

## Self-Control and Impulsiveness in Adult Humans: Comparison of Qualitatively Different Consumable Reinforcers Using a New Methodology

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**Abstract** Self-control can be defined as the choice of a larger, more delayed reinforcer over a smaller, less delayed reinforcer, and impulsiveness as the opposite. Previous experiments have shown that type or quality of reinforcer used affects self-control in humans. The purpose of the present series of experiments was to investigate the effects of qualitatively different reinforcers on the self-control of adult human females. Specifically, in a within-subjects design, participants made choices for two consumable-type reinforcers: food (preferred fruit juice) and video entertainment (preferred cartoon). A new methodology, designed to be similar to the self-control paradigm for delivering food, was used for the delivery of the cartoon. With the contingencies used, a significant difference in self-control for the two reinforcers was found. In addition, self-control and rating for food declined within the sessions; however, there were no declines for video reinforcers. The results are discussed with respect to satiation and habituation, and their implications for previous research findings of differences in self-control as a function of reinforcer differences.

**Keywords** Self-control · Impulsiveness · Choice · Reinforcers · Adults · Cartoon · Food

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Some of the data reported were presented at the meeting for the Association for Behavior Analysis International in Seattle, May 2012.

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Self-control has been defined as the choice of a larger, more delayed reinforcer over a smaller, less delayed reinforcer. Impulsiveness has been defined as the opposite (Ainslie 1974; Logue 1988; Rachlin and Green 1972). A number of factors have been shown to affect self-control demonstrated by adult humans. These factors include: manipulation of amount, delay, and rate of reinforcement (Logue et al. 1990), preference for the reinforcer (Forzano and Logue 1995; Forzano et al. 1997), sensitivity to amount and delay (Forzano et al. 1997; Logue et al. 1992), dieting status of the participant (Forzano and Logue 1992; Logue and King 1991), deprivation levels (Forzano et al. 2010; Kirk and Logue 1997), presence of cues (Forzano et al. 2010; Forzano and Corry 1998), use of different methods of reinforcer delivery (Forzano and Logue 1994; Logue and King 1990), and manipulation of time of receipt of reinforcement (Forzano and Logue 1994; Hyten et al. 1994).

In particular, previous research, using various methodologies, has shown that the type or quality of reinforcer used affects self-control in adult humans (Forzano and Logue 1994, 1995; Odum and Rainaud 2003; Takahashi et al. 2008). For example, previous research has shown that participants tend to exhibit exclusive self-control when points exchangeable for money are used as the reinforcer (Logue et al. 1990, 1986). However, when food is used as a reinforcer, participants demonstrate significantly more impulsiveness relative to when monetary-based reinforcers are used (Forzano and Logue 1994), and increased individual variation ranges between exclusive self-control and exclusive impulsiveness (Forzano and Logue 1992).

Specifically, in the Forzano and Logue (1994) experiment, food, a primary (unconditioned) reinforcer (Mazur 2002), was available to be consumed *during* each of the experimental trials. In other conditions, points exchangeable for money, which represents a secondary, or conditioned, reinforcer [i.e., a neutral stimulus that has been repeatedly paired with a

primary reinforcer (Mazur 2002)], were available. Further, with points exchangeable for money, the receipt of the reinforcement was *deferred* to the end of the experimental session, after an exchange delay (Hyten et al. 1994). Therefore, there were three differences between the two reinforcers: the reinforcer type or quality (food and money), how the reinforcer was conditioned (primary or secondary), and the time of reinforcer receipt (consumed during the experimental trials or following an exchange delay).

Further, the Forzano and Logue (1994) experiment explored these parameters and their relationship to participants' self-control choices. This was done by adding a third condition in which participants made choices to earn points exchangeable for juice. Participants showed greater self-control when they earned points for juice to be consumed at the end of the session (after an exchange delay) than when the juice was available to be consumed during the experimental trials. This result suggests that the original differences demonstrated in self-control for food versus money were due to the time of delivery of the reinforcer (during the experimental trials versus deferred to the end of the session) and not to the type of reinforcer per se (Forzano and Logue 1994).

Research using hypothetical delay-discounting procedures has also compared reinforcers. For example, Odum and Rainaud (2003) demonstrated that preferences for food, alcohol, and money decrease in a hyperbolic fashion as time of receipt is delayed. The discounting for food and alcohol (primary reinforcers) decayed more steeply than for money (a secondary reinforcer), suggesting that both time to receipt and reinforcer type (primary vs. secondary) affect impulsivity. Charlton and Fantino (2008) compared five different reinforcers, categorized by six characteristics: primary (vs. secondary) reinforcer, perishable, satiable, direct function (no exchange or manipulation is needed before consumption), immediate consumption (reinforcer may be consumed immediately upon the choice), and metabolic function (reinforcers that are metabolically processed). It was found that favorite food was discounted more quickly than DVDs. According to the theory presented by Charlton and Fantino (2008), this difference would be explained by one of the following three characteristic differences: perishability, satiability, and metabolic function.

The overall goal of the present series of experiments was to continue the exploration of comparing types of reinforcers that vary along different dimensions. More specifically, the purpose was to compare the proportions of self-control demonstrated for two different consumable or primary reinforcers (video cartoon and juice) in a within-subjects design. In the current experiments, both of the reinforcers were consumed during the experimental trials, with no difference in the time of delivery of the reinforcer. However, one of the reinforcers was ingested (juice), while the other was

watched and listened to (video cartoon). In addition to comparing choice for different reinforcers over the entire session, trial-by-trial comparisons of choice and rating of reinforcers were examined as well.

