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Failure to Obtain Instrumental Successive Negative Contrast in Tasks that Support Consummatory Successive Negative Contrast

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In four experiments (three in operant chambers, one in a runway) with food-deprived rats, we sought to obtain instrumental successive negative contrast (iSNC) and consummatory successive negative contrast (cSNC) following shifts in the value of liquid rewards. Despite finding robust cSNC in each of the four experiments, there was no indication of iSNC in any of the measured instrumental responses (pressing a lever, licking an empty spout, or time to traverse a runway). Consistent with the literature, these results might be taken to suggest that iSNC cannot be obtained following a downshift in liquid reward value. However, behaviors observed in the downshifted rats suggests that the absence of iSNC might be due to the occurrence of competing responses or nonoptimal test conditions. Thus, the failure to observe iSNC in rats that show cSNC is interpreted as a failure of performance.

Animals experiencing an unexpected shift from a high to a low value reward exhibit a decrease in performance to a level significantly below that of animals accustomed to the low value reward throughout the experiment. The behavioral effect caused by a surprising reward reduction is termed successive negative contrast (SNC; for comprehensive reviews see Flaherty, 1982, 1996). SNC can be further differentiated in terms of behavior types. If the performance decrease occurs to behavior involved in the procurement of the reward, it is characterized as instrumental SNC (iSNC; e.g., Crespi, 1942; Elliot, 1928; Tinklepaugh, 1928); if the performance decrease occurs to behavior directly involved in the ingestion of the reward, it is called consummatory SNC (cSNC; Flaherty & Hamilton, 1971; Riley & Dunlap, 1979; Vogel, Mikulka & Spear, 1968).

An immediate issue arises concerning whether the occurrence of cSNC is necessary for the occurrence of iSNC. Although it is intuitively appealing to suppose that iSNC is predicated upon the prior occurrence of cSNC, there is surprisingly little evidence that addresses this question. Accordingly, the present study sought to determine if iSNC occurs in animals that display cSNC. Furthermore, the availability of a procedure that supports both iSNC and cSNC will prompt work to examine whether the neural mechanisms underlying these phenomena operate independently or not. That is, do brain lesions that disrupt cSNC (e.g., Reilly & Trifunovic, 1999, 2003) also disrupt iSNC?

Although it is well established that a decrease in consummatory behavior can be reliably elicited by a reduction in the concentration of a liquid reward (Flaherty, 1996), the parallel effects on instrumental behavior are overwhelmingly negative (Flaherty, 1982). Flaherty and Caprio (1976), for example, found that a decrease of liquid sucrose reward from 32% to 4% produced cSNC but not iSNC in a runway. Other failures to obtain iSNC following a downshift in liquid reward

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value include Barnes and Tombaugh (1973), Collier, Knarr, and Marx (1961), Flaherty, Riley, and Spear (1973), Goodrich and Zaretsky (1961), Homzie and Ross (1962), Rosen (1966), Rosen and Ison (1965), and Spear (1965). Of further interest, Burns, Dupree, and Lorig (1978) demonstrated that iSNC occurs in a runway following a reduction in the number of sucrose pellets (8 to 2), but not following a reduction in the concentration of sucrose solution (30% to 3%).

There are, of course, numerous examples of iSNC in runway performance following an unexpected reduction in the number of food pellets (e.g., Capaldi & Singh, 1973; Crespi, 1942; DiLollo & Beez, 1966; Flaherty, Coppotelli, Hsu, & Otto, 1998; Gonzalez, Gleitman, & Bitterman, 1962; Salinas, Packard, & McGaugh, 1993). In these studies, running speeds in the shifted group decreased to a level significantly lower than that of the unshifted group following a reward downshift. A distinct disadvantage of using solid food reward is that consummatory behavior is difficult to monitor and quantify. One simple way around this problem involves the use of a liquid reward, with licking serving as the dependent measure. As noted above, few studies have adopted this approach with success in the runway. However, Weinstein (1970a) reported a significant iSNC when liquid rewards were used in a lever-pressing task. Specifically, rats in the experimental group received 9 preshift sessions of fixed ratio 1 (FR1) training, each lever press obtaining 2 s access to 16% sucrose from a retractable drinking tube. This was followed by 4 postshift sessions in which 4% sucrose was available after each lever press. The control group received 13 sessions of FR1 training with 4% sucrose. The dependent measure, mean lever presses per minute, was computed as the total number of lever presses in the session (including those recorded during the reward access periods) divided by session duration. A significant iSNC effect was found on the first two postshift sessions. Unfortunately, sucrose intake was not monitored in this experiment. In two subsequent studies (Weinstein, 1970b, 1978), the iSNC effect was replicated following a reward downshift from 16% to 4% sucrose and obtained when saccharin concentration was shifted from 0.10% to 1.5%, 1.2% to 0.1%, and 1.2% to 0.01%. An FR1 schedule was used in all these experiments, except Experiment 2 of the Weinstein (1970b) study when iSNC was obtained following a shift in saccharin reward value (0.10% to 1.5%) on an FR7 schedule. Although fluid intake was recorded, no cSNC data were reported in these 2 studies. It might be noted that these experiments each involved 30 or 40 rewards (i.e., maximally 60 or 80 s access to sucrose) per session. While it is not possible to draw any conclusions with certainty concerning the relationship between iSNC and cSNC from the results of these experiments, Weinstein's studies provided a starting point for the present research.

