



Increasing water intake and walking with a self-management intervention using negative and positive reinforcement

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Abstract

Introduction: This study compared the effectiveness of different types of reinforcement (positive, negative, and a combination of both) in a self-management intervention program designed to increase water intake and walking.

Methods: Four university students participated in a self-management program to increase water intake and walking. Multiple baseline design across behaviors that included baseline (A) condition, positive reinforcement (B) condition, negative reinforcement (C) condition, and combination of both (B + C), was introduced. The participants received \$2 every day they met the criteria during the positive reinforcement condition and no consequence if they failed to meet the criteria. In the negative reinforcement condition, \$2 was subtracted for each day that the participant did not meet the criteria from the total amount of money available to the participant during that phase of the study. During the condition with positive and negative reinforcement, the participants received \$2 every day they met the criteria. However, \$2 was subtracted from the total for every day they did not meet the criteria.

Results: There was a clear increase from baseline to the first intervention phase across all the behaviors and participants, and the increase was maintained throughout the study. There were no differences in the effectiveness of different types of reinforcement applied in self-management intervention programs.

Conclusions: The study did show that implementing a relatively low-cost reinforcement contingency increased both exercise and water drinking. The results suggest that there are no consistent differences in the effectiveness of positive or negative reinforcement contingencies in self-management intervention.

Key words: positive reinforcement, self-management, negative reinforcement.

INTRODUCTION

The skill of controlling one's behavior is a crucial component of an individual's life. B.F. Skinner [1] recognized the importance of self-control of behavior as a method for personal development throughout the lifespan. Later, the term self-management was introduced, which is now more widely in use, and is considered "a practice of techniques of self-control" [2].

Self-management/control is a broad area of research that includes many approaches and techniques such as self-instructing, self-monitoring, self-recording, self-reinforcing/punishing to name just a few [3-11].

In self-management interventions, reinforcement is provided by an external agent. It requires another person as an additional component and thus increases the costs

and dependence of the intervention. It is more reliable and likely a more effective procedure since there is no reliance on the individual's usually poor self-control. A literature search did not find any studies that directly targeted the comparison of reinforcement methods in self-management procedures to evaluate their effectiveness. Despite that, reinforcement is a very common component of self-management studies, thus its evaluation seems to be crucial. However, there were attempts in behavior analytic literature to investigate different types of reinforcement (but not in a self-management context). DeLeon, Neidert, Anders and Rodriguez-Catter [12] compared positive and negative reinforcement in the treatment of escape-maintained behaviors. They applied different types of reinforcement to increase the compliance of the child with autism and to reduce her prob-

lem behaviors. The results showed that, overall, positive reinforcement was more effective than negative. However, along with an increase in task requirements and possible choice between reinforcements, the effects and selection pattern became unstable (i.e., the participants chose negative reinforcement more often in comparison to the previous preference for positive reinforcement). Boussein, Roane, and Harper [13] investigated not only the effectiveness of different types of reinforcement but also their combination. A boy diagnosed with Down syndrome was exposed to positive or negative reinforcement or both, contingent on compliance. In this study, the data suggested that a combination of positive and negative reinforcement was the most effective.

Thus, the techniques used in self-management are based on both negative reinforcement [14] and positive reinforcement [15]. However, there is no empirical evidence regarding what type of reinforcement is more effective in self-control practices. Some theoretical papers suggest that even the distinction between positive and negative reinforcement could be unnecessary [16]. The goals of this study are twofold; first, to empirically verify the effectiveness of a behavioral self-management program regarding health-promoting activities using modern technology, and second, to determine if positive reinforcement, negative reinforcement, or a combination of both is most effective.

The target behaviors were walking and drinking water. They were chosen for their overall health-promoting nature. The Centers for Disease Control and Prevention [17] recommends at least 150 minutes of moderate-intensity physical activity or 75 minutes of vigorous intensity physical activity per week to lose weight or, at least, maintain a healthy weight. Besides physical activity, drinking water regularly throughout the day might increase weight loss and facilitate the maintenance of a healthy weight [18].

METHODS

Participants

The participants in this study were four California State University, Stanislaus students. The experimenter recruited two males and two females between 19 to 21 years old based on their willingness and availability to conduct a self-management procedure. Before collecting baseline data, all the participants reported drinking no more than two cups of water per day. All of them had access to a smartphone and the internet to collect self-recording data and forward the data to the researcher. Participants with prior knowledge of self-management were excluded from the study – this was assessed by interview. All the participants were treated according to the “Ethical Principles of Psychologists and Code of Conduct” [19].

