Behavioural Processes 94 (2013) 26–31

Contents lists available at SciVerse ScienceDirect

Behavioural Processes

journal homepage: www.elsevier.com/locate/behavproc

Choices between segmented and unsegmented schedules and the self-control paradigm

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ARTICLE INFO

Article history:
Received 2 July 2012
Received in revised form
11 November 2012
Accepted 14 November 2012

Keywords:
Preference
Choice
Segmentation
Conditioned reinforcement
Delay-reduction theory
Self-control
Concurrent-chains
Pigeons

ABSTRACT

A concurrent-chains procedure was used to examine choice between a segmented (two- or three-terminal-link segments schedules) and an unsegmented schedule (simple schedule) in terminal links with equal interreinforcement intervals. In most such experiments, preference for the unsegmented schedule has been found, but in a recent study with humans (Alessandri et al., 2010) a reversal in preference was found when, in the segmented schedule, the terminal link segmenting stimulus was presented briefly and closer to food delivery such that the early terminal link stimulus was temporally closer to the food delivery. In Experiment 1, an attempt to replicate this latter effect with pigeons was unsuccessful but this outcome was consistent with an account in terms of a self-control contingency involving conditioned reinforcers. According to this account, the unsegmented alternative consisted of an immediate, smaller presentation of a conditioned reinforcer (i.e., the impulsive, and thus usually the preferred, option in several experiments) and the segmented schedule led to a delayed, larger conditioned reinforcer (i.e., the self-control option). In Experiment 2, a reversal of preference toward the segmented schedule was found when a delay was added to both terminal links between the reinforced initial-link response and the onset of the corresponding terminal link stimulus. This result is consistent with a similar effect found with primary reinforcers in the self-control literature suggesting the utility of self-control as an account of preferences for unsegmented terminal links of concurrent chains schedules.

1. Introduction

The effect on choice of segmentation has been investigated using the concurrent chains procedure, where the first response meeting the scheduled contingency on either of the operanda results in an exclusive presentation of the terminal link associated with that initial link. In the case of segmentation, one of the terminal links is *segmented* – it is divided into two or more segments associated with distinct stimuli. The other terminal link is *unsegmented* – the stimuli in it are homogeneous for its duration. In the segmented terminal link, the *early stimulus* is the first-presented stimulus and the *segmenting stimulus* the second-presented stimulus.

In several previous experiments, on the one hand, pigeons (Duncan and Fantino, 1972; Leung and Winton, 1986, 1988) and humans (Leung, 1989, 1993) preferred the unsegmented terminal link. These preferences varied in degree from 55 to 99% of the total responses in the initial link associated with the unsegmented terminal link. On the other hand, Alessandri et al. (2010) found preference for segmented vs. unsegmented terminal links (the average preference for this alternative as measured by the allocation of initial link responses to the operandum associated with it ranged from 50 to 100% for the 14 subjects) in humans after making two procedural changes in the segmented schedule relative to the procedures in the aforementioned studies. First, the segmenting stimulus appeared temporally closer to reinforcement (after 80% of the terminal link duration had elapsed *versus* the 50% typically studied heretofore). Second, the change in the segmenting stimulus was brief (4-s), reinstating the early stimulus prior to reinforcement.

Preference for the unsegmented terminal link conflicts with a prediction of Fantino's (1969) delay-reduction theory (DRT), which suggests that the effectiveness of conditioned reinforcers depend on the reduction in the delay to food that they signal relative to the absence of such a signal. Thus, in the case of segmented vs. unsegmented terminal links, DRT predicts a preference e for the segmented link because the terminal-link segmenting stimulus is closer to food delivery than the stimulus associated with

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http://dx.doi.org/10.1016/j.beproc.2012.11.007

the unsegmented terminal link. This finding is consistent with Alessandri et al., but not with the other experiments described in the preceding paragraph.

The concurrent chains procedure for assessing segmented/unsegmented terminal link preferences is similar to Rachlin and Green's (1972) self-control paradigm, but with conditioned instead of food reinforcers. In that paradigm, subjects choose between a larger, more delayed reinforcer (the self-control choice) and a smaller, less delayed reinforcer (the impulsive choice). The unsegmented terminal link resembles the impulsive choice, in which a less-effective conditioned reinforcer (as it is correlated with less reduction in the delay to food reinforcement) is delivered immediately. The segmented terminal link resembles theself- control choice, in which a conditioned reinforcer correlated with greater reduction in the delay to food reinforcement is delivered after a delay from the terminal link onset. Using primary reinforcers, this procedure generally results in a preference for the impulsive choice in both nonhumans (for a review, see Logue, 1988) and humans (Kirk and Logue, 1997) alike. Two experiments comprised the present analysis of the segmentation effect. Because the Alessandri et al. findings were counter to much of the extant literature on the segmentation effect, it was of interest in Experiment 1 to attempt a replication using pigeons. Alessandri et al.'s results were not replicated, but the Experiment 1 results are consistent with both the general findings on segmentation and an interpretation based on the self-control analysis presented above. Experiment 2 then was conducted to further assess the utility of self-control as an account of preferences for unsegmented terminal links of concurrent chains schedules.

