Hyman; that is factors which relate to the repetition of a particular signal and other factors which relate to the repetition of a particular motor act. It becomes a real question how the proportionate contributions of these factors to the overall repetition-effect can be estimated.

A test case is a task in which the subject makes the same response to all members of one set of signals and makes other responses to signals in other arbitrary sets. In such a task the number of signals between which the subject has to discriminate, and the number of responses between which he has to choose, may be varied independently (Rabbitt, 1959). In most previous studies (Hyman, 1953; Bertelson, 1961; Falmagne, 1965; Leonard, Newman and Carpenter, 1966), the effects of signal and response entropy upon repetition-effects have been confounded because the repetition of a signal has always entailed the repetition of a particular motor act. An exception is an experiment by Bertelson (1965) who compared RTs for the three classes of transitions between successive signals and responses which are possible in a task in which subjects have to choose between two responses, each of which is appropriate to two of four possible signals (2R/4S mapping) which occur during a serial self-paced task. For convenience these classes of transitions may be defined and labelled as follows:

Identical transitions when the same signal, and implicitly the same response, are immediately repeated. *Equivalent transitions* when a signal is followed by a different signal to which the same response is appropriate and *New transitions* when a signal

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is followed by a different signal to which a new response must be made. Bertelson found that four practised subjects gave longer RTs for New transitions than for Equivalent or Identical transitions. For two of these subjects RTs for Equivalent transitions were slightly longer than for Identical transitions, while for the remaining two subjects Equivalent transition RTs were equal to Identical transition RTs.

Unfortunately it is not possible to derive a general model for signal-and-response repetition effects from Bertelson's results since he sampled a single level of signal and response entropy at a single point in practice. Previous work had suggested that the effect of signal and response entropy interact multiplicatively to determine choice RT (Rabbitt, 1959; Pollack, 1963) and that the nature of this interaction may change with practice (Rabbitt, 1962). It seemed that an investigation of variations in the proportional contributions of H_S and H_T to the total repetition effect at different points in practice might provide a useful tool for testing current models which undertake to describe the process of discrimination between classes of signals and the selection of responses to them. An experiment was therefore made to investigate the relative changes in RTs for Identical, Equivalent and New transitions, with practice, in four tasks between which H_S and H_T were systematically and independently varied.

Experiment

Subjects. Forty-five Royal Navy ratings aged from 18 to 27 served as subjects.

Apparatus and procedure. The experiment was made with a stimulus presentation and reaction-timing apparatus (SPARTA). This equipment was programmed with punched tape to present sequences of signals (digits) on a "Digitron" G.S.R. 10 J numerical display tube. The subject answered each signal in turn by pressing one of eight keys which were inset into a desk before him so as to rest conveniently under the four fingers of each hand. Within 20 msec. of the closure of a microswitch under any of these keys SPARTA presented a new signal on the Digitron tube. SPARTA then punched out on 5-channel tape the codes which specified the signal presented to the subject, the key he pressed in answer to it and the elapsed time since the last key closure (to within 10 msec.).

In all conditions an experimental run with SPARTA was a sequence of 301 signals and responses in a self-paced mode. In all experimental conditions all subjects experienced two such runs on each of five successive weekday mornings.

The same ten programmes of signals were used for three conditions of the experiment. These consisted of the digits 1 to 8 programmed from tables of random numbers with constraints to ensure that, as far as possible, all 64 transitions between signals occurred equally often. A different one of these sequences was used for each of the ten runs experienced by each subject. Three separate groups of subjects mapped responses on to these eight signals in the following ways:

2R/8S condition: 12 subjects responded to any of the digits 1, 2, 3, or 4 by pressing a key inset under their left forefinger, and to any of the digits 5, 6, 7 and 8 by pressing a key inset under their right forefinger.

4R/8S condition: 11 subjects responded to the digits 1 and 2 with their left middle fingers, to the digits 3 and 4 with their left fore-fingers, to the digits 5 and 6 with their right fore-fingers and to the digits 7 and 8 with their right middle fingers.