To accomplish this overall goal, a contemporary procedure to deliver a non-food consumable reinforcer in a self-control paradigm, identical to the delivery of food during the experimental trials (i.e., having no exchange delay), was developed. This procedure was also developed, with an eye towards developing a new methodology that in the future could be utilized with participants of different ages. Previous research comparing self-control in adults and young children of various ages (see for example, Tobin and Logue 1994) are limited in that procedural parameters across the age groups have varied, hence offering alternative explanations for any apparent differences observed. Therefore, reduction of trial length, number of trials, and delays, was done from Experiments 1 through 6, resulting in procedural parameters that closely approximate those typically used in self-control experiments with young children (Forzano and Logue 1995; Forzano et al. 2011, 2003; Logue et al. 1992, 1996). The SC Video Software (Forzano and Schunk 2008) allowed participants to make choices that provided access to a longer segment of a video cartoon after a longer delay (the self-control alternative), or a shorter segment accessible after a shorter delay (the impulsive alternative).

Viewing a video cartoon and video game playing has been considered a consumable, or intrinsic reinforcer, like food (Millar and Navarick 1984; Navarick 1996). "An intrinsic reinforcer may be operationally defined as a stimulus that reinforces behavior in a particular setting in the absence of a backup reinforcer" (Navarick 1996, pp. 551–552). Similarly, as stated by Millar and Navarick (1984, pp. 204–205), "... video game playing is at least partially intrinsically reinforcing. To that extent, playing a video game functions as a primary reinforcer, thereby strengthening the analogy to eating and drinking in animals." Neither food, nor audio or visual entertainment (video cartoon) requires a backup reinforcer to be reinforcing, so we refer to these reinforcers as intrinsic, or primary or consumable. Previous studies have explored self-control using various forms of video entertainment for reinforcement, including playing video games, viewing celebrity photos, viewing animated cartoons, viewing video programs, and viewing cartoon characters (Darcheville et al. 1992; Hackenberg and Pietras 2000; Millar and Navarick 1984; Navarick 1998; Sorama and Ito 2012; Sorama et al. 2007; Sorama et al. 2010). For example, in an experiment in which participants made choices to earn access to animated cartoons, Navarick (1998) found that when the duration of the small immediate reinforcer was relatively small (10 seconds of cartoon access), participants tended to choose the delayed option and viewed more of the cartoon. However, when the amount of the small reinforcer was increased to 15 seconds,

the participants fell into two clear groups, those who consistently demonstrated self-control, and those who consistently demonstrated impulsiveness. Similar bi-modal results have been found with food consumed during the experimental session (Forzano and Logue 1992; Logue and King 1991).

A prediction concerning the results was that a significant difference would be demonstrated between the self-control for food and that for video cartoon. This finding may be due to one or several factors. The first is the physiological reinforcing nature of food (which is metabolic) versus that of video cartoon (which provides audio and visual reinforcement). This finding would also support the explanation proposed in other of experiments that participants are more impulsive for food because of physiological cephalic phase reflexes (Forzano and Logue 1992). Other explanations for a significant difference between self-control for juice and video cartoon could be individual preferences for the two reinforcers (Forzano and Logue 1995; Forzano et al. 1997), differences in perishability, satiability, and metabolic function (see Charlton and Fantino 2008; Takahashi et al. 2008), and possible differences in habituation to the reinforcers (McSweeney 2004).

## Method

### Overview

There was a series of six experiments with a total of 57 participants. Experiment 1 exposed ten participants to three sessions in which juice was the reinforcer available during the session, and three additional sessions in which video cartoons were available as reinforcers during the session. Experiment 1 included 19 3-minute trials and the contingencies (both delay and amount) were equal for juice and video cartoon. Experiment 2, with ten participants, was identical to Experiment 1, except that the amounts of video cartoon were increased from 3 seconds to 6 seconds (for the impulsive choice) and from 9 seconds to 18 seconds (for the self-control choice). Experiment 3, conducted with 11 participants, was identical to Experiments 1 and 2, except that the amounts of video cartoon were further increased to 8 seconds (for the impulsive choice) and 24 seconds (for the self-control choice). Delays to receipt of reinforcers were identical in all three experiments. Experiment 4, conducted with eight participants, was identical to Experiment 2, except that the trial time was decreased to 1.5 minutes. Experiment 5, conducted with ten participants, was identical to Experiment 4 except that the number of trials was decreased to 14. Experiment 6, conducted with eight participants, was identical to Experiment 5 except that the delay was decreased from 60 seconds to 30 seconds (for the self-control choice).

### Participants

The participants were 57 females, ranging in age from 18 to 26 years. All participants were self-reported non-dieters, and none were psychology majors. All were recruited through advertisements posted on campus, were experimentally naïve, and were students at the College at Brockport, State University of New York. During phone screening, each caller chose her favorite fruit juice and favorite video cartoon from a list of choices, and chose a number in answer to the question, "On a scale from 1 to 9, 1 being 'not at all,' and 9 being 'extremely,' how much do you like (the selected) juice?" or "(the selected) cartoon?" Both ratings had to be 6 or higher in order for the caller to participate. The selected juice and cartoon were used for that participant for the duration of the experiment. Informed consent was obtained from each participant. Participants were paid \$7.00 per session and received juice and video entertainment in return for their participation. Participants were instructed to refrain from eating, drinking, exercising, and from watching TV, DVDs, videos, and on-line entertainment for at least 4 hours prior to their scheduled sessions.