Apparatus and materials

A variety of smartphones with internet access were supplied by the participants. The participants downloaded two applications, one to collect data about walking behavior and the second to collect data regarding water consumption.

Design

The study applied a multiple baseline design across behaviors that included a baseline (A) condition, a positive reinforcement (B) condition, a negative reinforcement (C) condition, and a combination of both (B + C)¹. To counterbalance possible order effects, participants were placed in a randomly selected condition order. After the baseline, there was an equal chance for any participant to begin the intervention with any of the three possible conditions followed by the other conditions in a random order. The transition to the next condition took place after 7 days with an exception for the baseline condition and last intervention condition in water consumption. The former lasted for 4 days and the latter lasted for 10 days to satisfy the control requirements of multiple baseline designs.

Procedure

The participants had an initial 45-minute training session with the researcher. The training session provided an overview of the study requirements and prepared the participants for the self-recording phase of the study. The training session included a general discussion about the purpose of the study, lessons on self-management, and the techniques that were to be implemented. Then, participants were instructed to download the applications and the researcher taught them how to use them. To assure valid data collection of water consumption, the researcher provided each participant with a water bottle with volume markings. Instructions about self-recording and the method of reinforcement for participants were provided.

The researcher informed the participants they would receive \$2 every day they met the criteria during the positive reinforcement condition and no consequence if they failed to meet the criteria during that condition. In the negative reinforcement condition, \$2 was subtracted for each day that the participant did not meet the criteria from the total amount of money available to the participant during that phase of the study. During the condition with positive and negative reinforcement, the partici-

¹ For detailed information on the methodology used, please refer to the following sources: Cooper JO, Heron TE, Heward WL (2019). *Applied Behavior Analysis* (3rd edition). Hoboken, NJ: Pearson Education; Ledford JR, Gast DL (eds.) (2018). *Single Case Research Methodology: Applications in Special Education and Behavioral Sciences* (3rd ed.). Routledge. <https://doi.org/10.4324/9781315150666>.

pants received \$2 every day they met the criteria. However, \$2 was subtracted from the total for every day they did not meet the criteria.

The total amount of reinforcement available to each participant was \$52 per behavior (\$58 for one behavior because of the three additional days in the last condition to satisfy the multiple baseline design requirements). The total amount included \$14 (\$20 in the last condition of one of the behaviors) available in each condition calculated by multiplying the number of days in the condition by \$2 and a \$10 incentive for participation and

consistent self-recording. See Table 1 for a summary of the monies available and the contingencies involved for each condition.

Participants were asked to send the researcher e-mail messages every day with screenshots from their phones showing current data for each behavior. This included the total number of steps and the total amount of water intake. The participants were also asked to self-evaluate by reporting if they met the criteria and whether they should receive reinforcement or avoid a loss. To provide immediate contact with the reinforcement contingency,

Table 1. Intervention contingency overview

Condition		Total money	Contingency stated
Positive reinforcement	7 (10)	\$14 (\$20)	Each day the goal is met, you will earn \$2 of the \$14 (\$20) available.
Negative reinforcement	7 (10)	\$14 (\$20)	Each day the goal is not met, you will lose \$2 from the pool of the \$14 (\$20) available.
Positive and negative reinforcement	7 (10)	\$14 (\$20)	Each day the goal is met, you will earn \$2 of the \$14 (\$20) available and each day the goal is not met, you will lose \$2 of the \$14 (\$20) available.
Self-recording – participation	28	\$10	You will get additional \$10 for providing self-recording data every day throughout the study.

Table 2. Feedback on daily gain or loss

Condition	Walking	Water intake
Positive reinforcement		
Criteria was met	Congratulations! Today, you did: XX steps You earned: \$2 You've accumulated: \$XX Days to go in this phase: X	Congratulations! Today, you drank: XX oz. You earned: \$2 You've accumulated: \$XX Days to go in this phase: X
Criteria was not met	Sorry. Today, you only did: XX steps You earned: \$0 You've accumulated: \$XX Days to go in this phase: X	Sorry. Today, you only drank: XX oz. You earned: \$0 You've accumulated: \$XX Days to go in this phase: X
Negative reinforcement		
Criteria was met	Congratulations! Today, you did: XX steps You didn't lose: \$2 You've accumulated: \$XX Days to go in this phase: X	Congratulations! Today, you drank: XX oz. You didn't lose: \$2 You've accumulated: \$XX Days to go in this phase: X
Criteria was not met	Sorry. Today, you only did: XX steps You lost: \$2 You've accumulated: \$XX Days to go in this phase: X	Sorry. Today, you only drank: XX oz. You lost: \$2 You've accumulated: \$XX Days to go in this phase: X
Positive and negative reinforcement		
Criteria was met	Congratulations! Today, you did: XX steps You earned: \$2 You've accumulated: \$XX Days to go in this phase: X	Congratulations! Today, you drank: XX oz. You earned: \$2 You've accumulated: \$XX Days to go in this phase: X
Criteria was not met	Sorry. Today, you only did: XX steps You lost: \$2 You've accumulated: \$XX Days to go in this phase: X	Sorry. Today, you only drank: XX oz. You lost: \$2 You've accumulated: \$XX Days to go in this phase: X