In our initial experiments, we used downshifts in sucrose concentration (16% or 32% to 4%) and varied response requirement (FR1, FR7, FR10) and reward access time (2, 3, 4, 5 s). The dependent measure in the FR1 experiments was lever press latency. When the response requirement was greater than 1, lever press rate was also recorded. In all of these experiments, we monitored lick latency, lick rate per s, and total licks for the liquid rewards (30 per session). None of these experiments found iSNC. Moreover, rats in the experimental groups continued to lick at high rates following reward downshift. Thus, cSNC effects were not observed either. Hypothesizing that the brevity of the reward access periods might be undermining our efforts to obtain cSNC, we extended the access duration to 30 s per

trial while reducing the number of rewards to 10 per sessions. Thus, comparable with the standard cSNC design, the rewards were available for 300 s per session. Furthermore, we started using 1.0 M sucrose and 0.15% saccharin, a combination that supports a cSNC effect of greater longevity than the transient effects that typically occurs in food deprived rats following a downshift in sucrose concentration (Flaherty, 1996; Reilly & Trifunovic, 1999, 2003). Using a FR1 schedule, our first experiment with these reward parameters produced cSNC but not iSNC.

In the present series of experiments, we sought to induce iSNC and cSNC at the same time by manipulating the required instrumental behavior and reward type. In Experiment 1, subjects were required to press a lever on an FR5 schedule for 0.15% saccharin or 1.0 M sucrose. Because lever pressing is a response that requires shaping, which inevitably affects variance in performance, in Experiment 2 we shifted the required instrumental response from lever pressing to licking an empty spout (which requires no shaping) on the same FR5 schedule for the same rewards as used in Experiment 1. However, some rats failed to respond for saccharin in the first 2 experiments. To minimize this problem, in Experiment 3 we substituted 0.15% saccharin with 0.12 M sucrose, which more consistently supports operant responding. Finally, in Experiment 4, a different instrumental behavior and apparatus was employed. That is, we sought to obtain iSNC and cSNC following a downshift in liquid reward value (1.0 M to 0.12 M sucrose) in a runway, an apparatus that is typically used in iSNC experiments with solid food rewards. Since these experiments were concerned with the co-occurrence of iSNC and cSNC, postshift training continued until the cSNC effect dissipated (i.e., five sessions in Experiments 1 and 2, three sessions in Experiments 3 and 4).

Method

Subjects

Experimentally naive male Sprague-Dawley rats were obtained from the breeding colony maintained in the Department of Psychology at the University of Illinois at Chicago. The animals were individually housed in stainless steel hanging cages in a vivarium maintained on a 12:12 h light: dark cycle (lights on at 07:00 h). Water was continuously available in the home cage. All behavioral testing was performed during the light phase of the cycle.

Apparatus

In Experiments 1-3, the rats were trained in one of 6 identical modular test chambers (Med Associates, St. Albans, VT), measuring 30 cm X 24 cm X 29 cm (long X wide X high). The chambers had clear Plexiglas front and back walls, the triple-channel sidewalls were made of aluminum, and the ceilings of Plexiglas. Each chamber was equipped with a retractable reward spout (located in the center channel of the right side wall) and an instrumental manipulandum (mounted in the right channel). In Experiment 1, the manipulandum was a retractable lever. In Experiments 2 and 3 the lever was replaced with an empty sipper tube. The reward spout and the empty instrumental tube could enter the chamber through rounded access holes (1.3 cm wide X 2.6 cm high). In the extended position, the tip of each tube was aligned in the center of the hole, approximately 1 cm outside the sidewall to prevent constant contact. A lickometer circuit was used to monitor licking. A shaded bulb, which reflected light off the ceiling, was located 2 cm below the ceiling and directly above the cage speaker in the center channel on the left sidewall. Each chamber was housed in a light- and sound-attenuating cubicle that was fitted with a ventilation fan and white noise source providing a background noise level of 70 dB(A). Isolated in a separate room, a modular runway (Med Associates), 275 cm X 9 cm X 18 cm (long X wide X high), was used in Experiment 4. The runway included a start box (46 cm), separated from the runway by a manually operated aluminum guillotine door, a runway (183 cm), and a goal box (46 cm). The goal box was equipped with a retractable sipper tube

of the type described above. The time to traverse the runway (from exit of the start box to the sipper tube) was detected by interruption of infrared photobeams mounted 1.9 cm above the floor. For each type of apparatus, control of events and collection of the data were carried out on-line by computers using programs written in the Medstate notation language (Med Associates).