### Apparatus

The experiment was conducted in a 2.15 m by 2.26 m windowless room that contained a chair and two tables. On the larger table, facing the chair, was the juice apparatus shown in Fig. 1. It is a wooden box, 79.5 cm high, 78.5 cm wide, and

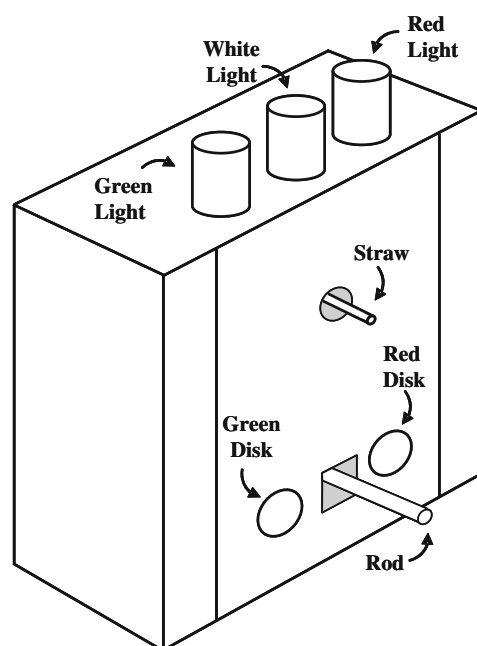


Fig. 1 Juice apparatus

53.5 cm deep, and open in the back. The apparatus used was identical to that used in many previous experiments (e.g., Forzano et al. 2010; Forzano and Corry 1998). Behind the table with the apparatus was a white noise generator to help to mask extraneous sounds. A Gateway computer, located in a separate room, controlled the apparatus and recorded responses using a CONMAN program (Lucas 1988). Responses recorded during a session were printed out on an attached printer.

For sessions in which a video cartoon was used as the reinforcer, participants used a Dell (Optiplex GX260) desktop computer with a Dell Ultrasharp 15 inch flat screen monitor, located on the other table in the same small room that contained the juice apparatus. Control of experimental stimuli and recording of responses was accomplished with the SC Video Software (Forzano and Schunk 2008). The choice interface was a screen that mimicked the front panel of the food apparatus, as depicted in Fig. 2. Participants made choices using a mouse, by clicking on either the red disk or the green disk. After the chosen delay time, the video cartoon would come up on a full screen and play for the appropriate amount of time. Then the choice screen would return. Responses recorded during each session were printed out on an attached printer.

#### Procedure

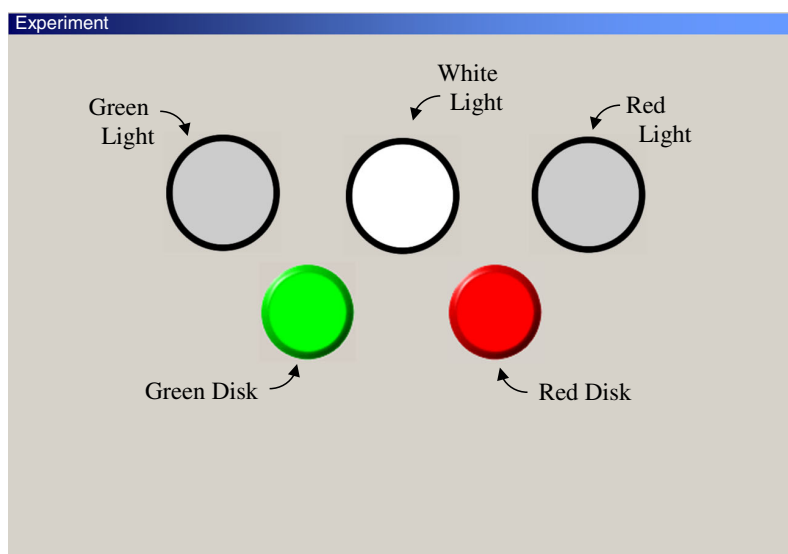
Each participant was exposed to two conditions: juice and cartoon, in a within-subjects design. Each participant completed six sessions: two training sessions (i.e., sessions 1 and 4) and four experimental sessions (i.e., sessions 2, 3, 5, and 6). Participants were randomly assigned to one of four orders of conditions. Those in Orders 1 and 3 completed three juice

sessions and then three cartoon sessions, while those in Orders 2 and 4 completed three cartoon sessions before completing the three juice sessions. In all cases, the first of the three sessions for each reinforcer was a training session in which the contingencies on the left and right sides (rod push direction for juice or click on left or right disk for cartoon) were equal. After this initial session, for those in Orders 1 and 2, in the next session the self-control side was on the left, and then on the right for the final sessions. For Orders 3 and 4, the self-control choice was on the right for the session following the training session, and then on the left for the last of the three sessions. See Table 1 for a list of the conditions. Note that Table 1 presents conditions in the Order 1 sequence.

At the beginning of each session, participants completed a questionnaire that instructed the participant to list everything they ate and drank that day, the type and amount of any exercise done that day, and the name and amount of any television viewing, DVDs or videos watched, or entertainment viewed online so far that day. This was to ensure that they had been deprived of all of these reinforcers for approximately 4 hours prior to the session.

Participants were asked to remove all jewelry and were asked to turn off and leave any electronic devices, such as cell phones or iPods. They were then told that they would be going to another room, and were taken into the experimental room by the experimenter. They were given no directions except to read a set of minimal instructions. The instructions were posted on the wall in the experimental room for juice sessions, and were displayed on the computer screen used for cartoon sessions when the participant sat down (see Appendix A).

**Fig. 2** Video screen



**Table 1** Order 1 conditions

Session #	Condition		
	Reinforcer Type	Condition Type	Self-Control Side
1	Juice	Training	
2	Juice	Experimental	Left
3	Juice	Experimental	Right
4	Cartoon	Training	
5	Cartoon	Experimental	Left
6	Cartoon	Experimental	Right

Each session consisted of 19 trials for Experiments 1 through 4, and 14 trials for Experiments 5 and 6, which were all scheduled using a discrete-trials procedure (for use of identical procedure with adults, see for example, Forzano et al. 2010; Forzano and Logue 1992; Kirk and Logue 1997; Logue and King 1991). The inter-trial interval varied in duration such that the reinforcer access period was kept constant at one reinforcer per access period (i.e., 3-minute trial time for Experiments 1 through 3, and 1.5-minute trial time for Experiments 4 through 6), regardless of the participants' choices. Therefore, session time remained constant at 57 minutes for Experiments 1 through 3, 28.5 minutes for Experiment 4, and 21 minutes for Experiments 5 and 6. The contingencies for each session are shown in Table 2. Note that Table 2 presents the conditions of the experiment for Experiment 1 for Order 1. For a complete list of the contingencies for each of the sessions for each experiment, see Table 3.