8R/8S condition: 11 subjects responded to the eight decimal digits using one of their eight fingers for each digit.

The allocation of digits to fingers was in numerical order reading across from left little finger (1) to right little finger (8).

Ten similar programmes of 301 signals were made up so that the digits 1 to 4 occurred in random order, with approximately equal numbers of transitions between signals. These were used to provide a further condition:

2R/4S condition in which subjects responded to digits 1 and 2 with their left fore-fingers and to digits 3 and 4 with their right fore-fingers.

In all these conditions the apparatus never gave the subject any indication whether any of his responses was correct or wrong. The recording of signals and responses nevertheless allowed the experimenter to detect errors when they were made.

Results

Errors

A teleprinted record was made of each subject's output tapes for the second and tenth practice runs in each condition. These records were analysed by eye to locate errors. The percentages of errors made at each level of practice sampled in each condition are set out in Table I below.

TABLE I

Mean Percentage of Incorrect Responses made by Subjects Early and Late in Practice on Each of Four Serial, Self-Paced Choice-Response Tasks

Group		*Responses 301 to 600*	*Responses 1,201 to 1,500*
2R/4S	Two responses, four signals	7·2	3·4
2R/8S	Two responses, eight signals	8·4	2·9
4R/8S	Four responses, eight signals	6·9	3·6
8R/8S	Eight responses, eight signals	8·8	3·2

A separate analysis of variance was made at each level of practice on the error-scores over all conditions. Differences between conditions were significant on the second practice run ($p < 0{\cdot}01$) but not on the tenth practice run ($p < 0{\cdot}1$).

Reaction times

Errors, and the three responses following each error, were known to be atypical (Rabbitt, 1966) and so were left out of the analyses described below. The remaining correct responses were divided into three classes: *Identical transitions* where the identical signal and the response to it were repeated, *Equivalent transitions* where a signal was followed by another in the same response class (so that the response was repeated though the signal was not), and *New transitions* where neither the signal nor the response was repeated.

Each subject's mean RT for each of these classes of response was calculated from the SPARTA print-out. Means of these means, for each level of practice, are set out in Table II. To render comparisons between conditions more accurate RTs for Identical responses made with the fore-fingers of each hand are set out for comparison between conditions.

Two analyses of the data were undertaken at each level of practice: RTs were first compared between transition classes within each condition and then RTs within each transition class were compared between conditions. Data for the second and tenth practice runs are discussed separately.

Second practice run. *t*-tests were used to analyse the data within each condition. In all conditions Identical transition RT < New transition RT ($p < 0{\cdot}01$). Within the 2R/4S, 2R/8S and 4R/8S conditions Identical RT < Equivalent RT ($p < 0{\cdot}01$ in all cases). However, in marked contrast to previous findings (Bertelson, 1965) Equivalent transition RT was not significantly different from New transition RT in any condition ($p > 0{\cdot}1$).

In order to analyse differences between conditions within each transition class an Analysis of Variance was made, and the residual term was used to calculate S^2. New transition RTs were significantly different across conditions (An.o.Va. $p < 0{\cdot}001$). S^2 showed that 8R/8S > 4R/8S > 2R/8S > 2R/4S ($p < 0{\cdot}01$ in each case).

TABLE II

MEAN RTs FOR THREE CLASSES OF TRANSITIONS BETWEEN SIGNALS AND RESPONSES. DATA FROM FOUR SERIAL, SELF-PACED CHOICE-RESPONSE TASKS AT TWO-LEVELS OF PRACTICE

Group		*Responses 301 to 600*		*Responses 1,201 to 1,500*		*Fore-finger RTs only. Responses 1,201 to 1,500*	
		Mean	*s.d.*	*Mean*	*s.d.*	*Mean*	*s.d.*
2R/4S ($n = 11$)	New signal/New response	584	219	424	182		
	Equivalent signal/Same response	567	231	394	126		
	Identical signal/Same response	491	184	383	142		
2R/8S ($n = 12$)	New signal/New response	608	251	484	197		
	Equivalent signal/Same response	580	237	416	159		
	Identical signal/Same response	510	219	377	162		
4R/8S ($n = 11$)	New signal/New response	725	270	592	201		
	Equivalent signal/Same response	720	284	532	215		
	Identical signal/Same response	652	247	416	224	386	183
8R/8S ($n = 11$)	New signal/New response	970	291	770	234		
	Identical signal/Same response	693	252	461	209	429	214