Procedure

Experiment 1. Twenty-four male Sprague-Dawley rats were food deprived and maintained at 85% of their *ad libitum* body weights (400 g) by a once per day feeding given at least 30-min after any experimental manipulations scheduled for that day. The subjects were randomly assigned into one of two groups (HL or LL) according to the solution (H, 1.0 M sucrose; L, 0.15% saccharin) that they would receive in each of the two phases of the experiment. In this and the other 3 experiments, solutions (weight/volume) were prepared using laboratory grade sucrose or sodium saccharin dissolved in room temperature water purified through reverse osmosis and micro filtration. Pretraining consisted of sipper tube training followed by lever press training, each conducted with the solution that would be used during the preshift, phase 1 sessions of the experiment. To reduce the influence of neophobia on subsequent performance, rats initially were given access to ~5.0 ml of H or L on their home cage. At the start of each session in the operant chamber, the houselight was illuminated and remained on throughout the session until it was turned off at the end of the session. On the first 2 sessions of sipper tube training, rats were allowed 500 licks for H or L. On the next 3 sessions, 30 s trials of access to H or L were programmed on a variable time 60 s schedule. Ten trials were given during this and all subsequent sessions. Lever training began the next day. In all sessions, the lever was extended into the chamber when the houselight was turned on and it remained extended until the session terminated. During the first 4 sessions, rats were required to press the lever once (FR1) to obtain 30 s access to H or L. On each of the next 5 sessions the ratio requirement was increased to 3 (i.e., FR 3). In the preshift phase of the experiment proper, rats in Group HL received 6 sessions during which 5 lever presses (i.e., FR5) earned 30 s access to H. During the postshift phase, the rats were switched to L for a 5 further sessions of FR 5 training. The rats in the Group LL were given 11 sessions of training with L. Four rats in Group LL failed out of the experiment during pretraining.

Experiment 2. The type and number of subjects used, body weights and food deprivation schedule were identical to those described above in Experiment 1. Similarly, the procedure of Experiment 2 was identical in all respects to that of Experiment 1, except the lever was replaced with an empty sipper tube and 1 session of FR1 and 1 session of FR 3 instrumental licking were given prior to FR5 training. Five rats in Group LL were excluded from the experiment due to failures to complete pretraining.

Experiment 3. Twenty-two male Sprague-Dawley rats (ad libitum body weights 350 g) were used in this experiment. Other than the use of 0.12 M sucrose (which, unlike saccharin, contains calories) as the L solution and a reduction to 3 postshift sessions, Experiment 3 training was identical to that of Experiment 2.

Experiment 4. Eighteen male Sprague-Dawley rats were food deprived and maintained at 80% of their ad libitum body weights (350 g) by a once per day feeding given at least 30-min after runway training. The food deprivation schedule and runway procedure were modeled after an experiment in which an iSNC effect was obtained following a shift in the number (10 to 1) of food pellets (Sastre & Reilly, 2005). The experiment began following two days of sipper tube training with H (1.0 M sucrose) or L (0.12 M sucrose) according to group assignment. Six preshift sessions and three postshift sessions were run. There were 6 trials each session and a fixed time 30 s intertrial interval. As in the earlier experiments, 30 s access to H or L was permitted on each trial. One rat was excluded from Group HL for failure to perform in the runway.

Data Analysis

In each experiment, an analysis of variance (ANOVA) was conducted on data obtained from the final preshift session together with data from all postshift sessions (5 or 3 depending on the experiment). If needed, post hoc analyses were conducted with the Newman Kuels test. The alpha level was set a $p = 0.05$.

Results

Experiment 1

As is evident from inspection of the graphs in Figure 1, an iSNC effect was not obtained following the shift from H (1.0 M sucrose) to L (0.15% saccharin) despite the occurrence of a large cSNC effect. As described below, statistical analyses confirmed these impressions of the data. For lever press latency there was a significant main effect of group, $F(1, 18) = 20.20$, $p < 0.001$, a significant main effect of sessions, $F(5, 90) = 5.45$, $p < 0.001$, but no Group X Sessions interaction ($F < 1$). The main effect of group indicates that over the final 6 sessions the control subjects (LL; $n = 8$) consistently displayed longer latencies (~30 s) than the experiment rats (HL; $n = 12$). The main effect of sessions indicates that for both groups latencies increased across these sessions. Although the lever response rate of the HL rats declined following the downshift in reward value, it never fell below that of the LL subjects. Unsurprisingly, then, post hoc analysis of the significant Group X Sessions interaction, $F(5, 90) = 6.67$, $p < 0.001$, revealed that the HL rats responded at a significantly faster rate than the LL subjects on final preshift session (session 6; $p < 0.05$) and on the first postshift session (session 7; $p < 0.05$). However, for the final 4 postshift sessions the between-group rates of lever pressing were indistinguishable ($ps > 0.30$). In terms of consummatory responding, a highly significant Group X Sessions interactions, $F(5, 90) = 36.61$, $p < 0.001$, was obtained. Demonstrating the occurrence of an absolute value of reward effect, HL rats licked more for H than LL subjects did for L ($p < 0.05$) on the final preshift session. As evidence of a cSNC effect, the performance of the HL rats precipitously declined, falling by more than 1000 licks, in the first postshift session ($p < 0.05$). The significant underresponding continued through the next three sessions ($ps < 0.05$). By session 11, however, both groups were licking at the same frequency for saccharin ($p > 0.05$). Thus, despite the occurrence of cSNC, an effect that was sustained for 4 postshift sessions, there was no suggestion of iSNC. Rather, the lever response rate of the HL rats adjusted downwards to match that of the unshifted control subjects whereas lever latency was insensitive to the reward downshift.