The first four trials of each 19-trial and 14-trial session were forced-choice trials (only one alternative was available

**Table 2** Conditions of experiment (Experiment 1, Order 1)

Session	Left Response		Right Response	
	Delay	Amount	Delay	Amount
Juice as Reinforcer				
Training Session				
1	6	6	6	6
Experimental Sessions				
2	60	9	1	3
3	1	3	60	9
Cartoon as Reinforcer				
Training Session				
4	6	6	6	6
Experimental Sessions				
5	60	9	1	3
6	1	3	60	9

*Note.* The values for amount and delay represent time in seconds

and effective). The forced-trials ensure that the participants were exposed to the contingencies for both left and right rod pushes. The remaining 15 trials for Experiments 1 through 4 and ten trials for Experiments 5 and 6 were free-choice trials for which both response alternatives were available (see Forzano et al. 2010; Forzano and Corry 1998 for identical trial procedure for juice apparatus).

At the beginning of a free-choice trial with the juice apparatus, the white house light was lit and the left and right disks were illuminated green and red. If the rod was pushed to the left, the white house light and both disks were darkened, the green house light was lit, and a reinforcer delay period began. This was followed by the amount period of access to the straw (i.e., the straw protruded through the front of the apparatus, which allowed the participant to suck and drink juice from the straw). Following the amount period, the white house light was again illuminated and an inter-trial interval began. The next choice period began when both disk lights were again illuminated. The sequence of events following a right rod push was similar, except that a red house light was used. The sequence of events for forced-choice trials was the same, except that only one disk was illuminated and only a response in that direction was effective.

At the beginning of a free-choice trial with the video program, the white light was lit, as well as the green and red disks. If the green disk on the left side was clicked on, the white light and both disks darkened, the green light lit up, and a reinforcer delay period began. This was followed by the amount period of access to the cartoon (i.e., the cartoon began to play for the participant to watch). Following the amount period, the white light was again illuminated and an inter-trial interval began. The sequence of events following a click on the red disk on the right side was similar except that the red light became lit. The sequence of events for forced-choice trials was the same except only one disk was lit, and only a response on that side was effective.

During the trials, participants also completed a satiation questionnaire. Specifically, at the beginning of each session, and after every time they received the reinforcer, participants selected a number from 1—*not at all* to 9—*extremely* to rate how much they wanted to drink the juice or watch the cartoon. After completing the 19 trials for Experiments 1 through 4 and the 14 trials for Experiments 5 and 6, the participant was escorted out of the experimental room and asked to complete the Final Study Questionnaire (see Appendix B), on which they responded to questions comparing their experiences with the reinforcers.

## Results

All analyses were performed using the data from the free-choice trials for each of the experimental conditions (Sessions

**Table 3** Contingencies for experimental sessions

Experiment Number	Number of Trials	Trial Time	Juice		Cartoon	
			Amount <sup>a</sup> (seconds)	Delay <sup>b</sup> (seconds)	Amount <sup>a</sup> (seconds)	Delay <sup>b</sup> (seconds)
1	19	3 min	3/9	1/60	3/9	1/60
2	19	3 min	3/9	1/60	6/18	1/60
3	19	3 min	3/9	1/60	8/24	1/60
4	19	1.5 min	3/9	1/60	6/18	1/60
5	14	1.5 min	3/9	1/60	6/18	1/60
6	14	1.5 min	3/9	1/30	6/18	1/30

<sup>a</sup> 3/9 indicates 3 s of reinforcer on left side and 9 s of reinforcer on right side

<sup>b</sup> 1/60 indicates 1 s of delay on left side and 60s of delay on right side

2, 3, 5, and 6). There were no significant differences in proportion of self-control demonstrated between sessions in which the self-control choice was on the left and those in which the self-control choice was on the right for the juice sessions,  $t(56)=1.081$ ,  $p=0.284$ ,  $d=0.137$ , or for the cartoon sessions,  $t(56)=0.023$ ,  $p=0.981$ ,  $d=0.004$ . In other words, there were no statistically significant position or color biases. Therefore, for all further analyses, the left and right data were combined for each reinforcer. Hence, the proportion of self-control responses (i.e., number of free-choice self-control responses divided by 15 free-choice trials) was averaged across sessions 2 and 3 and sessions 4 and 5.

A  $4 \times 6$  mixed design ANOVA was performed with order and experiment numbers as the between-subjects independent variables and proportion of self-control in the juice condition as the within-subjects dependent variable. There was no significant main effect of order or of experiment, and no significant two-way interaction. An identical analysis, with proportion of self-control in the cartoon condition as the within-subjects dependent variable, yielded identical results.

Table 4 displays self-control proportions for each participant and mean of self-control proportion for the juice and the cartoon conditions. The relationship between proportion of self-control for juice versus cartoon was addressed in a  $4 \times 6 \times 2$  ANOVA, with order and experiment numbers as the between-subjects independent variables and proportion of self-control in the juice and cartoon conditions as the within-subjects repeated dependent variable. There was a significant main effect of reinforcer,  $F(1, 33)=15.376$ ,  $p=0.000$ ,  $\eta^2=0.318$ . There was no significant main effect of order or of experiment, and no significant two-way or three-way interactions were found. Because no effects of order or experiment were found, data were collapsed across order and experiment for all further analysis. Figure 3 shows the means for the proportion of self-control for each reinforcer. It indicates that the self-control proportion for the cartoon was significantly higher than that for the juice. The relationship between proportion of self-control control for juice and cartoon was also assessed as a

correlation,  $r(55)=0.409$ ,  $p=0.002$ , suggesting a positive significant relationship between the two reinforcers.