the researcher provided daily feedback about participants' achievements and the accumulated money for each phase (see Table 2 for a summary).

After each week, the researcher totaled the amount of obtained reinforcement, met with participants to deliver the money, and provide information on the next actions. Following the discussion about the procedures and reinforcement, the participants were encouraged to ask questions and express concerns. After all questions and concerns were addressed, the participants signed the informed consent. They were asked to immediately inform the researcher about any health problems during the study and were given the contact information for the university Student Health Center. Participants were then assigned to a unique random order of conditions. Finally, they were asked to start collecting daily baseline data until the researcher contacted them with further instructions.

Subsequent meetings were provided individually for each participant based on the collected data to change the condition at the appropriate time to meet the requirements of the multiple baseline design. After the first training session, the researcher met with each participant a total of seven times, once after each phase for each behavior (three phases with two behaviors each) and once after the study to summarize the results, provide incentives, collect the data on weight and conduct a debriefing process.

The daily criteria for walking took into consideration The Centers for Disease Control and Prevention [17] suggested amount of physical activity per week. However, the actual criteria were established using baseline data to ensure an appropriate level of difficulty without unnecessary risk and effort to reveal potential differences between reinforcements. These criteria were established by calculating the average of four days with the highest number of steps during baseline and increasing it by 50%.

The daily water intake criteria considered the WHO [20] recommendations. However, because the minimal participants' water intake prior to the study did not match the recommendations, the criteria were determined by increasing the average of two days with the highest water intake by 50%.

The criteria levels for both behaviors were kept constant throughout the study. Since the objective of this study was to compare the effectiveness of different types of reinforcement, emphasis was placed on consistency (i.e., performing the behavior every day at a particular level). The criteria were relatively easy to achieve, but enough of a challenge to reveal any differences among the reinforcing contingencies during conditions.

Before conducting this research, the participant selection criteria, informed consent document, and methodology were approved by the Psychology Institutional Review Board at California State University Stanislaus.

RESULTS

The data from the four participants are presented in Figure I.

The visual analysis of data² indicates a clear distinction in the dependent variables between the baseline and experimental phases. There was a clear increase from baseline to the first intervention phase across all the behaviors and participants, and the increase was maintained throughout the study.

Regarding water consumption, each participant met the criteria across the entire intervention. Only 1 participant was able to meet the criteria every day for walking behavior and the other three participants failed to meet the criteria 2 to 3 times during the intervention phases. There were days when the total number of steps exceeded the criterion. The participants reported that all unusual performance was due to common events such as a day off work or a trip to another city. In general, we observed more variability in walking compared to water intake. This makes sense considering the nature of both behaviors. Drinking water is possible almost at any time, while walking requires more time to perform and interfered with participants' other activities.

DISCUSSION

For all the participants, there is a fairly large increase in walking and water consumption from baseline to intervention. This suggests that the contingencies established good control over both behaviors. A visual analysis of the data does not reveal any significant differences in the effectiveness of the different types of reinforcement since the change is maintained across all of the conditions. These results are different from the previous findings of DeLeon *et al.* [12] and Bouxsein *et al.* [13]. They found that, at least regarding compliance, positive reinforcement is more effective than negative reinforcement but the combination of both is the most effective approach. There are several possible reasons for these discrepancies.