Experiment 2

Switching to instrumental licking on an empty tube had the desired effect of reducing the preshift performance difference between the groups. However, despite the similarity of the instrumental and consummatory responses, iSNC did not emerge (see Figure 2). Thus, as indicated by a significant main effect of group, $F(1, 17) = 31.85$, $p < 0.001$, and the absence of a significant main effect of sessions or Group X Sessions interaction (both $F < 1$), latency to initiate instrumental responding in the two groups was stable and consistently different (8-10 s) across sessions 6-11. Post hoc analysis of the significant Group X Sessions interaction, $F(5, 85) = 4.20$, $p < 0.01$, revealed that the instrumental lick run rate for HL rats ($n = 12$) was significantly faster than that of the LL rats ($n = 7$) on the final preshift session ($p < 0.05$). After the reward downshift, however, there were no significant between-group differences in instrumental licking ($ps > 0.06$). Finally, for con-

summatory responding, the HL rats licked significantly more on session 6 ($p < 0.05$) and significantly less frequently on each of the 5 postshift sessions ($ps < 0.05$) than the LL rats. Once again, then, despite the occurrence of robust cSNC, iSNC was notably absent.

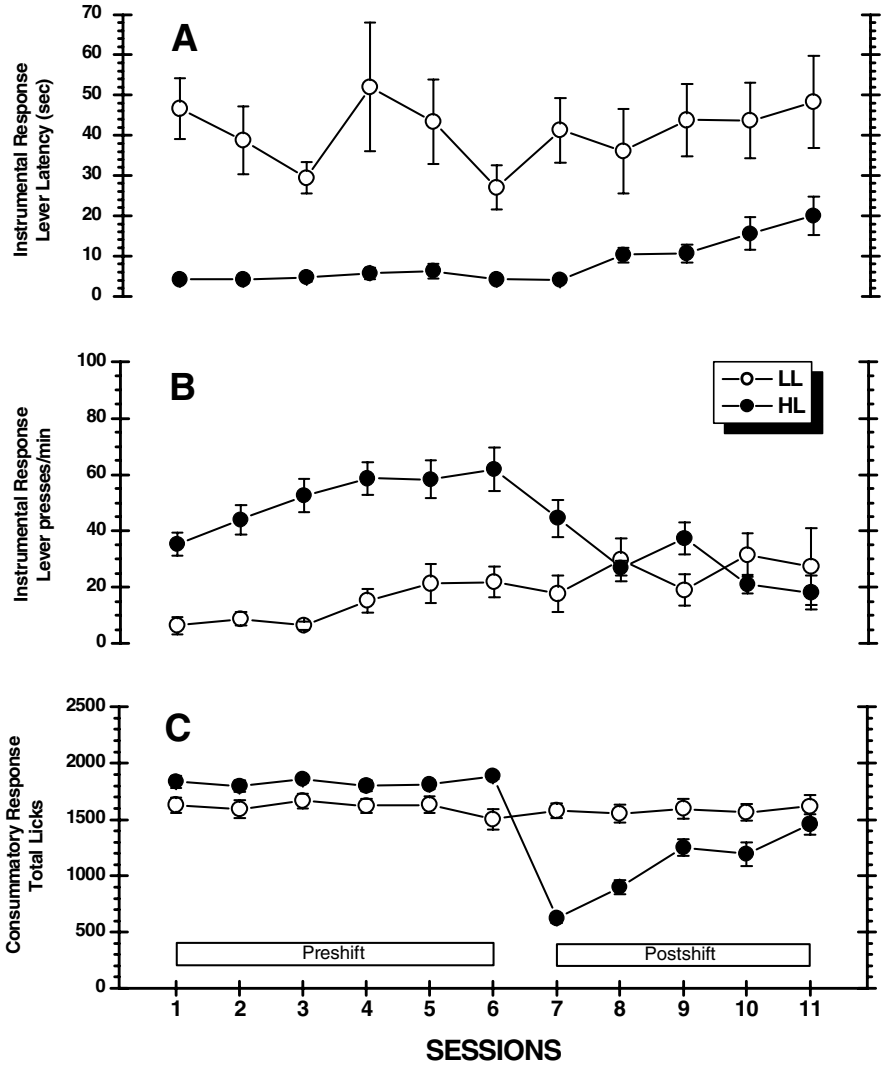

Figure 1. Mean (± SE) instrumental lever press latency (panel A), lever pressing rate (panel B), and consummatory licks (panel C) during preshift and postshift phases of each session for the HL group and LL group in Experiment 1. The LL group received 0.15% saccharin in each session. The HL group received 1.0 M sucrose during the preshift phase and 0.15% saccharin during the postshift phase.