For all experiments, to examine changes in self-control over time during a session, self-control as a function of blocks of trials was analyzed. Figure 4a shows the means for the proportion of self-control for free-choice trials 1–5 and 6–10 (i.e., block 1 and 2) for each reinforcer. Only two blocks were compared for these analyses, because all experiments have a minimum of two blocks. A  $2 \times 2$  repeated-measures ANOVA was conducted, with proportion of self-control for the two different reinforcers in the two blocks as the dependent variable. There was a significant main effect of reinforcer,  $F(1, 56)=10.226$ ,  $p=0.002$ ,  $\eta^2=0.154$ . There was no main effect of block. There was a significant interaction between reinforcer and block,  $F(1, 56)=5.953$ ,  $p=0.018$ ,  $\eta^2=0.096$ . Post-hoc tests revealed a significant difference between proportion of self-control for juice and proportion of self-control for cartoon in block 1,  $t(56)=2.107$ ,  $p=0.040$ ,  $d=0.312$ , and block 2,  $t(56)=3.640$ ,  $p=0.001$ ,  $d=0.542$ . For juice, there was a significant difference in proportion of self-control between block 1 and block 2,  $t(56)=2.931$ ,  $p=0.005$ ,  $d=0.266$ . But for cartoon, there was no significant difference in proportion of self-control between block 1 and block 2.

For Experiments 1–4, all of which had three blocks of trials, self-control as a function of three blocks of trials was analyzed. Figure 4b shows the means for the proportion of self-control for each third of the session (block; free-choice trials 1–5, 6–10, and 11–15), for each reinforcer. A  $2 \times 3$  repeated-measures ANOVA was conducted, with proportion of self-control for the two different reinforcers in the three blocks as the dependent variable. There was a main effect of reinforcer,  $F(1, 38)=4.914$ ,  $p=0.033$ ,  $\eta^2=0.115$ . There was a main effect of block,  $F(1, 38)=8.208$ ,  $p=0.007$ ,  $\eta^2=0.178$ . There was a significant interaction between reinforcer and block,  $F(1, 38)=5.907$ ,  $p=0.020$ ,  $\eta^2=0.135$ . Post-hoc tests revealed no significant difference between proportion of self-control for juice and proportion of self-control for cartoon in block 1, but there was a significant difference in block 2,  $t(38)=2.378$ ,  $p=0.023$ ,  $d=0.475$  and block 3,  $t(38)=2.551$ ,  $p=0.015$ ,  $d=0.521$ . For juice, there was a significant

**Table 4** Proportion of self-control in juice and cartoon conditions for each participant

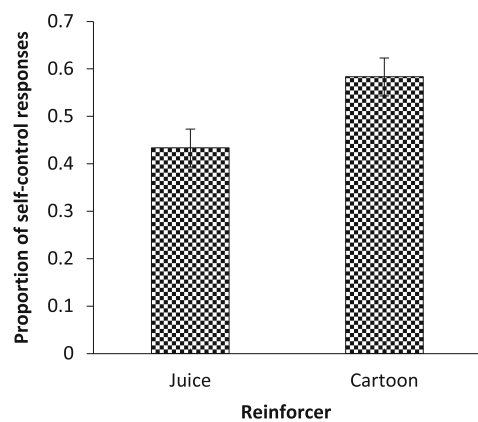
	Participant Number	Order	Proportion of Self-Control		
			Juice	Cartoon	
Experiment 1	2	2	0.67	0.87	
	3	1	0.10	0.47	
	4	2	0.37	0.07	
	5	3	0.47	0.13	
	6	4	0.70	0.90	
	7	3	0.80	0.60	
	8	1	0.37	0.93	
	9	4	0.53	0.47	
	32	2	0.33	0.57	
	33	3	0.20	0.23	
Experiment 2	11	2	0.07	0.87	
	12	3	0.37	0.47	
	13	4	0.30	0.90	
	14	1	0.43	0.67	
	15	1	0.57	0.47	
	16	2	0.50	0.47	
	19	3	0.03	0.03	
	21	4	0.57	0.80	
	35	1	0.60	0.50	
	43	1	0.47	0.40	
	Experiment 3	22	1	0.07	0.13
		23	2	0.27	0.47
		24	3	0.63	0.07
		26	1	0.73	0.93
		27	2	0.10	0.47
29		4	1.00	0.27	
30		4	0.33	1.00	
31		3	0.17	0.20	
37		2	0.40	0.17	
40		4	0.83	0.50	
42		4	0.43	0.70	
Experiment 4		45	2	0.70	0.93
		47	4	0.97	0.87
	48	1	0.50	0.77	
	49	1	0.57	0.90	
	50	2	0.03	0.97	
	51	3	0.60	0.90	
	54	4	0.67	0.83	
	55	3	0.13	0.47	
	Experiment 5	57	2	0.53	0.85
		58	3	0.78	0.85
59		4	1.00	0.75	
60		1	0.53	0.90	
62		3	0.98	0.95	
63		4	0.00	0.00	
64		1	0.10	0.85	

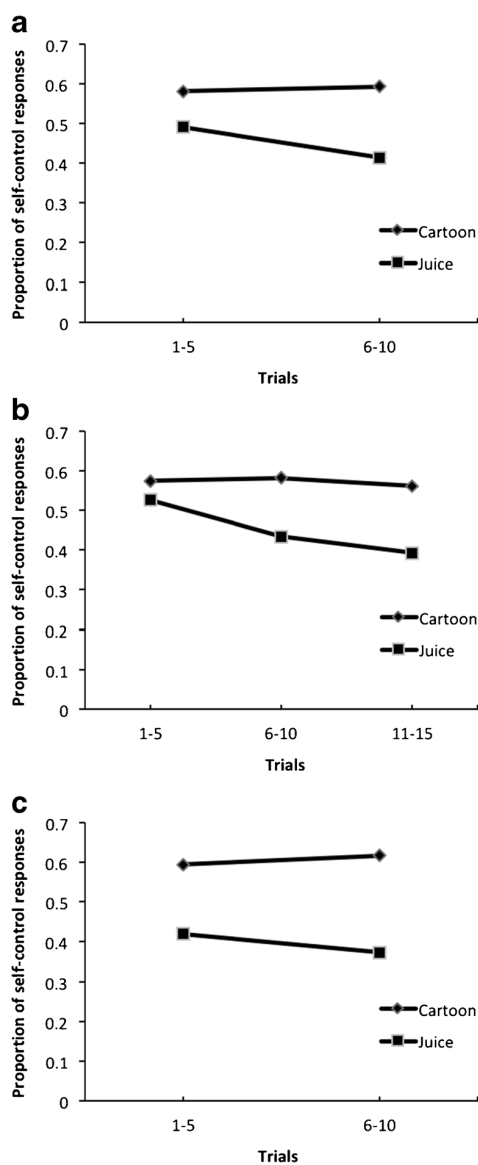
**Table 4** (continued)