Equivalent transition RTs were also significantly different between conditions (An.o.Va. $p < 0{\cdot}001$). Again S^2 gave 4R/8S > 2R/8S > 2R/4S ($p < 0{\cdot}01$ in each case).

Identical transitions RTs were significantly different between conditions (An.o.Va. $p < 0{\cdot}01$). S^2 gave 8R/8S > 4R/8S > 2R/8S ($p < 0{\cdot}01$). The difference between 2R/8S and 2R/4S was not significant.

Tenth practice run. *t*-tests were again used to analyse differences between transition-classes within each condition. In all conditions New RT > Identical RT ($p < 0{\cdot}01$) and (where applicable) New RT > Equivalent RT ($p < 0{\cdot}01$). In contrast to the data for the second practice run (where the difference between New RT and Equivalent RT was not significant) on the final run in the 2R/4S, 2R/8S and the 4R/8S conditions New RT > Equivalent RT ($p < 0{\cdot}01$). In the 2R/4S and 4R/8S conditions Equivalent RT > Identical RT ($p < 0{\cdot}05$).

Analysis of Variance and S^2 were again used to analyse differences between conditions within each transition class. New RT was significantly different between conditions ($p < 0{\cdot}001$ and An.o.Va.). S^2 gave 8R/8S > 4R/8S > 2R/8S or 2R/4S (at $p < 0{\cdot}01$) and New RT 2R/8S > New RT 2R/4S (at $p < 0{\cdot}05$). The same trend appeared in Equivalent RTs (An.o.Va. $p < 0{\cdot}01$). That is, 4R/8S > 2R/8S ($p < 0{\cdot}01$) and 2R/8S > 2R/4S ($p < 0{\cdot}05$).

In contrast to New transition RTs and Equivalent transition RTs, Identical transition RTs did *not* differ significantly between conditions (An.o.Va. $p > 0{\cdot}1$). However, on using Mann-Whitney U tests to compare Identical transition RTs between conditions, it emerged that Identical transition RTs in the 8R/8S condition were significantly longer than in any other ($p < 0{\cdot}05$ to $p < 0{\cdot}01$ two-tailed). No other differences between conditions were found ($p > 0{\cdot}2$).

Discussion

The results of these experiments show that the proportions of the overall repetition effect attributable to the repetition of signals and to the repetition of responses do not simply vary with H_s or with H_r, but rather with some complex interaction between these two factors. The nature of this interaction changes sharply with practice.

It is fashionable to describe the classification of complex signals in terms of models derived from computer programs for character-recognition. Let us consider the present data in terms of two classes of these models respectively put forward by Sternberg (1966) and by Neisser (1963; 1964). The main features of the present results, for which any model must account, may be listed as follows:

Identical transition RTs vary with both H_s and H_r on the second practice run. But by the tenth practice run variations in H_s and H_r affect Identical RT very little (8R/8S) or not at all (2R/4S; 2R/8S; 4R/8S). Any model must explain this change in practice, and also explain why Identical transition RT provides an exception to the general rule that RT = f(H_s and H_r).

Equivalent transition RTs vary sharply with the number of response sets into which the signal ensemble is partitioned (2R/8S vs. 4R/8S) and to a lesser extent with the number of signals in each response set (2R/4S vs. 2R/8S). This is true at both levels of practice examined.