Experiment 3

As expected, using 0.12 M sucrose as the L reward further reduced the between-group preshift performance differences. This change did not, however, lead to the occurrence of iSNC. For latency to the first instrumental lick, there was a significant main effect of group, $F(1, 20) = 7.26$, $p < 0.05$, but no main effect of

sessions (p > 0.05) and no Group X Sessions interaction ($F < 1$). Similarly, analysis of the instrumental lick run rate revealed a significant main effect of group, $F(1, 20) = 9.11$, $p < 0.05$, but no main effect of sessions ($p > 0.12$) or Group X Sessions interaction ($p > 0.15$). Analysis of consummatory responding confirmed a significant Group X Sessions interaction, $F(3, 60) = 34.56$, $p < 0.05$. Although the HL rats ($n = 11$) consistently licked more frequently than the LL subjects ($n = 11$) during the preshift sessions, post hoc analysis found no significant difference between the groups on the final session of that stage ($p > 0.05$). There was, however, a substantial reduction in the lick frequency of the HL rats on the first postshift session ($p < 0.05$). This cSNC dissipated rapidly such that there were no between-group differences in licking for L over the final 2 sessions of the experiment ($ps > 0.05$).

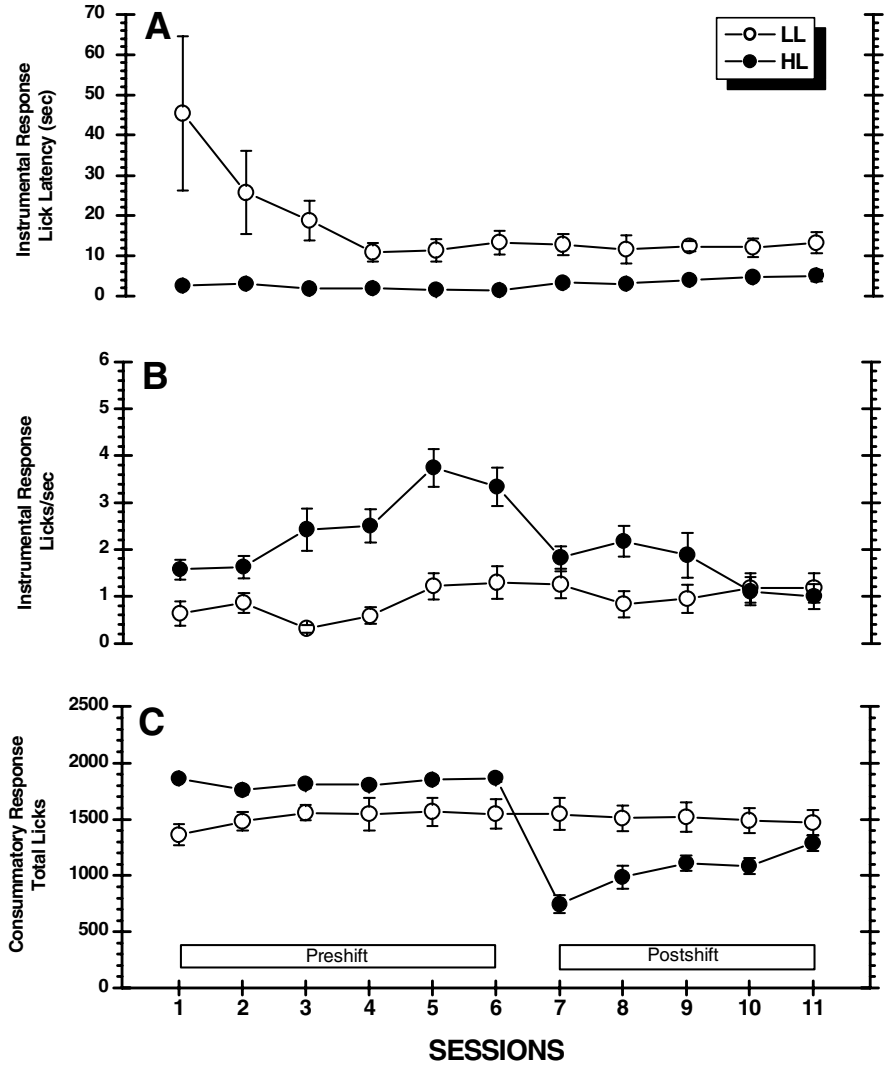

Figure 2. Mean (± SE) instrumental lick latency (panel A), instrumental licking rate (panel B), and consummatory licks (panel C) during preshift and postshift phases of each session for the HL shifted group and LL group in Experiment 2. The LL group received 0.15% saccharin in each session. The HL group received 1.0 M sucrose during the preshift phase and 0.15% saccharin during the postshift phase.