	Participant Number	Order	Proportion of Self-Control	
			Juice	Cartoon
	66	2	0.80	0.85
	67	1	0.13	0.00
	68	3	0.13	0.60
Experiment 6	72	1	0.33	0.75
	73	2	0.40	0.50
	74	3	0.00	0.05
	75	4	0.00	0.10
	76	1	0.25	0.90
	77	2	0.60	0.80
	78	3	0.33	0.75
	79	4	0.28	0.45
M			0.43	0.58
SE			0.04	0.04

difference in proportion of self-control between block 1 and block 2,  $t(38)=2.496$ ,  $p=0.017$ ,  $d=0.336$ , and between block 1 and block 3,  $t(38)=3.120$ ,  $p=0.003$ ,  $d=0.459$ , but there was no significant difference between block 2 and block 3. For cartoon, there was no significant difference in proportion of self-control between block 1 and block 2, between block 1 and block 3, and between block 2 and block 3.

For Experiments 5 and 6, all of which had only two blocks of trials, self-control as a function of two blocks of trials was analyzed. Figure 4c shows the means for the proportion of self-control for free-choice trials 1–5 and 6–10 (i.e., block 1 and 2) for each reinforcer. A  $2 \times 2$  repeated-measures ANOVA was conducted, with proportion of self-control for the two different reinforcers in the two blocks as the dependent variable. There was a main effect of reinforcer,  $F(1, 17)=11.156$ ,  $p=0.004$ ,  $\eta^2=0.398$ . There was no main effect of block and no

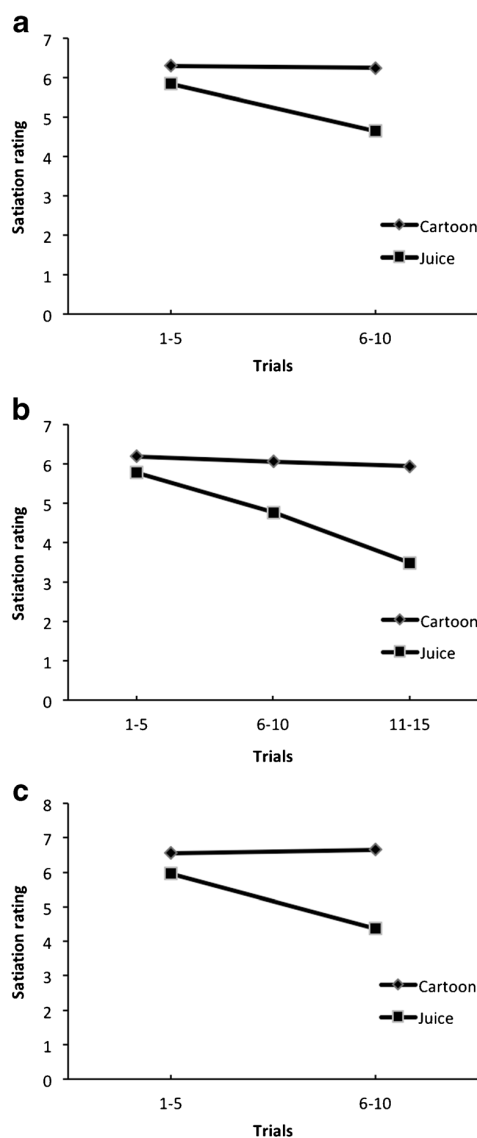
**Fig. 3** Means for the proportion of self-control responses for each experimental condition



**Fig. 4** Means for the proportion of self-control responses for each experimental condition, for **a**) each Trials 1–5 and 6–10 (for Experiments 1–6), **b**) Trials 1–5, 6–10, and 11–15 (for Experiments 1–4), and **c**) Trials 1–5 and 6–10 (for Experiments 5 and 6), respectively

significant interaction between reinforcer and block. Post-hoc tests revealed a significant difference between proportion of self-control for juice and proportion of self-control for cartoon in block 1,  $t(17)=2.653$ ,  $p=0.017$ ,  $d=0.550$ , and block 2,  $t(17)=3.183$ ,  $p=0.005$ ,  $d=0.657$ . For juice, there was no significant difference in proportion of self-control between block 1 and block 2. Also for cartoon, there was no significant difference in proportion of self-control between block 1 and block 2.