The magnitude of differences between New, Equivalent and Identical transition RTs varies with the level of practice. On the second practice run Equivalent transition RTs are not significantly different from New transition RTs. However, Equivalent transition RTs reduce more sharply with practice than do either New or Identical transition RTs, so that by the tenth practice run Equivalent transition RTs are within 11 msec. (2R/4S) to 30 msec. (2R/8S) of Identical transition RTs. Because the New, Equivalent and Identical transition RTs are differentially altered by practice it is obvious that no single "steady state" model can adequately fit all the data. Let us therefore consider results for the second and for the tenth practice runs separately:

During the tenth practice run, on Identical transitions, the subjects seem to be able to respond without considering any of the other possible signals which they may have to identify (viz. 2R/4S vs. 2R/8S) or any of the other possible responses between which they may have to choose (viz. 2R/8S vs. 4R/8S). To account for repetition effects Bertelson (1963) suggested that subjects carrying out serial choice-response tasks always begin their analysis of each successive signal by making a test to determine whether or not it is the same as the last signal to which they responded. Bertelson suggested that if such a test is positive the subject can immediately repeat his last response without going on to test for any of the remaining signals in the ensemble. Thus, whatever the size of the signal and response ensembles, Identical RT should always be the time required to make a single test on perceptual input, and to repeat the same motor act.

Recent descriptions of perceptual analysis in terms of computer routines for character identification (Neisser, 1963; Sternberg, 1966) allow us to re-state Bertelson's suggestion as one of several models which we may test against the present results.

Computer routines which identify complex signals may be broadly sub-divided into serial testing routines, parallel testing routines or a combination of the two (hybrid routines).

A *parallel routine* is conceived as simultaneously making a set of X_t independent tests on input, each of these tests establishing whether the input can, or cannot, be classified as one of X_i different states (e.g. Neisser, 1963; 1964).

A *serial routine* would also solve the same problem by making X_t independent tests, but would make them one at a time in succession.

A *hybrid routine* would also make X_t tests, but would do so by successively making batches of parallel tests for n different sub-groups of states.

Serial and hybrid routines may be further broken down, since they may be either self-terminating or exhaustive.

An *exhaustive routine* always continues until all possible X_t tests have been made before input is classified.

A *self-terminating routine* only continues testing until any test, or set of tests, is successful. At this point input is classified without any further tests being made. Bertelson's (1965) suggestion that the subject always repeats a test for the last signal which he identified can therefore be re-stated as an hypothesis that the subject's perceptual analysis is a serial or hybrid self-terminating process—with the additional assumption that the first test is made for the signal identified on the last trial. Let us see how this model fits the data for each level of practice.

Data from the tenth practice trial allow us to discount models based on either parallel or serial exhaustive routines. If the subject always tests for all signals in parallel there is no reason why repetition of an identical signal should give faster RTs than repetition of an Equivalent signal (the same motor response is repeated in either case). For the same reason we can reject serial exhaustive models, which also suppose that, before a decision is made, tests must be made for *all* signals in turn (whether in the entire ensemble, or within a given sub-set of signals within that ensemble). It seems that the subjects use a serial self-terminating routine—but the present data do not allow us to say whether this is an hybrid routine or not. With an hybrid routine Identical RTs would be faster than Equivalent RTs, if the subject repeated, to each signal, a set of X_t tests; but where X_t did not coincide with any set of signals which included the test which had identified the preceding item. An exception to this would occur when the sub-set of tests X_t coincided exactly with the limits of a set of "Equivalent" signals (as defined for the subject by the experimenter). In this case Equivalent and Identical transition RTs would be the same, since repetition of any test would necessarily imply repetition of tests for all Equivalent signals. Thus, at least on the tenth practice run, we may assume that if subjects *do* use a hybrid testing routine, the sub-sets of tests which they make do not exactly coincide with those into which the experimenter partitioned the signal set.