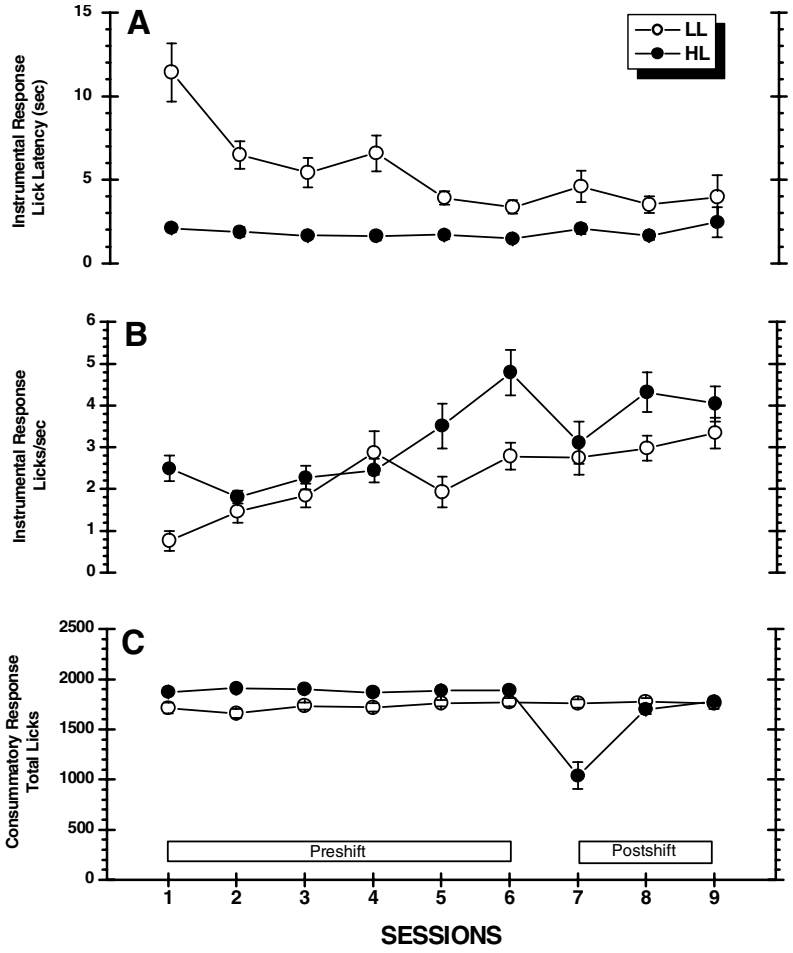

Figure 3. Mean (± SE) instrumental lick latency (panel A), instrumental licking rate (panel B), and consummatory licks (panel C) during preshift and postshift phases of each session for the HL group and LL group in Experiment 3. The LL group received 0.12 M sucrose in each session. The HL group received 1.0 M sucrose during the preshift phase and 0.12 M sucrose during the postshift phase.

Based on an observation during the postshift phase of Experiment 2, an additional dependent measure was collected in Experiment 3. Specifically, we monitored the number of licks on the instrumental (empty) spout following the first lick on the reward spout (see Table 1). These licks on the instrumental manipulandum might be considered noncontingent in the sense that the FR requirement had been completed and the reward spout was available. An ANOVA conducted on the data summarized in the table found a significant Group X Sessions interaction, $F(3, 60) = 33.72$, $p < 0.001$. For Group LL, post hoc analysis found no significant between-session differences in performance (ps > 0.05). Similarly, there were no between-group differences on sessions 6, 8 and 9 (ps > 0.05). However, on session 7 the HL rats showed a substantial and significant elevation of noncontingent instrumental licks relative to the LL rats on that session and to their own performance on the preceding and following sessions (ps < 0.05). Thus, on the first, and only, postshift session on which a significant cSNC effect was obtained, the HL rats, while underresponding on the reward spout, were found to be

returning to, and licking, the instrumental spout during the reward access periods. Furthermore, for the HL rats, a Spearman's correlation revealed that the number of licks on the reward spout on session 7 was inversely related to the number of noncontingent licks on the instrumental spout (r = -0.89; $p < 0.001$). That is, the fewer the reward licks the greater the number of noncontingent instrumental licks.

Table 1
During the Reward Access Periods on the Final Preshift Session (6) and the Three Postshift Sessions (7–9), Mean (±SE) Number of Noncontingent Responses on the Instrumental (Empty) Spout Following the First Lick on the Reward Spout.