For all experiments, to examine satiation over time during a session, satiation ratings as a function of blocks of trials were



**Fig. 5** Means for the satiation ratings for each experimental condition, for **a**) each Trials 1–5 and 6–10 (for Experiments 1–6), **b**) Trials 1–5, 6–10, and 11–15 (for Experiments 1–4), and **c**) Trials 1–5 and 6–10 (for Experiments 5 and 6), respectively

analyzed. Figure 5a shows the means for the satiation ratings for free-choice trials 1–5 and 6–10 (i.e., block 1 and 2) for each reinforcer. Only two blocks were compared for these analyses because all experiments have a minimum two blocks. A  $2 \times 2$  repeated-measures ANOVA was conducted, with satiation ratings for the two different reinforcers in the two blocks as the dependent variable. There was a main effect of reinforcer,  $F(1, 56)=17.608$ ,  $p=0.000$ ,  $\eta^2=0.239$ . There was a main effect of block,  $F(1, 56)=29.905$ ,  $p=0.000$ ,  $\eta^2=0.239$ . There was a significant interaction between reinforcer and block,  $F(1, 56)=47.895$ ,  $p=0.000$ ,  $\eta^2=0.461$ . Post-hoc tests



revealed no significant difference between proportion of self-control for juice and proportion of self-control for cartoon in block 1, but there was a significant difference between satiation ratings for juice and proportion of self-control for cartoon in block 2,  $t(56)=5.643$ ,  $p=0.000$ ,  $d=0.984$ . For juice, there was a significant difference in satiation ratings between block 1 and block 2,  $t(56)=7.520$ ,  $p=0.000$ ,  $d=0.742$ . But for cartoon, there was no significant difference in satiation ratings between block 1 and block 2.

For Experiments 1-4, all of which had three blocks of trials, satiation ratings as a function of three blocks of trials were analyzed. Figure 5b shows the means for the satiation ratings during free-choice trials 1-5, 6-10, and 11-15 for each reinforcer. A  $2 \times 3$  repeated-measures ANOVA was conducted with satiation ratings for the two different reinforcers in the three blocks as the dependent variable. There was a main effect of reinforcer,  $F(1, 38)=20.240$ ,  $p=0.000$ ,  $\eta^2=0.348$ . There was a main effect of block,  $F(1, 38)=35.051$ ,  $p=0.000$ ,  $\eta^2=0.480$ . There was a significant interaction between reinforcer and block,  $F(1, 38)=53.978$ ,  $p=0.000$ ,  $\eta^2=0.587$ . Post-hoc tests revealed no significant difference between satiation ratings for juice and satiation ratings for cartoon in block 1, but there was a significant difference in block 2,  $t(38)=3.766$ ,  $p=0.001$ ,  $d=0.781$  and block 3,  $t(38)=7.291$ ,  $p=0.000$ ,  $d=1.346$ . For juice, there was a significant difference in satiation ratings between block 1 and block 2,  $t(38)=6.504$ ,  $p=0.000$ ,  $d=0.623$ , between block 1 and block 3,  $t(38)=8.527$ ,  $p=0.000$ ,  $d=1.352$ , and between block 2 and block 3,  $t(38)=7.674$ ,  $p=0.000$ ,  $d=0.732$ . But, for cartoon, there was no significant difference in satiation ratings between block 1 and block 2, between block 1 and block 3, and between block 2 and block 3.

For Experiments 5 and 6, each of which had only two blocks of trials, satiation ratings as a function of two blocks of trials were analyzed. Figure 5c shows the means for the satiation ratings for free-choice trials 1-5 and 6-10 (i.e., block 1 and 2) for each reinforcer. A  $2 \times 2$  repeated-measures ANOVA was conducted, with satiation ratings for the two different reinforcers in the two blocks as the dependent variable. There was a main effect of reinforcer,  $F(1, 17)=16.056$ ,  $p=0.001$ ,  $\eta^2=0.486$ . There was a main effect of block,  $F(1, 17)=9.435$ ,  $p=0.007$ ,  $\eta^2=0.357$ . There was a significant interaction between reinforcer and block,  $F(1, 17)=22.884$ ,  $p=0.000$ ,  $\eta^2=0.574$ . Post-hoc tests revealed no significant difference between satiation ratings for juice and satiation ratings for cartoon in block 1, but there was a significant difference between the two reinforcers in block 2,  $t(17)=4.708$ ,  $p=0.000$ ,  $d=1.455$ . For juice, there was a significant difference in satiation ratings between block 1 and block 2,  $t(17)=4.369$ ,  $p=0.000$ ,  $d=0.989$ . But for cartoon, there was no significant difference in proportion of self-control between block 1 and block 2.

## Discussion

The purpose of the present series of experiments was to compare proportion of self-control in adult human females between two qualitatively different consumable reinforcers, food (i.e., juice) and video entertainment (i.e., video cartoon). Self-control for juice was measured with an apparatus used in previous experiments (e.g., Forzano et al. 2010; Forzano and Corry 1998). Self-control for video cartoon was measured using a new computerized operant conditioning methodology (i.e., SC Video Software; Forzano and Schunk 2008) that mimicked the juice apparatus in its appearance and procedure. Participants made choices for juice in three sessions, and for video in three separate sessions in a within-subjects design.

Overall, across the different experimental parameters, a significant difference was found between self-control proportions (i.e., ratio of choices made for the larger, but delayed reinforcer, to the total number of trials) for juice versus video cartoon, with lower self-control proportions for juice than for video cartoon. This finding is consistent with research conducted by Charlton and Fantino (2008), in which it was found that food was discounted more quickly than DVDs. In the model proposed by Charlton and Fantino, the characteristics that make these reinforcers dissimilar are metabolic function, perishability, and satiability. In the case of our current findings, juice and video cartoons also vary on these three dimensions. The current finding also supports the explanation proposed in other experiments that participants are more impulsive for food because of physiological cephalic phase reflexes (Forzano and Logue 1992, 1994; Logue and King 1991). At first glance, the current findings appear to be in contrast to Odum and Rainaud's (2003) results of no differences found between primary reinforcers. The inconsistency in reinforcer effect could be accounted for by a difference in the primary reinforcers used in the former and current experiments. Odum and Rainaud used food and alcohol as their primary reinforcers. These reinforcers do not vary in metabolic function, perishability, and satiability in the same way as the current reinforcers of juice and video cartoon do.

