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Duration, response, and location: The influence of upcoming 32% sucrose on rats' licking or lever pressing for 1% liquid sucrose

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Abstract

The present study investigated whether rats' rates of licking or pressing a lever for 1% liquid sucrose delivered by a continuous reinforcement schedule would decrease (contrast) or increase (induction) when the upcoming period would allow access to 32% sucrose and whether such changes would be influenced by how long each substance was available. In Experiment 1, different groups of rats licked a spout or pressed a lever for 1% sucrose in the first half of the session and, in different conditions, for 1% or 32% sucrose in the second half. Across conditions, halves of the session were 3, 6, 12, or 24 min long. Upcoming 32% sucrose significantly decreased rates of licking at each duration whereas it increased rates of lever pressing except when access duration was 3 min. Experiment 2 replicated Experiment 1 with the exception that rats that licked did so from the same spout in both halves of the session and rats that pressed a lever collected the sucrose reinforcers in the different halves at different locations. In these procedures, upcoming 32% sucrose significantly increased rates of licking. Significant, but small, increases in rates of lever pressing were still observed. The present results suggest that continuous reinforcement or duration of access to sucrose are not primary determinants of whether contrast or induction is observed. Rather, they suggest that the type of behavior (licking versus pressing a lever) and the location at which the substances are collected and consumed play a large role in which effect occurs.

Keywords: Anticipatory contrast; Positive induction; Continuous reinforcement; Lick; Lever press; Rat

King et al. (2002) reported that rats' behavior to obtain 1% liquid sucrose varied as a function of what substance would soon be available. Their findings were of interest because they demonstrated that the same upcoming substance could cause different changes in behavior. Rats' rate of consumption of 1% sucrose

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during a 3-min period decreased if 32% sucrose or food pellets would be available in the following 3-min period relative to when 1% sucrose would remain available. Alternatively, rats' rate of lever pressing to obtain 1% sucrose reinforcement delivered by an intermittent schedule of reinforcement during the first half of a 30-min session increased if 32% sucrose or food-pellet reinforcement would be available in the second half of the session relative to when 1% sucrose reinforcement would remain available. Intriguingly, these different changes in behavior were observed in the same rats.

The former effect, a decrease in consumption of a substance low in hedonic value (e.g., 1% sucrose) when a substance high in hedonic value will soon be available, is known as negative anticipatory contrast (Flaherty and Checke, 1982) and has been widely studied (see Flaherty, 1996, for a review). The latter effect, an increase in the rate of operant responding to obtain a reinforcer low in hedonic value when a reinforcer high in hedonic value will be available in the upcoming half of a session, is known as positive induction and has been reported in a series of recent studies (e.g., Weatherly and Moulton, 2001; Weatherly et al., 2002, 1999).

Although both effects have been reported previously, it is not clear why the same animals displayed the different effects when responding for the same substances. Weatherly et al. (2003b) noted that, although the procedures King et al. (2002) used to produce the different effects were similar to one another, they differed in at least three ways. First, one measured consummatory behavior whereas the other measured strictly operant behavior. Second, one required licking whereas the other required pressing a lever. Third, one provided 1% sucrose for every response whereas the other provided 1% sucrose on an intermittent schedule of reinforcement. Weatherly et al. (2003b) argued that any of these procedural differences could potentially account for why different effects were observed.

To test which aspect of the procedure determined which effect occurred, Weatherly et al. (2003b) had rats either lick or lever press for 1% sucrose reinforcers delivered in the first half of a 30-min session. Both responses were operant (i.e., only licks made to obtain, and not to consume, the sucrose were analyzed). Across conditions, the reinforcer in the second half of the session was either 1% or 32% liquid sucrose. Furthermore, across conditions, the rate of reinforcement in both halves varied from high (a random-interval (RI) 7.5-s schedule) to low (a RI 60-s schedule). Results indicated that upcoming 32% sucrose produced either no change (Experiment 1) or a decrease (Experiment 2) in operant rates of licking in the first half of the session. On the other hand, upcoming 32% sucrose always produced an increase in operant rates of lever pressing. Because the dependent measure for both groups was operant behavior and because the rate at which the substances were available varied across conditions, these data suggested that the type of response (i.e., licking versus lever pressing) was a key factor in which effect emerged.

Weatherly et al.'s (2003b) findings do not, however, definitively rule out the possibility that the frequency of substance availability plays a role in whether contrast or induction is observed. Their procedure varied how often the substances were available, from very to not very often, but the substances were never continuously available. This fact may be important because, in studies of anticipatory contrast, each lick results in the obtainment of the substance. It is thus possible that contrast would have been observed for rats that lever pressed for reinforcement if the sucrose reinforcers had been delivered by a continuous reinforcement (CRF) schedule.

Weatherly et al.'s (2003b) study also did not address another difference in the two procedures employed by King et al. (2002). Studies designed to produce negative anticipatory contrast typically give the subject brief opportunities to consume each substance. King et al., in fact, measured consummatory behavior in successive 3-min periods. Procedures designed to produce positive induction have typically measured responding in different halves of a relatively long session. Both King et al. (2002) and Weatherly et al. (2003b), for instance, reported finding induction when rats pressed a lever during 30-min sessions.

The literature on contrast effects suggests that duration of access the substances influences whether contrast is observed. For instance, Flaherty et al. (1996) found that the size of anticipatory contrast was largest when access durations were 2–3 min. The size of contrast decreased as access time increased (e.g., 10 min). Research on negative behavioral contrast (Reynolds, 1961), an effect similar to anticipatory contrast observed for operant responding on multiple schedules of reinforcement, has also shown that the size of contrast decreases with increases in component duration (see McSweeney and Weatherly, 1998, for a review). Thus,