Firstly, it should be noted that DeLeon *et al.* [12] as well as Bouxsein *et al.* [13] attempted to decrease escape-maintained behaviors by increasing compliance to demand. This is important because any positive reinforcement such as access to tangibles was by default more reinforcing than negative reinforcement since it also included a break from the demand necessary for the delivery of reinforcement and time to eat the edibles and listen to music. In the current study, the amount of reinforcement (\$2) and hence its value was the same for all the condi-

² For detailed information on the visual analysis used, please refer to the Ledford JR, Gast DL (eds.). (2018). *Single Case Research Methodology: Applications in Special Education and Behavioral Sciences* (3rd ed.). Routledge. <https://doi.org/10.4324/9781315150666>

Increasing water intake and walking with a self-management intervention using negative and positive reinforcement

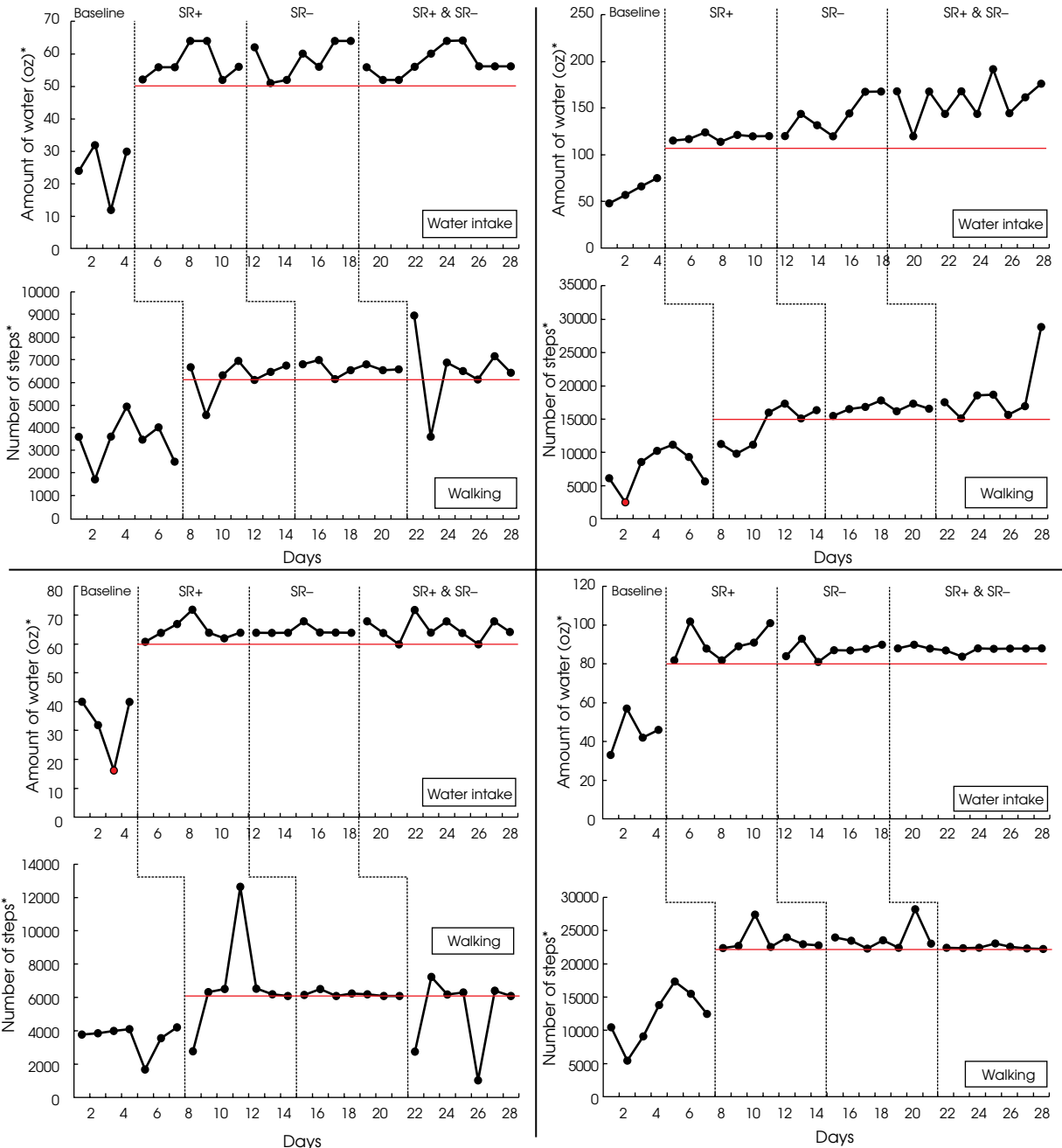


Figure 1. The data from the four participants. For each participant, there is a separate panel with water intake presented in the upper part of the panel, and walking presented in the lower part of the panel. SR+ is a positive reinforcement, SR- is a negative reinforcement, SR+ & SR- is a combination of both. The red line indicates the individual criteria for each participant. *Notice the differences in scales dependent on the type of behavior and participant.

tions. Thus, one explanation could be that the differences in reinforcement effectiveness in DeLeon *et al.* [12] and Boussein *et al.* [13] studies were not a result of the different nature of positive and negative reinforcement but, rather, the difference in the value of the reinforcers.