In the second practice run, in all conditions, Identical transition RTs were again faster than Equivalent transition RTs. As we have seen, we can only account for this by assuming that they use a serial or hybrid self-terminating routine. It is tempting to conclude that subjects use the same broad class of testing routine both early and late in practice—but this statement would leave the most striking features of the data unexplained. Early in practice Identical transition RT varies with the number of signal and response alternatives among which the subject has to select, and Equivalent transition RTs are not significantly different from New transition RTs. We must conclude that when an Identical transition occurs the subject must, at least on some occasions, consider other signal and response alternatives before making a decision. At this stage in practice, in marked contrast to Bertelson's (1965) findings (and to the data from the tenth practice session) the repetition of a response seems to facilitate RT much less than the repetition of a *signal*. It seems that practice does not merely shift the overall distribution of RTs, but selectively affects the rank order of transition-classes within this overall distribution. Any model we propose must account for this fact. We may choose between different models, depending on whether we assume that subjects use an hybrid routine or a serial self-terminating routine.

A serial self-terminating routine assumes that the first test of a series is always for the signal which had last been successfully identified—but implies no assumption about the order in which further tests are made. It is possible to suppose that, with practice, subjects progressively adapt the order of testing to coincide with the experimenter's partitioning of the signal ensemble. That is, having unsuccessfully tested for the last signal which he identified, we may suppose that the subject systematically tests through all signals in the Equivalent response class before considering (New) signals in other classes. A gradual trend in this direction during practice would progressively alter the distributions of Equivalent transition RTs so that they increasingly approximated to Identical transition RTs (while never, on this hypothesis, becoming as fast as Identical transition RTs).

If we assume that subjects use an hybrid self-terminating testing routine it also does not follow that the sub-sets of parallel tests which we suppose the subject makes (and which we suppose that he repeats when any one of them successfully identifies a signal) coincide with the sub-sets into which the experimenter partitions the signal ensemble. It is possible that one effect of practice is to progressively modify the sub-sets of parallel tests made by subjects until they coincide with the experimenter's partitioning of the signal ensemble. This would progressively alter the distributions of RTs within transition-classes, so that Equivalent transition RTs gradually approximate to Identical transition RTs (and become equal to Identical transition RTs at some limiting level of practice).

Both these hypotheses beg the question as to *why* the subject should modify his testing strategy so as to be able to respond relatively quickly when Equivalent transitions occur. A possible answer lies in the fact that the magnitude of the repetition effect reduces sharply as the interval between successive responses increases (Bertelson, 1961; 1965). Any reduction in the time taken for the perceptual identification of Equivalent signals may therefore allow the subjects to benefit from facilitation of RT due to repetition of motor components of a response. On this line of argument the absence of a *response* repetition effect on Equivalent transitions early in practice might mean that identification and classification of signals takes so long that successive responses are too widely separated in time for maximum facilitation to occur.

Either a serial self-terminating or an hybrid testing model can also serve to explain another, apparently anomalous, feature of these results. In the 2R/4S condition, where each response class has two members, the difference between Identical and Equivalent RT is 11 msec. We must therefore explain why this difference is so much larger (126 msec.) in the 4R/8S condition, where response classes are of the same size. Whether we base explanations for practice effects on a serial or on an hybrid self-terminating model, we assume that subjects gradually adapt their testing routines to the experimenter's partitioning of the signal ensemble. Previous investigations of RTs to classes of signals have shown that the time taken to learn a partition of a given signal ensemble is proportional to the number of sets into which it is classified (Rabbitt, 1959; 1962; Pollack, 1963). It would be consistent with these findings that a 4R/8S classification should take longer to learn than a 2R/8S classification—and that the approximation of Equivalent transition RTs to Identical transition RTs is delayed in the 4R/8S condition for this reason.

Previous studies of signal classification give results of two kinds. On the one hand experiments with relatively unpractised subjects have shown that $RT = f(H_S)$ when H_r is constant (Nickerson and Feehrer, 1964). This may amount to a linear relationship between RT and relevant set size when subjects briefly experience many different partitionings of a single ensemble of signals during a relatively short

experiment (Sternberg, 1966). On the other hand, data from highly practised subjects suggest that the effects of H_S upon RT diminish with practice (Rabbitt, 1962) until there may be little (Rabbitt, 1959; Pollack, 1963) or no (Broadbent and Gregory, 1962) measurable effect of signal entropy (H_S) on choice RT. In visual search, where subjects discriminate between two sets of (relevant and irrelevant) signals, it has been specifically claimed that, at some limiting level of practice, search time becomes independent of relevant set size because subjects gradually learn to adopt a parallel routine, and to test simultaneously for all relevant items (Neisser, 1963; 1964).