	Sessions			
Group	6	7	8	9
LL	1.09 ±1.09	2.36 ±1.32	4.27 ±2.24	0.18 ±0.12
HL	0.36 ±0.36	168.1 ±28.09	21.45 ±8.99	4.82 ±2.91

Experiment 4

During the preshift sessions, the HL rats (n = 8) not only licked more frequently than the LL rats (n = 9) for their respective rewards, they also ran more quickly from the startbox to the sipper tube (see Figure 4). By both dependent measures, then, absolute reward value effects were evident. However, whereas lick frequency showed a marked cSNC effect, there was no suggestion of an iSNC effect in run time. More specifically, post hoc analysis of the significant Group X Sessions interaction, $F(3, 45) = 4.29$, $p < 0.05$, revealed a group difference in run time during the final preshift session ($p < 0.05$) but no differences on the three postshift sessions (ps > 0.45). With regard to licking, although group differences were clear over the initial preshift sessions, a ceiling effect in licking for 1.0 M sucrose reduced the magnitude of the intergroup difference over the final 4 preshift sessions. Thus, post hoc analysis of the significant Group X Sessions interaction, $F(3, 45) = 24.02$, $p < 0.001$, found no significant between-group difference on the final preshift session ($p > 0.30$). Nonetheless, cSNC was obtained on the first and second postshift sessions ($p < 0.05$), an effect that dissipated by the final session ($p > 0.45$).

Discussion

Why is iSNC so elusive following a reduction in the value of a liquid reward? The experiments of the present study examined this question by seeking evidence of the co-occurrence of iSNC and cSNC. None of the results could be considered successful, however. In the first three experiments, suddenly decreasing the reward value did cause a reduction in response rate on the instrumental manipulanda (lever or empty tube) within the HL group, but only to a level equal to the performance of the LL rats. Similarly, in Experiment 4, the decreased run times induced by the unexpected shift of sucrose concentration were not slower than the

baseline performance of the LL group. In each of the 4 experiments, however, significant cSNC was obtained.

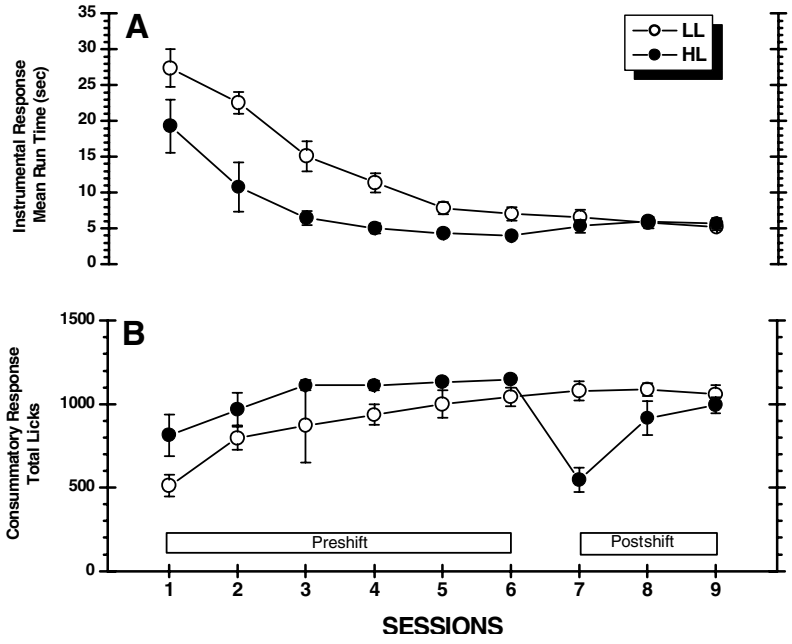

Figure 4. Mean (± SE) instrumental run time (panel A) and total consummatory licks (panel B) during preshift and postshift phases of each session for the HL group and LL group in Experiment 4. The LL group received 0.12 M sucrose in each session. The HL group received 1.0 M sucrose during the preshift phase and 0.12 M sucrose during the postshift phase.

To our knowledge, only three studies have reported significant iSNC when using liquid rewards in an operant chamber (Weinstein 1970a, 1970b, 1978). In the five SNC experiments reported in these three studies, food and water deprived rats pressed a lever (FR1 or FR7) to obtain brief (2 s) access to liquid rewards. These positive results encouraged the view that it might be possible to obtain iSNC and cSNC in the same experiment, thereby providing the opportunity to clarify the relationship between these two phenomena. As noted in the Introduction, in our initial attempts to replicate Weinstein's results relatively small variations in procedure were involved. None of these preliminary experiments found iSNC or cSNC. However, as demonstrated in the present experiments, following a switch to 30 s reward access periods, cSNC was consistently obtained. The rats in all of our experiments were food deprived whereas Weinstein used food and water deprivation. It seems improbable, but perhaps not impossible, that the occurrence of iSNC is predicated upon the use of the more severe deprivation conditions employed by Weinstein. Indeed, there is some evidence that water deprivation can, in certain situations (e.g., fear conditioning), augment learning (for further discussion see Maren, DiCola, & Fanselow, 1994; Maren & Fanselow, 1998). On the other hand, it is easy to suppose that the occurrence of cSNC for liquid rewards might be antagonized by the need for water in rats that are fluid and food deprived. Thus, despite a number of reasonable attempts, we are unable to obtain iSNC following a downshift in concentration of liquid reward.