On the other hand, a part of the current data seems to be consistent with previous findings [12, 13]. For 2 out of 4 participants, the data show that the behavior

in the negative reinforcement phase was stable, usually just above the daily criteria. Positive reinforcement and a combination of positive and negative reinforcement conditions produced more variability in data. Participants were more likely to not only meet the criteria but also exceed them by a fair amount. However, the interesting issue was that these two participants (numbers 2 and 4) were men, and considering the other two, who

were women (numbers 1 and 3) the situation is almost the opposite. They were more likely to exceed the criteria in the negative reinforcement condition alone than in conditions that included positive reinforcement. However, no general assumptions should be made in this regard based on that data because the number of participants is small and represents specific population.

The sampled population itself may have contributed to the obtained data. It is possible that university students respond differently to negative reinforcement due to the history of aversive control (for instance deadlines, exams, presentations, etc.) resulting in similar changes across different reinforcement phases. If that is accurate, this data is consistent with the behavior analysis view of the history of reinforcement and its influence on future behavior.

There are also some considerations regarding the independent variable. It is possible that the value of reinforcement was either too low or too high to reveal differences. Simultaneously, the same applies that the criteria were at a level that prevented observing potential differences. Because of a lack of supporting literature, both the value of reinforcement and criteria were determined arbitrarily. These issues should be considered in the design of future studies. In addition to the reinforcement values, another consideration is the effort necessary to meet the criteria. This factor could have influenced the data. The amount of effort required to meet the criteria should be addressed in the future.

In this study, we used modern technology (smartphones with an internet connection) to collect data. This kept the intervention as close as possible to natural settings to ensure better external validity. Although this approach seems promising for future studies it should be used with caution. There was no objective control over the accuracy of the participants' reporting of the dependent variables. It would be beneficial for future research to use a more direct measure of those variables. Perhaps a change in target behavior or the use of more sophisticated technology could eliminate that issue because it is currently impossible to measure water intake easily and directly. Keeping track of walking is relatively easier (pedometers) however, there are several ways for participants to cheat.

Another consideration when analyzing this data is the period each phase lasted. It may be beneficial to extend the period after each condition to observe possible changes in data or additional side effects of a particular type of reinforcement. All the participants also reported a learning effect throughout the study thus, it is another issue that could be addressed in future studies. However, it seems reasonable to claim that procedural change in condition order somewhat counterbalanced the effect across participants.

CONCLUSIONS

The distinction between positive and negative reinforcement and the question as to which intervention is more effective in behavior change procedures is a long-standing topic of discussion. In 1975, Jack Michael [16] proposed that the distinction between positive and negative reinforcement is unnecessary. In 2005, 30 years after Michael's paper, Baron and Galizio [21] reiterated the call that the distinction should be abandoned. Their paper sparked a discussion among the most prominent behavior analysts and resulted in a series of papers devoted to the topic in *The Behavior Analyst* in 2006. In their response to those various commentaries, Baron and Galizio [22] write that "perhaps further analysis will lend support to a continued distinction between positive and negative reinforcement, but in the meantime, we continue to wonder whether the distinction does more harm than good". The authors refer to the societal implications of the results of basic science. One of the reasons for retaining the distinction that was considered and rejected by Michael [16] was that the distinction could be used to make applied behavior analysts more aware of the "undesirable" aspects of negative reinforcement. Similarly, in 2017 Magoon *et al.* [23] write that extrapolation of early experimental work "offered an extensive commentary on the purported dangers of applying aversive control in the everyday world, and it has become de rigeur for applied behavior analysis textbooks". The authors address in their empirical work the fundamental question of whether the two processes indeed differ. The conclusion is that positive and negative reinforcement may not control behavior differently. However, their results are only one investigation in the stagnant and incomplete literature addressing aversive control. Thus, the authors urge against making statements about technology of behavior change based on incomplete basic research literature. In the light of the above-mentioned publications, we believe that our study provides data regarding two ways to increase health-related behaviors, without the possibility or the interest in making recommendation which one is better or whether there are indeed two different processes at work.

In conclusion, despite previous research that suggested differences in the effectiveness of different types of reinforcement, the current study does not support those findings. The data obtained in this research shows no large differences between different reinforcement contingencies. However, the study did show that implementing a relatively low-cost reinforcement contingency did seem to increase both exercise and water drinking. Further research may be able to clarify the best type of reinforcement system, as well as maximize the behavioral change.

Conflict of interest

Absent.

Financial support

Absent.

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