For juice as a reinforcer, the present results of self-control decreasing during the session and co-occurring juice ratings decreasing during the session are consistent with research findings demonstrating that self-control varies with individual preference for the reinforcer (Forzano and Logue 1995; Forzano et al. 1997). Both adults and children have been found to demonstrate more self-control with more preferred reinforcers than with less preferred reinforcers. For juice as a reinforcer, the present results of significantly lower levels of self-control for juice by block as the trials progressed and the participants reporting feeling more satiated for juice on the

Satiation Questionnaire, replicate the findings of Forzano et al. (2010) and Kirk and Logue (1997). It has been demonstrated in previous experiments (Forzano et al. 2010; Kirk and Logue 1997) that self-control decreases with satiation level. That is, as the participant becomes satiated, they make more impulsive choices. The present experiment supports these findings in that self-control decreases as participants drink juice and report becoming satiated. Likewise, self-control did *not* decrease as participants continued to watch video cartoon and report that they still very much wanted to watch the cartoon (i.e., they were *not* satiated).

An alternative, and perhaps better explanation of the above findings, is to consider them within the context of habituation. As pointed out by McSweeney (see e.g., McSweeney 2004), for within-session changes in operant responding produced by systematic changes in the effectiveness of the reinforcer, satiation is not the only description for these changes. Satiation is commonly defined as the cessation of ingestive behavior, and habituation is commonly defined as a decrease in the responsiveness to a stimulus that is presented repeatedly (see McSweeney 2004 for discussion and comparison). In the case of the current data, habituation theory better predicts the differences we document between the reinforcers. For example, habituation theory would predict that for juice reinforcers, because of the repeated presentation of identical reinforcers (i.e., same juice each trial), a decrease in responding would occur. In this experiment, a decrease in responding may be reflected by a change in responding from the larger-later reinforcer to the smaller-sooner reinforcer. Because of the nature of the video cartoon reinforcer (i.e., it being a continuous progression of the show), the reinforcer is not *identical* from trial to trial, and hence habituation theory would predict no change in responding, as was the case with the current results. In contrast, within the context of satiation, it is expected that there should have been a change in responding for both reinforcers, which was not demonstrated. Future research could examine possible habituation effects, by asking participants not only to rate their desire for the juice, as was done in the current experiments, but to rate the sensory qualities of the reinforcer.

To further assess the utility of this new methodology (i.e., the use of the SC Video Software), additional experimentation varying reinforcer amount and delay could be conducted. Although Experiments 1 and 3 used different amounts and Experiments 6 used different delays, within-subject comparisons using different delay values to assess the effect of delay of reinforcement with constant amount values is warranted [see for example, Logue et al. (1986) for comparison], as discounting models predict greater self-control when delay is shorter (Green et al. 1994; Rachlin et al. 1991). In addition, within-subject comparisons using different amount values are warranted as well, as Jimura et al. (2009) found discounting of larger

delayed rewards less steeply than smaller ones with a directly consumable liquid reinforcer.

The SC Video Software developed for this series of experiments can be used to further explore various types of reinforcer characteristics. With modifications to the software, reinforcers, such as video games, viewing celebrities, listening to music, reading a book, and viewing artwork can be delivered immediately during the experiment. The software can also be used in the study of reinforcers that are received after an exchange delay (i.e., money and food items). This computer application is easier to implement in starting up an operant conditioning laboratory, compared to building a traditional operant conditioning apparatus for humans. The computer application is also portable, making it easier to potentially collect data outside of the lab, and it is flexible in use for both adults and children.

## Appendix A

### Instructions for Participants

#### *Juice Sessions*

Please read carefully. Do not ask for additional information concerning what you are about to do. The task is to earn access to the liquid food dispenser. You may touch anything on this panel to earn access. The session will begin when one or more lights become lit and it will end when all the lights are off. To minimize interference with the equipment, please leave all metal objects (jewelry, watches, etc.) with the experimenter for the duration of the session. All other personal property (coats, books, writing utensils, etc.) should also be left with the experimenter. These materials will be returned promptly at the session's end.

#### *Video Cartoon Sessions*

Please read carefully. Do not ask for additional information concerning what you are about to do. The task is to earn access to cartoons. After you click on Start, you may click on anything on the screen to earn access. The program will notify you when the session is complete with a message "You have finished." Please exit the room at this time. To minimize interference with the equipment, please leave all metal objects (jewelry, watches, etc.) with the experimenter for the duration of the session. All other personal property (coats, books, writing utensils, etc.) should also be left with the experimenter. These materials will be returned promptly at the session's end.

## Appendix B

### Final Study Questionnaire

Please answer the following questions by circling a number. Notes are optional.

1. How did you feel about the overall length of the juice sessions?

Too short					Just right				Too long
1	2	3	4	5	6	7	8	9	

2. How did you feel about the overall length of the video cartoon sessions?

Too short					Just right				Too long
1	2	3	4	5	6	7	8	9	

3. How did you feel about the amount of juice you got each time the straw came out?

Not enough					Just right				More than enough
1	2	3	4	5	6	7	8	9	

4. How did you feel about the amount of the cartoon you got to watch each time it came on?

Not enough					Just right				More than enough
1	2	3	4	5	6	7	8	9	

5. How much do you like juice when you are hungry?

Not at all					Somewhat				Very Much
1	2	3	4	5	6	7	8	9	

6. How much do you like to watch this cartoon when you are in the mood for entertainment?

Not at all					Somewhat				Very Much
1	2	3	4	5	6	7	8	9	

7. Thinking about the times when the straw came out and you got MORE juice, how much more did you like that than when you got LESS juice?

No better					Somewhat				A Lot Better
1	2	3	4	5	6	7	8	9	

8. Thinking about the times when the cartoon came on and you got a LONG cartoon segment, how much more did you like that than when you got a SHORT cartoon segment?

No better					Somewhat				A Lot Better
1	2	3	4	5	6	7	8	9	

9. Thinking about the video you watched, how satisfied were you with the total amount of the episode you were able to watch?

Unsatisfied					Somewhat satisfied				Very satisfied
1	2	3	4	5	6	7	8	9	

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