We have no ready explanation for our consistent failures to replicate

Weinstein's results. However, we do have some speculations concerning the absence of iSNC in Experiments 1-3. In our procedure (as in Weinstein's), the instrumental manipulandum (be it a lever or an empty spout) remained extended into the test chamber when the reward spout became available. During the preshift sessions, the rats in both groups, having completed the instrumental response requirement, quickly moved to the reward spout where they remained licking until that spout was retracted after 30 s access. However, as shown in Experiment 3, a different pattern of behavior emerged during the first postshift session when the HL rats displayed cSNC. That is, the HL rats, having made contact with the unexpected low value reward, returned to the instrumental manipulandum and licked the empty spout despite the availability of the reward spout. These noncontingent instrumental responses may be due to increased behavioral arousal or frustration consequent to the unexpected reward downshift (see, for example, Amsel, 1992; Papini, 2003; Papini & Dudley, 1997). Alternatively, they may be comparable to the search behaviors that other investigators have observed when animals stop making contact with the substitute reward (e.g., Elliott, 1928; Flaherty, Powell & Hamilton, 1979; Pecoraro, Timberlake & Tinsley, 1999; Pellegrini & Mustaca, 2000; Tinklepaugh, 1928). For both noncontingent instrumental responses and search behaviors, the detection of the unexpected and, at least temporarily, unwanted low value reward triggers a switch from consummatory responding to situationally relevant behaviors that would, if successful, recover the missing high value reward. Furthermore, in the present experiments in the operant chamber, the occurrence of noncontingent instrumental responses may be incompatible with expression of an iSNC effect. If this analysis has merit, then procedural changes that prevent the occurrence, or reduce the influence, of noncontingent instrumental responses might benefit expression of iSNC. For example, removal of the instrumental manipulandum coupled with the use of an intertrial interval or, perhaps, training and testing animals with a procedure that involves only a single trial per session may aid detection of iSNC. The possibilities are currently under investigation in our laboratory.

Unquantified observations during the runway procedure of Experiment 4, suggested that the HL rats on the first postshift session tended to retreat back down the runway to the start box (the goal box had no door) following contact with the low value reward. Such behaviors were not displayed by the LL rats. Interestingly, retreat behaviors were not observed in the HL rats of a recently completed experiment in our laboratory that involved the same apparatus and iSNC procedure, except for the use of food pellets (Sastre & Reilly, 2005). The between experiment differences in the behavior of the downshifted rats serves to highlight a subtle and, while the experiments were being conducted, unappreciated methodological issue. In the solid food experiment, each rat was removed from the runway when it consumed the reward that, for the HL group during the downshifted sessions, was fairly brief in duration since only 1 pellet was available. However, for the liquid reward experiment, irrespective of the concentration of the sucrose solution, the rat was removed from the runway when the 30 s access period terminated. Thus, despite the use of the same apparatus and same procedure, inherent differences are present in terms of the time the two types of reward are available and the quantity of the downshifted reward that was consumed (all, in the case of solid food, or a subtotal amount, in the case of liquid food when cSNC occurs). While it would

seem that little could be done to match feeding times, it should be possible to ensure that liquid reward rats consumed all their food before removal from the runway. For example, the rats could be required to lick a fixed number of times per trial (with cSNC defined in terms of lick rate). Furthermore, as noted above with regard to the operant chamber experiments, reducing the number of trials per session to one also may benefit the occurrence of iSNC in the runway.

Despite the occurrence of cSNC in each of the 4 experiments of the present report, we consistently failed to obtain iSNC with liquid rewards (see also Flaherty & Caprio, 1976). Although this may suggest that independent sets of mechanisms are responsible for iSNC and cSNC (Flaherty et al., 1998; Leszczuk & Flaherty, 2000), examination of the results provided reasons to believe that iSNC might be obtained with liquid rewards following some procedural manipulations. This optimism reflects commitment to the view that, whether cSNC is observed or not (as is the case with solid food reward), iSNC is keyed off the detection of the unexpected low value reward. The fact that cSNC typically is not measured when solid food is used as the reward in iSNC tasks, clearly should not be viewed as a failure by the animal to detect the reward disparity. If no discriminable reduction in the value of the reward were detected then iSNC would not occur. As evidenced by the occurrence of cSNC, the rats in the present experiments obviously perceived the downshift in reward value. Thus, rather than an indication of a genuine dissociation between iSNC and cSNC, we favor an interpretation of the results that emphasizes a failure of performance.

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