

*TECHNICAL INFORMATION**REPRESENTING BEHAVIORAL STREAMS*

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Skinner argued that a unit of behavior be composed “of a response of identifiable form functionally related to one or more independent variables...” and that, “We are concerned... not only with the fact that certain specific forms of... behavior are observed but that they are observed under specific circumstances” (1992/1957, p.20-22). Glenn (2004)¹ suggests that the principle of operant selection requires a distinction between the unit of analysis (an operant) and instances of response that are part of this unit. The relation between these two levels of events is not simple;² both are behavioral events. One, the particular instance in a given circumstance, constitutes the other, the unit of analysis (or a response “lineage” in Glenn’s terminology) but, “they are two different kinds of things” (Glenn, 2004, p. 135). Identifying the unit of analysis therefore requires the identification of orderly relationships between response properties and environmental events. This, in turn, demands that the sequence of response instances and environmental events be described in a way that shows these relationships.

This report intends to present a simple and innovative way to describe behavior in some free-operant situations in which two different behaviors are simultaneously analyzed, for example, observing behavior and the behavior under control of the stimuli produced by the observing behavior – hereon called producing

behavior. In this situation it would be useful to simultaneously assess the observing response, the different stimuli produced by it, the producing response (controlled by these stimuli) and the stimuli produced as a consequence of this second response (the reinforcing stimulus).

Until now, all these events have typically been presented in experimental reports with a figure consisting of several parallel horizontal lines, with one or more lines for each listed event. For example, Mulvaney, Hughes, Jwaideh and Dinsmoor (1981) studied observing behavior on a behavioral task in which participants (children) could produce coins by pressing a key on a mixed schedule with alternating variable interval (VI) and extinction (EXT) components. Observing responses consisted of pressing a second key that “transformed” the mixed into a multiple schedule with the same components. The “transforming consequences” produced by observing responses were blue or red lights, that were correlated with one of the components of the multiple schedule. The lights were turned on while the observing key was pressed and both keys could be pressed at the same time. If the

¹Glenn’s formulation (2004) was a decisive influence on the present authors’ decision of publishing this paper. The term “stream” was borrowed from this formulation.

²Skinner (1936) emphasizes that “It has been point out that in the description of behavior two activities may be distinguished: the demonstration of certain correlations between parts of behavior and parts of the stimulating environment (which may be called reflexes) and the discovery of the laws governing their states. The second activity is often necessary for the first ...” (p.296).

The authors thank Dr. Maria Amalia Andery (Pontifícia Universidade Católica – São Paulo) and the editors for the careful reading.

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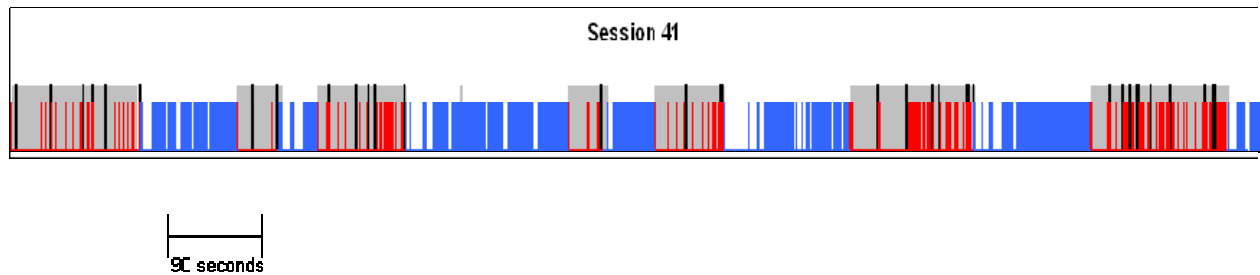


Figure 1

component changed during an observing response, the light color changed accordingly. To show their results, Mulvaney et al. (1981) constructed figures with four parallel horizontal lines that were read from left to right as timelines. Each line represented a different event. Displacements on the top line represented producing responses, displacements on the second line represented delivery of coins (reinforcements), displacements on the third line represented observing responses that produced the light related to the VI component, and finally displacements on the bottom line represented observing responses that produced the light related to the EXT component.

With the four lines together, one could simultaneously analyze both observing responses and producing responses. The top line made it possible to see the duration, frequency, and distribution of the producing response. The second line made it possible to determine the moments of reinforcement. Together, these first two lines made it possible to analyze the effect of reinforcement on the producing response. The two bottom lines showed the effects of the different light colors on the duration, frequency and distribution of the observing responses. Finally, the top and the two bottom lines showed the degree of control of the stimuli produced by the observing response.

The present report describes another figure that may be used to present data similar to those just described. With this figure, one may present the same kind of results, but one may also present more information about experimental events and the timing of those events.