2. Experiment 1

This experiment was, procedurally, a systematic replication of Alessandri et al. (2010) with pigeons rather than humans. Using pigeons was of interest because the putative terminal reinforcer used by Alessandri et al. was somewhat atypical (access to preferred pictures) and it is not known whether it is functionally equivalent to more typical reinforcers like food in pigeons or money in humans (e.g., Leung, 1993).

2.1. Materials and methods

2.1.1. Subjects

Three male White Carneau pigeons were maintained at 80% of their free-feeding body weights by mixed grain obtained during the experimental session and provided by the experimenter immediately following the session. They were housed individually, with free access to water and health grit, in a colony room with a 12 h:12 h light:dark cycle. Each had a history of responding under a variety of reinforcement schedules.

2.1.2. Apparatus

Two plywood operant chambers for pigeons (30 cm long × 32 cm wide × 38 cm high) were used. The front wall was an aluminum panel with three 2-cm diameter Gerbrands Co. response keys, 9 cm apart (center to center) and with their lower edge 25 cm from the floor. The left and right keys were used and each was operated by a minimum force of 0.15 N and could be transilluminated white, red or green. General illumination was provided by a white houselight located in the lower right corner of the aluminum panel. A food hopper was located behind a 6 cm wide by 6.5 cm high rectangular aperture was located on the midline of the panel, with its base 8 cm from the floor. The aperture allowed access to mixed grain when the hopper was raised. A 28-V DC clear bulb illuminated the aperture and all other lights were dark during the 3-s presentations of the hopper that

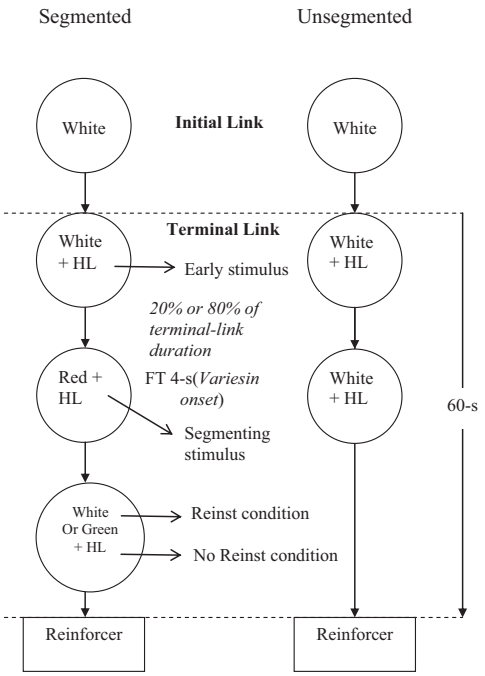

Fig. 1. Schematic diagram of the procedure in Experiment 1. The left portion of the figure shows the segmented terminal link and indicates the sequence of events when it was in effect following a response on the initial link key associated with this terminal link. The right portion shows the unsegmented schedule and indicates the sequence of events when a terminal link was entered following a reinforced response on the initial link key associated with this terminal link.

defined reinforcer deliveries (5 s for Pigeon 691). White noise and a ventilation fan in each chamber masked extraneous sounds. Programming of conditions and data recording were accomplished by using MED-PC® interfacing (MED Associates, Inc. & Tatham, 1991) and software and a microcomputer located in an adjacent room.

2.1.3. Procedure

Because subjects were experienced, training commenced immediately on the concurrent-chains schedule diagrammed in Fig. 1. During the initial link, the two side keys were transilluminated white and responding on either key occasionally produced the respective terminal-link schedule, correlated with illumination of the houselight, while the selected key remained white and the other key was darkened. A single variable-interval (VI) 30-s schedule was in effect on both response keys in the manner described by Stubbs and Pliskoff (1969). This procedure was used to ensure that the scheduled and obtained number of reinforcers for the two keys were identical. An initial-link response was reinforced by terminal link entry provided that (a) an interval selected from a VI 30-s schedule had elapsed; (b) the response was to the preselected key; and (c) a 2-s changeover delay (COD) was satisfied (i.e., at least 2-s had elapsed following a changeover to the side on which the terminal-link entry was arranged). For one alternative terminal-link responses were reinforced according to a tandem VI VI (unsegmented) schedule, and in the other alternative responses were reinforced according to a chained VI FT 4-s VI (segmented schedule). The sum of the different terminal-links values were equal to those of the tandem schedule on the other key. The mean overall terminal link duration was 60 s (based on 12 intervals ranging from 25-s to 150-s selected randomly without replacement). In the unsegmented terminal link, the same key color was present until reinforcement delivery (i.e., white + houselight). In the segmented terminal link, the key color changed from white to green (for Pigeon 567) or red (for Pigeons 691 and 775) for 4-s after 20%