The present results support the view that practice does not merely bring about a gross reduction in RT, but rather alters the distribution of RTs in a way which can only be interpreted on the assumption that strategies of perceptual analysis are gradually modified as subjects learn a given classification. The present results preclude the possibility that parallel processing occurs by the tenth practice session. Neither these results (—nor perhaps any others!) can preclude the possibility that at some undefined limiting level of practice subjects may be able to change from a serial to a parallel hybrid testing strategy. Indeed, some support for this view is the fact that three out of 12 subjects in the 2R/4S condition and two out of the 12 subjects in the 2R/8S condition showed no significant difference between Identical transition RT and Equivalent transition RT on their tenth practice runs. The same was also true for two out of four subjects highly practised by Bertelson (1965) in a 2R/4S task.

The most general conclusions of this paper thus reinforce those of a previous study of the ways in which practice allows subjects to optimize their techniques of discrimination between sets of complex stimuli (Rabbitt, 1967). Unlike poorly programmed computing systems of limited capacity, human beings can apparently use many alternative routines to classify perceptual input. If we attempt to describe performance in terms of some unique classification routine (Sternberg, 1966; Neisser, 1963; 1964) it is very possible that our model can be validated—but only at a carefully selected level of practice. A more realistic, and interesting, research strategy is surely the investigation of the subject's progression through a series of classification routines until he evolves one which reflects the optimal relation of his information-processing capacity to the task which we require him to perform.

References

Bertelson, P. (1961). Sequential redundancy and speed in a serial two-choice responding task. *Quart. J. exp. Psychol.*, **13**, 90–102.

Bertelson, P. (1963). S–R relationships and reaction times to new vs. repeated signals in a serial task. *J. exp. Psychol.*, **65**, 478–84.

Bertelson, P. (1965). Serial choice reaction-time as a function of response versus signal-and-response repetition. *Nature*, **206**, 217–8.

Broadbent, D. E., and Gregory, M. (1962). Human response to classes of stimuli. *Nature*, **192**, 1315.

Falmagne, J. C. (1965). A linear model for choice R.T. with application to experimental results. *J. math. Psychol.*, **2**, 77–127.

Hyman, R. (1953). Stimulus information as a determinant of reaction-time. *J. exp. Psychol.*, **45**, 188–97.

Leonard, J. A., Newman, R. C., and Carpenter, A. (1966). On the handling of heavy bias in a self-paced task. *Quart. J. exp. Psychol.*, **18**, 130–141.

Neisser, U. (1963). Decision-times without reaction-time: Experiments in visual scanning. *Amer. J. Psychol.*, **76**, 376–85.

Neisser, U. (1964). Visual search. *Scient. Amer.*, **210**, 94–102.

Nickerson, R. S., and Feehrer, C. E. (1964). Stimulus categorisation and response-time. *Percep. mot. Skills.*, **18**, 785–93.

POLLACK, I. (1963). Speed or classification of works into superordinate categories. *J. verb. Learn. verb. Behav.*, **2**, 159–65.

RABBITT, P. M. A. (1959). Effects of independent variations in stimulus and response probability. *Nature*, **183**, 1212.

RABBITT, P. M. A. (1962). *Perceptual Discrimination and the Choice of Responses.* Unpub. Ph.D. thesis. Univ. of Cambridge.

RABBITT, P. M. A. (1965). Response-facilitation on repetition of a limb-movement. *Brit. J. Psychol.*, **56**, 303–4.

RABBITT, P. M. A. (1966). Errors and error correction in choice response tasks. *J. exp. Psychol.*, **71**, 264–72.

RABBITT, P. M. A. (1967). Learning to ignore irrelevant information. *Amer. J. Psychol.*, **80**, 1–13.

STERNBERG, S. (1966). High-speed scanning in human memory. *Science*, **3736**, 652–4.

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