To illustrate the possibilities of this new figure, data are presented from a systematic replication of Mulvaney et al. (1981) (Pessoa, 2005). Adults received points that accumulated on a counter display. Points were later exchanged for money. On a board attached to a wall, one key could be pressed for observing and another key could be pressed for producing points. Both keys could be pressed independently or together and as long as the observing key was pressed a red light would turn on during the VI components and a blue light would turn on during the EXT component. If components changed during an observing response the light color changed accordingly. Sessions lasted for approximately 20 min and were composed of seven VI and seven EXT components. Components alternated during the session and each lasted 90 s on average. Some participants were exposed to this experimental situation (a mixed schedule with the availability of observing response) without previous training on the multiple schedule. Figure 1 displays the results of the 41st session of one participant without the multiple-schedule training. The figure has four different colors and should be read from left to right as a timeline. Time is represented in seconds along the x-axis. Gray bars represent when producing responses were emitted. Black bars represent producing responses that were followed by points. Red bars represent observing responses emitted during VI components (therefore producing red keys) and blue bars represent observing responses emitted during EXT. Horizontal lines at the bottom of the figure indicate which component is in effect each moment: horizontal

	A	B	C	D	E	F	G	H
1		producing responses	reinforced producing responses	observing during VI	observing during EXT	VI component	EXT component	
2	0.1	1	0	0.75	0	0.05	0	
3	0.2	1	0	0.75	0	0.05	0	
4	0.3	1	0	0.75	0	0.05	0	
5	0.4	1	0	0.75	0	0.05	0	
6	0.5	1	0	0.75	0	0.05	0	
7	0.6	1	0	0.75	0	0.05	0	
8	0.7	1	0	0.75	0	0.05	0	
9	0.8	1	0	0.75	0	0.05	0	
10	0.9	1	0	0.75	0	0.05	0	
11	0.10	0	1	0.75	0	0.05	0	
12	0.11	1	0	0.75	0	0.05	0	
13	0.12	1	0	0.75	0	0.05	0	
14	0.13	1	0	0.75	0	0.05	0	
15	0.14	1	0	0.75	0	0.05	0	
16	0.15	1	0	0.75	0	0.05	0	
17	0.16	1	0	0.75	0	0.05	0	
18	0.17	1	0	0.75	0	0.05	0	
19	0.18	1	0	0.75	0	0.05	0	
20	0.19	1	0	0.75	0	0.05	0	
21	0.20	1	0	0.75	0	0.05	0	
22	0.21	1	0	0.75	0	0.05	0	
23	0.22	1	0	0.75	0	0.05	0	
24	0.23	1	0	0.75	0	0.05	0	
25	0.24	1	0	0.75	0	0.05	0	
26	0.25	1	0	0.75	0	0.05	0	
27	0.26	1	0	0.75	0	0.05	0	
28	
29								
30								
31								
32								
33								
34								

Figure 2

red lines indicate the VI component and blue horizontal lines indicate the EXT component

The figure is a histogram composed of a series of thin bars, each one representing the occurrence of one of the above events in an interval of 0.1 s. As several repetitions of the same event occur, the bars form a rectangular shape that represents the duration of the event (or the length of time of the event). The same information presented on the Mulvaney et al. (1981) figure is presented here, but this figure also shows information about the ongoing component moment by moment. The figure also shows whether the producing response was followed by reinforcement in the presence or in the absence of the discriminative stimulus. In addition, the figure shows events at the start of a component: in this example, at the beginning of each extinction component the participant paused. This control by the extinction stimulus was likely made possible by the emission of

observing responses at the beginning of the EXT components. It is also clear that observing responses were emitted during EXT near the end of the component and continued until responding produced the red (VI) stimulus light. With this type of figure various other interactions among producing responses, observing responses and the experimental contingencies could be analyzed.

It is easy to build the intended histogram with a standard electronic worksheet such as EXCEL.[®] The figure is constructed from a worksheet in which each event is plotted in a column that will be individually represented in the figure (Figure 2). In the given example six columns were used; four columns consisted of behavioral events (producing responses, producing responses followed by point delivery, observing responses during VI, and observing responses during EXT), and two columns consisted of the programmed contingencies (VI

and EXT components). Each row of the worksheet represented sequential interval units for the period of time described in the figure. The smaller the interval unit the more precise will be the measure of the duration of the event. In each cell of the worksheet, the occurrence or non-occurrence of an event (column) is marked for each unit of time (row). In the example given above each line was 0.1 s and the entire period of time described in the figure was a session of one participant (approximately 20 min).

Once the worksheet is prepared, it is necessary to fill in the data. To represent the occurrence of simultaneous events in the figure, different values should be assigned for each event that will later be represented in the figure by bars of different heights. In the present example it was necessary to allow for the representation of three different events at the same interval unit – a producing response, an observing response and the actual component. The number one was typed in for each unit of time (row) in which a producing response occurred (column); occurrences of observing responses were marked in each cell with 0.75; and the components were marked as 0.05. To show similar events that did not occur simultaneously (i.e., that would not overlap on the figure), the same number was used in the worksheet (and these events were later distinguished on the figure by different colors. For example, in Figure 2, the same number was used for producing responses and producing responses followed by delivery of points (1), the same number was used for observing responses during VI and during EXT (0.75), and for the two different components (0.05).

After the worksheet described above had been constructed and data entered, it was transformed into a standard bar graph in which each column of the worksheet is plotted as data series on the graph. Bar heights and colors can then be adjusted. Because events can be simultaneous, it is necessary to order the bars so that those with lower values appear in front and those with the higher values appear in the back. Colors must also be adjusted to differentiate non-simultaneous events. In Figure 1 the same

color was used for the horizontal bar indicating the component that was in effect and for observing responses emitted during this component. To improve the readability of the figure, bar borders have been omitted. It is better not to use any border for the bars because the number of bars is too large. Finally, events can be described in a figure caption and also shown on a figure legend.

The above example illustrates one of the several situations in which such a figure may provide an innovative description of behavior. The figure could be helpful in showing data from various other situations in which a behavioral stream needs to be represented, such as when a response can produce several different consequences. For example, such a figure could be used to present the tracking of eye movements or could be used to present verbal behavior.

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